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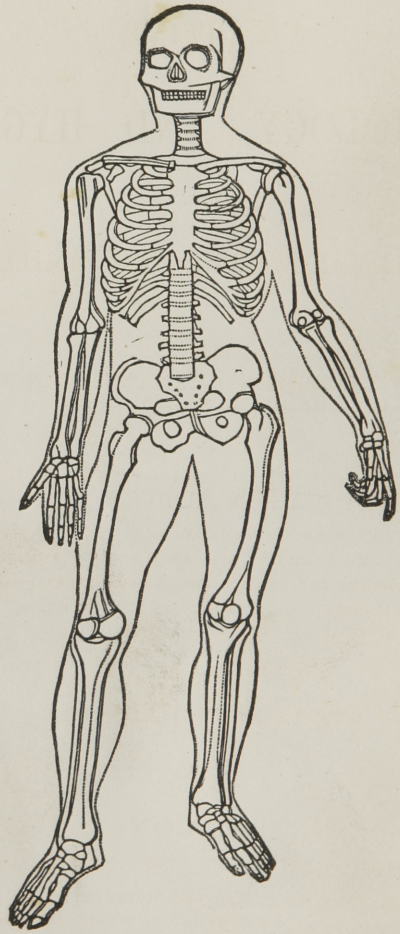

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FIRST BOOK

ON

ANATOMY, PHYSIOLOGY, AND HYGIENE,

FOR

GRAMMAR SCHOOLS AND FAMILIES.

WITH EIGHTY-THREE ENGRAVINGS.

BY CALVIN CUTTER, M. D.

AUTHOR OF "ANATOMY, PHYSIOLOGY, AND HYGIENE, FOR COLLEGES, ACADEMIES, AND FAMILIES;" "SECOND BOOK ON ANATOMY, PHYSIOLOGY, AND HYGIENE, FOR ACADEMIES, SCHOOLS, AND FAMILIES;" "ANATOMICAL OUTLINE PLATES FOR SCHOOLS," &c.

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PREFACE.

In presenting this work to the public, the author would indulge in a few prefatory suggestions.

Education, to be complete, must be not only moral and intellectual, but physical. As the culture of the mind and of the affections is the subject of systematic attention in early life, should not the education of the physical powers be commenced as early? It will demand no more maturity and thought to understand the reasons for adequate clothing, bathing, the necessity of an erect position in standing and sitting, regularity in taking food, the supply of pure air to the lungs, &c., than to comprehend geographical details or moral truths. Is not a knowledge of the laws upon which health depends, as important to the development of a vigorous physical constitution, as moral instruction is to the formation of correct moral principles? Can any reason be given why both should not be taught in the school-room?

A child should be taught to call each organ by its correct name. No more effort is required to learn the meaning of a *proper*, than an improper term. For example: a child will pronounce the word as readily, and obtain as correct an idea, if you say *lungs*, as if you used the word *lights*.

In preparing this work, it has not been deemed necessary to use low, vulgar terms, for the purpose of being understood; but such words have been selected

as good usage sanctions. Should the pupil meet with any word he does not understand, let him consult his dictionary, as he should do in perusing works upon history, when a similar difficulty occurs.

To insure a correct pronunciation of the technical words interspersed with the text, they have been divided into syllables, and the accented syllables designated. An ample Glossary of technical terms has aiso been appended to the work, to which reference should be made.

To the teacher we would suggest the propriety of calling on a pupil of the class, to describe the anatomy of an organ from an anatomical outline plate; afterwards call upon another to give the physiology of the part, while a third may state the hygiene; after which, the questions at the bottom of the page may be asked promiscuously, and thus the detailed knowledge which each pupil possesses of the subject will be tested.

With advanced pupils, it is recommended that the subject be examined in the form of *topics*. The questions in *Italics* are designed for this method of recitation.

For a more full and complete explanation of Anatomy, Physiology, and Hygiene, the pupil is referred to the Author's treatise, of 450 pages, for Colleges, Academies, and Families, or to his second book, of 300 pages, for Academies, Schools, and Families.

To the instructors of youth, and the patrons of education, this work is respectfully submitted.

BOSTON, *October*, 1848.

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FIRST BOOK

ON

ANATOMY, PHYSIOLOGY, AND HYGIENE.

CHAPTER I.

GENERAL REMARKS.

1. ANATOMY is a description of the *organs*, or parts of a body.

Examples. 1st. Flowers have roots, stems, and blossoms. These are their organs. 2d. The teeth, stomach, and heart, are some of the organs of the human body.*

2. PHYSIOLOGY is a description of the *function*, or use of an organ.

Examples. 1st. The roots of flowers suck up water, to make them grow. This is their function. 2d. The stomach, in man, is one of the organs that prepare the food for his growth. This is its function.

3. Anatomy and Physiology are divided into two kinds, namely, *Animal* and *Vegetable*.

---

* Where examples are given, let the pupil mention other analogous ones.

---

1. What is anatomy? Give examples. 2. What is physiology? Give examples. 3. How many kinds of anatomy and physiology are there?

4. Animal Anatomy and Physiology are again divided into *Human* and *Comparative*.

5. Human Anatomy and Physiology describe the structure and functions of the organs of *man*.

6. Comparative Anatomy and Physiology describe the structure and functions of the organs of *other animals* than man.

Examples. As the horse, the monkey, and the whale.

7. Vegetable Anatomy and Physiology describe the structure and functions of different parts of trees, shrubs, plants, and flowers.

8. HYGIENE is the art of preserving health, or that department of medicine which treats of the preservation of health.

9. All bodies in nature are divided into *Organic* and *Inorganic*. Organic bodies include animals and plants. Inorganic bodies include earths, metals, and other minerals.

10. All organized bodies have a limited period of life, and this period varies with every species. The duration of some plants is limited to a single summer, as many garden flowers; while some trees, as the olive, live many hundred years. Some animals live but a short time, while the elephant lives more than a century.

11. The life of man is shortened by disease; but disease is under the control of fixed laws — laws which we are capable of understanding and obeying. How important, then, is the study of physiology and hygiene! For how can we expect to obey laws which we do not understand?

---

4. How are animal anatomy and physiology divided? 5. What do human anatomy and physiology describe? 6. What do comparative anatomy and physiology describe? 7. What do vegetable anatomy and physiology describe? 8. What is hygiene? 9. How are all bodies in nature divided? What bodies are called organic? What bodies are called inorganic? 10. Have all animals and plants a limited period of life? Does this period vary with different species of animals and plants? Give some examples. 11. How is life usually shortened? Why is the study of physiology and hygiene important to every person?

CHAPTER II.

THE BONES.

12. THE bones are firm and hard, and of a dull white color. In all the higher orders of animals, among which is man, they are in the interior of the body, while in lobsters, crabs, &c., they are on the outside, forming a case, which protects the movable parts from injury.

ANATOMY OF THE BONES.

13. There are two hundred and eight * bones in the human body, beside the teeth.

14. These, for convenience, are divided into four parts: 1st. The bones of the *Head.* 2d. The bones of the *Trunk.* 3d. The bones of the *Upper Extremities.* 4th. The bones of the *Lower Extremities.*

15. The bones of the HEAD are divided into those of the *Skull*, *Ear*, and *Face.*

16. The SKULL is formed of eight bones. These are joined together by ragged edges, called *sut'ures.* (Fig. 2.)

Observation. The sutures stop, in a measure, the jars caused by external blows. Children should never strike each

---

* Some anatomists reckon more than this number, others less, for the reason that, at different periods of life, the number of pieces of which one bone is formed, varies. *Example.* The breast-bone, in infancy, has *eight* pieces; in youth, *three;* in old age, but *one.*

---

12. Describe the bones. 13. How many bones in the human body? 14. How are they divided? Name them. 15—18. *Give the anatomy of the bones of the head.* 15. How are the bones of the head divided? 16. How many bones in the skull? How are the bones of the skull joined together?

other upon the head, because the bones of the skull in them are softer than in adults.

17. In each EAR are four small bones. They aid in hearing.

18. In the FACE are fourteen bones. They support the softer parts outside of them.

19. The TRUNK has fifty-four bones — twenty-four *Ribs;* twenty-four bones in the *Spi'nal Col'umn*, (back-bone;) four in the *Pel'vis;* the *Ster'num*, (breast-bone;) and one at the root of the tongue.

20. All the RIBS are joined to the spinal column. There are twelve on each side.

Fig. 2.

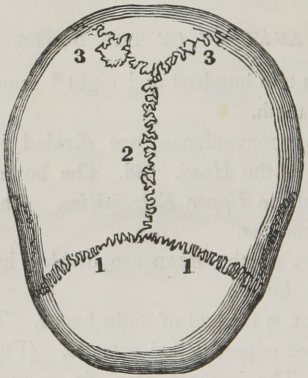

Fig. 2. The bones of the upper part of the skull. 1, 1, 2, 3, 3, The sutures that join the bones.

21. The seven upper ribs are united in front to the sternum, by a yielding substance called *car'ti-lage*,* (gristle.) The

* See paragraph 46.

17. What is the use of sutures? How many bones in each ear? What is their use? 18. How many bones in the face? 19 — 29. *Give the anatomy of the bones of the trunk.* 19. How many bones in the trunk? Name them. 20. To what are all the ribs joined? How many on each side? What does fig. 2 represent? 21. How are the first seven ribs united in front?

remaining five are not attached, directly, to the sternum. Three are joined to each other by cartilage; two are not confined; hence they are called "floating ribs."

22. The cavity formed by the sternum, ribs, and spinal column, is called the *Chest*. It contains the heart, lungs, and large blood-vessels.

23. The shape of the chest is conical, or like a sugar-loaf.

Fig. 3.

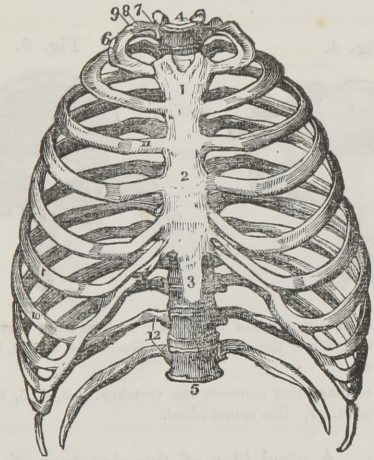

Fig. 3. The form of the chest. 1, 2, 3, The sternum, (breast-bone.) 4, 5, The spinal column, (back-bone.) 6, 7, 8, 9, The first rib. 10, The seventh rib. 11, The cartilage of the third rib. 12, The floating ribs.

Observation. The lower part of the chest is broader and fuller than the upper part, when it is not made smaller by tight clothing.

The next three? What are the last two called? Why? Describe fig. 3.

22. How is the chest formed? What does it contain? 23. What is the shape of the chest? How does the lower part of the chest compare in size with the upper?

24. The SPINAL* COLUMN is composed of twenty-four pieces of bone. Each piece is called a *vert'e-bra.*

25. Between the pieces, or vertebræ, is a thick piece of cartilage, which is elastic, or springs like India-rubber. This not only unites the vertebræ, but permits them to move in different ways.

26. There is an opening in each vertebra. By a union of these openings, a canal is formed the whole length of the spinal column, in which the *spinal cord* (pith of the back-bone) is placed.

Fig. 4.

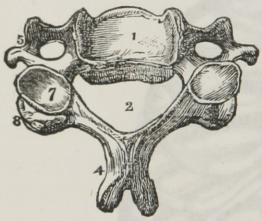

Fig. 5.

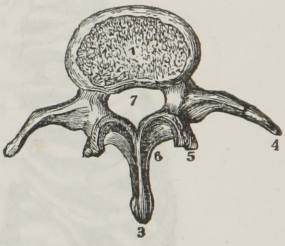

Fig. 4. The form of a vertebra of the neck. 1, The main portion of the bone. 2, The spinal canal, in which the spinal cord is placed. 4, 5, 7, 8, Points, or projections of the vertebra.

Fig. 5. 1, The cartilage that connects the vertebræ. 3, 4, 5, 6, Points, or projections of the vertebra. 7, The spinal canal.

Observation. A good idea of the structure of the vertebræ may be obtained, by examining the spinal column of a domestic animal, as the dog, cat, or pig.

---

* From the Latin *spi'na*, a thorn ; so called from the points of the vertebræ that are felt beneath the skin.

---

24. How many pieces of bone in the spinal column? What is each piece called? 25. What is placed between the vertebræ? Give its use. 26. How is the spinal canal formed, and what does it contain? Describe fig. 4. Describe fig. 5. How may an idea of the structure of the vertebræ be obtained?

27. The spinal column is a very curious and perfect piece of mechanical art. By its structure, great strength and sufficient movement or flexibility are combined. The vertebræ are so firmly joined together, that dislocation of them, without fracture, is very rare.

28. The PELVIS is composed of four bones. They are so arranged as to form a bony basin. The spinal column rests on these bones, and they also serve to support the lower extremities.

Fig. 6.

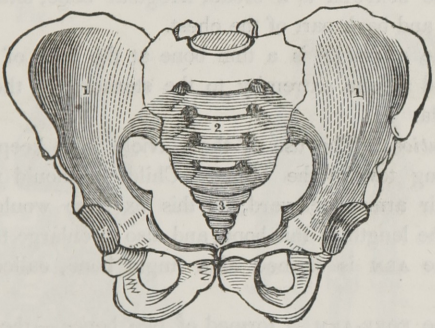

Fig. 6. 1, 1, The hip-bones. 2, The sacrum, upon which the spinal column rests. 3, The extremity of the spinal column, named the *coc'cyx*. 4, 4, The cavities for the head of the thigh-bone.

29. In the sides of these bones is a deep, round cavity, called *a-ce-tab'u-lum*, in which the head of the thigh-bone is placed.

---

27. What is said of the structure of the spinal column? 28. Of how many bones is the pelvis composed? What is their use? Describe fig. 6. 29. What is found in the sides of these bones?

CHAPTER III.

ANATOMY OF THE BONES, CONTINUED.

30. THE UPPER EXTREMITIES contain sixty-four bones — the *Scap'u-la*, (shoulder-blade;) the *Clav'i-cle*, (collar-bone;) and the bones of the *Arm*, *Fore-arm*, *Wrist*, and *Hand*.

31. The SCAPULA is a broad, irregular bone, situated upon the upper and back part of the chest.

32. The CLAVICLE is a thin bone at the base of the neck. It is joined at one extremity to the sternum, at the other to the scapula.

Observation. The use of the clavicle is to keep the arms from sliding toward the breast. Children should frequently throw their arms backward, as this exercise would tend to increase the length of this bone, and also to enlarge the chest.

33. The ARM is formed of a single bone, called the *hu'-mer-us*.

34. The FORE-ARM is formed of two bones — the *ul'na*, on the inner side, and the *ra'di-us*, on the outside, (the side on which the thumb is placed.) By a beautiful arrangement of these bones, the hand is made to *rotate*, or turn, permitting its complicated and varied movements.

35. The WRIST is formed of eight irregular bones. They move but little upon each other.

36. The HAND consists of nineteen bones — five in the palm, and fourteen bones in the fingers and thumb.

30—37. *Give the anatomy of the bones of the upper extremities.* 30. Name the bones of the upper extremities. 31. Describe the scapula. 32. Where is the clavicle situated? What is the use of the clavicle? 33. How is the arm formed? 34. The fore-arm? 35. How many bones in the wrist? 36. How many bones in the hand?

37. Each finger is formed of three bones of different lengths; the thumb has but two. Proofs of a designing Creator are nowhere more manifest than in the simple but wonderful structure and adaptation of the human hand.

38. The LOWER EXTREMITIES contain sixty bones—the *Fe'mur*, (thigh-bone;) the *Pa-tel'la*, (knee-pan;) the *Tib'i-a*, (shin-bone;) the *Fib'u-la*, (small bone of the leg;) and the bones of the *Foot*.

39. The FEMUR is the longest bone of the body. It supports the weight of the head, trunk, and upper extremities.

Fig. 7.

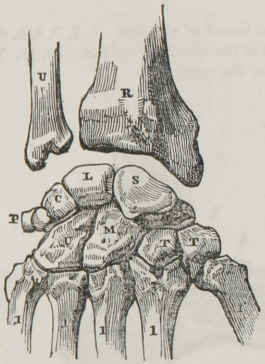

Fig. 8.

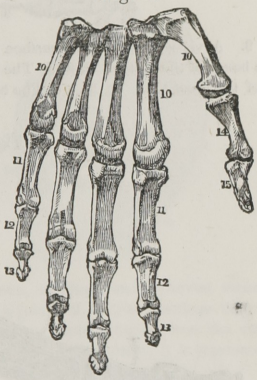

Fig. 7. U, The ulna. R, The radius. S, L, C, P, U, M, T, T, The eight bones of the wrist. 1, 1, 1, 1, 1, The five bones of the palm of the hand.

Fig. 8. 10, 10, 10, The bones of the palm of the hand. 11, 12, 13, The bones of the fingers. 14, 15, The bones of the thumb.

40. The TIBIA and the FIBULA are situated between the knee and ankle.

---

37. What is said of the bones of the fingers and thumb? 38—41. *Give the anatomy of the bones of the lower extremities.* 38. Name the bones of the lower extremities. 39. What is said of the femur? Describe fig. 7. Fig. 8. 40. What bones between the knee and ankle?

41. The FOOT is formed of twenty-six bones — seven in the instep; five in the middle of the foot; and fourteen toe-bones.

Observation. The bones of the foot are so united as to give it the form of an arch, — convex on its upper surface, and concave on the lower surface.

Fig. 9.

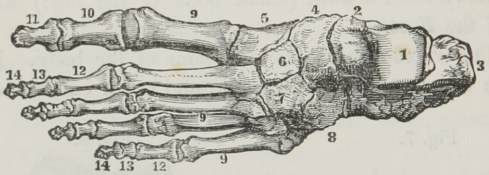

Fig. 9. A view of the upper surface of the bones of the foot. 1, 2, 3, 4, 5, 6, 7, 8, The bones of the instep. 9, 9, 9, The bones of the middle of the foot. 10, 11, The bones of the great toe. 12, 13, 14, The bones of the small toes.

Fig. 10.

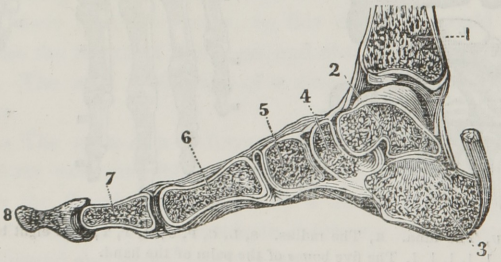

Fig. 10. A side view of the bones of the foot, showing its arched form. The arch rests upon the *heel* behind, and the *ball* of the toes in front. 1, The lower part of the tibia. 2, 3, 4, 5, Bones of the instep. 6, A bone of the middle of the foot. 7, 8, The bones of the great toe.

42. The bones consist of animal matter, (jelly,) and earthy matter, (phosphate and carbonate of lime.)

---

41. How many bones in the foot, and name them? What is the form of the foot? Describe fig. 9. Fig. 10. 42. Of what are the bones composed?

43. To show the animal without the earthy matter of the bones, immerse a slender bone for a few days in a weak acid, (one part muriatic acid and six parts water,) and it can then be bent in any direction.

44. To show the earthy without the animal matter, burn a bone in a clear fire for about fifteen minutes, and it becomes white and brittle.

45. The JOINTS form an interesting part of the body. They are composed of the extremities of two or more bones, *Car'ti-lages*, (gristles,) *Syn-o'vi-al* membrane, and *Lig'a-ments.*

Fig. 11.

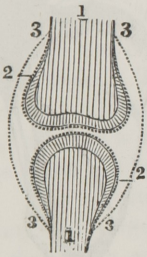

Fig. 12.

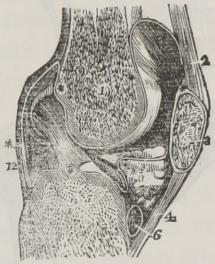

Fig. 11. The relative position of the bone, cartilage, and synovial membrane. 1, 1, The extremities of two bones, to form a joint. 2, 2, The cartilage that covers the end of the bone. 3, 3, 3, 3, The synovial membrane, which covers the cartilage of both bones, and is then doubled back from one to the other; it is represented by the dotted lines.

Fig. 12. A vertical section of the knee-joint. 1, The femur. 3, The patella. 5. The tibia. 2, 4, Ligaments of the patella. 6. Cartilage of the tibia. 12, The cartilage of the femur. * * * *, The synovial membrane.

46. CARTILAGE is a smooth, solid, elastic substance, that covers the ends of the bones that form a joint. It prevents the ends of the bones from wearing off, and also diminishes the jar that the joint receives, in walking or leaping.

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43. How can the animal matter be shown? 44. The earthy? 45—48. *Describe the parts that form a joint.* 45. What is said of the joints? Of what are they composed? What is represented by fig. 11? Fig. 12? 46. Define cartilage. What is its use?

47. The SYNOVIAL MEMBRANE is a thin, membranous layer, which covers the cartilages, and is thence bent back, or reflected upon the inner surfaces of the ligaments which surround and enter into the composition of the joints. This membrane forms a closed sac. (Fig. 11.)

48. The LIGAMENTS are strong, inelastic substances; they serve to connect and bind together the bones of the body.

Fig. 13.

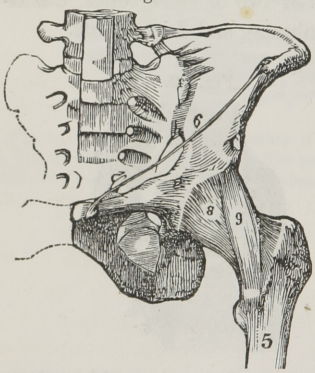

Fig. 14.

Fig. 13. 8, 9, The ligaments that extend from the hip-bone (6) to the thigh-bone, (5.)

Fig. 14. 2, 3, The ligaments that extend from the collar-bone (1) to the shoulder-blade, (4.) The ligaments 5, 6, extend from the shoulder-blade to the first bone of the arm.

Observation. The joints of the domestic animals, are similar in their construction to those of man. To illustrate this part of the body, a fresh joint of the calf or sheep may be used.

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47. Define synovial membrane. 48. What are ligaments? What is their use? What is represented by fig. 13? Fig. 14? How can the structure of the joints be illustrated?

CHAPTER IV.

PHYSIOLOGY OF THE BONES.

49. THE bones are the framework of the body. They support all the soft parts, as the flesh and vessels, and likewise afford a firm surface for the attachment of the ligaments.

50. The use of the various bones is different. Some protect organs, as those of the skull and chest, while others are used when we move, as those of the extremities and spinal column.

51. The bones are covered with a firm *mem'brane*, or skin, called *per-i-os'te-um.* This membrane and the bones, when healthy, give us but little pain if wounded; but, if diseased, as in "felons," the pain is very severe.

52. The joints are constantly supplied with a fluid called *syn-o'vi-a.* This operates like oil on the joints of a machine. By the smooth cartilages and synovia, the joints are enabled to bear all the motion required of them during a great number of years.

53. The joints vary in their functions. Some are movable, as the finger-joints; while others are immovable, as the sutures of the skull.

54. The union of the spinal column with the skull exhibits one of the most ingenious contrivances to be met with in the body. 1st. It permits the backward and forward movement, as in bowing and nodding the head. 2d. The motion which is made in turning the head from side to side.

49—51. *Give the physiology of the bones.* 49. What is the use of the bones? 50. Give the function of some of the bones. 51. With what are the bones covered? 52—56. *Give the physiology of the joints.* 52. With what are the joints constantly supplied? What is the use of this fluid and the cartilages? 53. Mention some of the functions of the joints. 54. What is said of the union of the spinal column with the skull?

55. This admirable piece of mechanism affords great protection to the spinal cord, at the top of the neck; this being, perhaps, the most vital portion of the whole body. Injury to it, or pressure upon it, is instantly fatal.

56. Some joints move but in one direction, like a hinge of a door. These are called *Hinge Joints;* as the ankle and the knee-joint. Some joints move in different directions, like a ball in a socket. These are called *Ball and Socket Joints;* as the shoulder and the hip-joint.

Fig. 15.

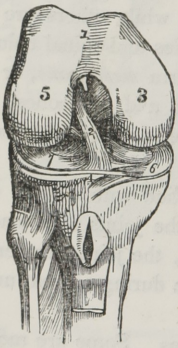

Fig. 16.

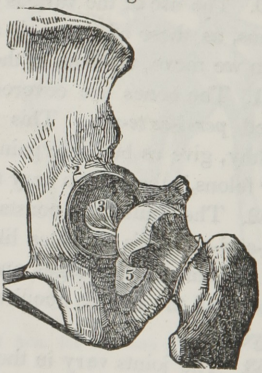

Fig. 15. The knee-joint. 1, The lower extremity of the thigh-bone. 3, 5, The two rounded extremities that rest upon the upper extremity of the tibia, (shin-bone.) 2, Two ligaments within the knee-joint. 6, 7, The cartilage that tips the upper extremity of the tibia, (4.)

Fig. 16. 2, The deep socket of the hip-joint. 5, The round head of the thigh-bone, which is lodged in the socket. 3, The ligament within the socket.

Observation. The more movable a joint, the less firm it is, and the more frequently dislocated, or "put out." It is for this reason that the shoulder-joint is more frequently displaced than any other in the body.

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55. What is protected by this admirable piece of mechanism? 56. What are hinge joints? What are ball and socket joints? Why is the shoulder-joint more frequently dislocated than any other in the body?

Fig. 17.

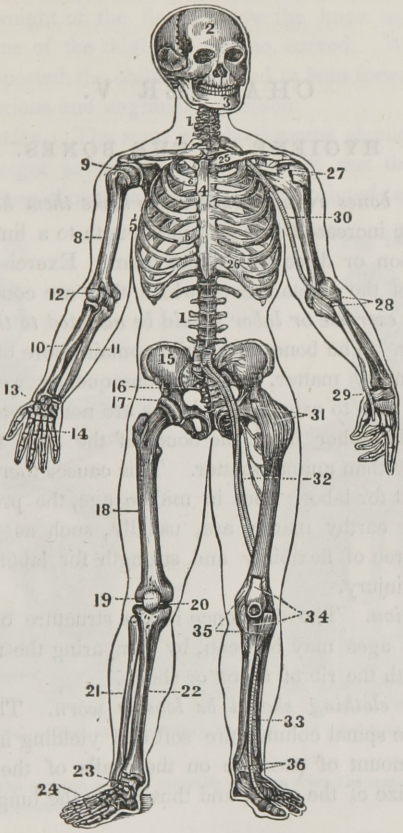

Fig. 17. 1, 1, The spinal column. 2, The skull. 3, The lower jaw. 4, The sternum. 5, The ribs. 6, 6, The cartilages of the ribs. 7, The clavicle. 8, The humerus. 9, The shoulder-joint. 10, The radius. 11, The ulna. 12, The elbow-joint. 13, The wrist. 14, The hand. 15, The haunch-bone. 16, The sacrum. 17, The hip-joint. 18, The thigh-bone. 19, The patella. 20, The knee-joint. 21, The fibula. 22, The tibia. 23, The ankle-joint. 24, The foot. 25, 26, The ligaments of the clavicle, sternum, and ribs. 27, 28, 29, The ligaments of the shoulder, elbow, and wrist. 30, The large artery of the arm. 31, The ligaments of the hip-joint. 32, The large blood-vessels of the thigh. 33, The artery of the leg. 34, 35, 36, The ligaments of the patella, knee, and ankle.

Note. Let the pupil, in form of topics, review the anatomy and physiology of the bones from fig. 17 or from anatomical outline plates 1 and 2.

CHAPTER V.

HYGIENE OF THE BONES.

57. *The bones require exercise to make them healthy.* By use they are increased in size and strength to a limited extent, while inaction or disease weakens them. Exercise favors the deposition of the substances of which they are composed.

58. *The exercise or labor should be adapted to the condition of the bones.* The bones of a child contain more of the animal than the earthy matter, and are consequently weak; though the child is able to exercise, its bones are not adapted to severe toil. On the other hand, the bones of the aged man contain more earthy than animal matter. This causes them to be brittle and unfit for labor. But in middle age, the proportions of animal and earthy matter are, usually, such as to give the proper degree of flexibility and strength for labor, with little liability to injury.

Observation. The difference in the structure of the bones at different ages may be seen, by comparing the rib of a calf or lamb, with the rib of an ox or sheep.

59. *The clothing should be loosely worn.* The ribs and bones of the spinal column are soft and yielding in childhood. A small amount of pressure on the walls of the trunk will lessen the size of the chest, and thus injure the lungs, stomach, and heart.

60. *In sitting, the feet of the child should be supported.* If

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57—63. *Give the hygiene of the bones.* 57. What effect has exercise upon the bones? 58. Give the reasons why the amount of labor should be adapted to the condition of the bones. How can the difference in the structure of the bones at different ages be illustrated? 59. Give a reason why the clothing should be loosely worn. 60. Why should the feet of children, when sitting, be supported?

the stool is so high as not to permit the feet to rest upon the floor, the weight of the limbs below the knee may cause the flexible bone of the thigh to become curved. When the feet are not supported, the child is inclined to lean forward, contracting an injurious and ungraceful position.

Observation. The seats in school-rooms should not only be of such height as to enable the pupil to rest the feet on the floor, but they should have properly-constructed backs.

Fig. 18. Fig. 19.

Fig. 18. The position assumed when the seat is of proper height, and the feet supported.

Fig. 19. The position a child naturally assumes when the seat is so high that the feet are not supported.

61. *Children should stand and sit erect.* This position tends to keep the spinal column erect and healthy. When a slight curvature of the spine exists, it can be improved by walking with a book, or a heavier weight, upon the top of the head; to

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Should seats in a school-room have backs? 61. Why should children stand and sit erect?

balance which, the spine must be nearly erect. Those people that carry their burdens upon their heads seldom have crooked spines.

62. Pupils, while writing, drawing, and sometimes while studying, frequently incline the spinal column to one side, in order to accommodate themselves to the desks at which they are seated. This position elevates one shoulder, while it depresses the other.

Fig. 20.

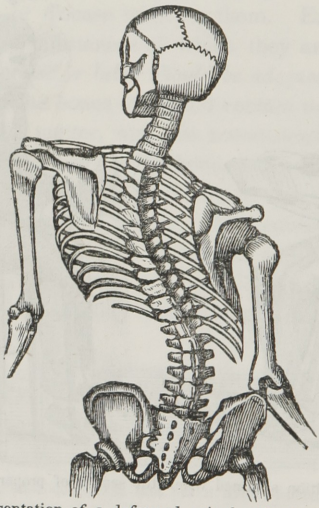

Fig. 20. A representation of a deformed spinal column. A well-formed spinal column has three curves, two forward and one backward, (2, 2, 2, fig. 25,) but no lateral curvature, (1, 1, fig. 17.)

63. One shoulder may be thus elevated for a short time, and no injurious results follow, provided care is taken not to keep it in the raised position too long, or if the opposite shoulder is elevated for the same period of time.

What is the effect of carrying burdens upon the head? 62. What is the effect of pupils using desks that are too high or improperly constructed? 63. How can one shoulder be elevated, and no injurious results follow?

CHAPTER VI.

THE MUSCLES.

64. ALL the great motions of the body are caused by the movement of some of the bones which form the framework of the body; but these, independently of themselves, have not the power of motion, and only change their position through the action of other organs attached to them, which, by contracting, or shrinking, draw the bones after them. In some of the slight movements, as the winking of the eye, no bones are displaced, or moved. These moving, contracting organs are the *Mus'cles*, (lean meat.)

ANATOMY OF THE MUSCLES.

65. A MUSCLE is composed of many little strings, called *fi'bres*. Some of these fibres run in straight lines; others spread like a fan; while some are inclined like the feathery part of a quill. (Fig. 21.)

66. Toward the extremities of a muscle the fibres unite, and form a substance of a whitish color, harder and tougher than the muscle. This is called *ten'don*, (cord, sinew.)

Observation. The pupil can examine a piece of boiled beef, or the leg of a fowl, and see the structure of the fibres and tendons of a muscle, with the attachment of the tendons to the bones.

67. Tendons have various shapes. Sometimes they are

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64. How are all the great motions of the body produced? What are these moving, contracting organs called? 65—72. *Give the structure of the muscles.* 65. Of what is a muscle composed? 66. What is a tendon? How can the structure of a muscle be shown? 67. What is the shape of tendons?

long, slender strings; sometimes they are short and thick; again, in some situations, they are thin and broad. They serve to fasten the muscles to the bones, or to each other.

Observation. In some instances, the synovial membrane, which forms the sheath of the tendons, is ruptured, and the synovial fluid escapes. This forms a tumor, called a *gan'gli-on*, (weeping sinew.) It is called a *wind-gall* when on the limbs of a horse.

68. In the description of a muscle, its attachments are expressed by the terms *origin* and *insertion*. The term *origin* is generally applied to the more fixed or central attachment, or to the points toward which motion is directed; while *insertion* is assigned to the more movable point, or to that most distant from the centre. The middle, fleshy portion, is called the "belly," or *swell*.

Fig. 21.

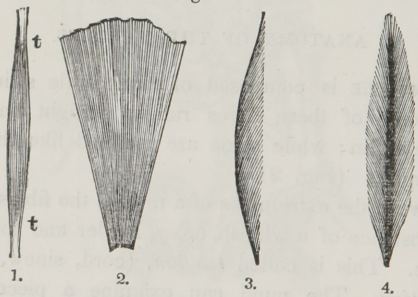

Fig. 21. 1, Represents the fibres of a muscle running in straight lines. 2, The fan-shaped fibres. 3, 4, Fibres inclined like the plumes of a quill. *t, t*, Tendons at the extremities of the muscle, 1.

69. In some parts of the body, there is but one layer of muscle over the bones; in other parts, there are five or six

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How are the tumors formed, called weeping sinews? 68. How are the attachments of muscles expressed? What is the middle portion called? 69. How many layers of muscles are there around the bones?

layers, one muscle being placed over another. They are separated by a thin, whitish membrane, called *fas'ci-a.*

Observation. An instance is seen in the membrane which envelops a leg of beef, and which is observed on the edges of a slice when it is cut for broiling.

70. In general, the muscles form about the bones two layers, called the *superficial*, or external muscles; and the *deep-seated*, or those nearest the bone.

71. There are more than four hundred muscles in the human body. To these, and a yellow substance, called *fat*, that surrounds and fills the spaces in the muscles, the child and youth are indebted for the roundness and beauty of their limbs.

Observation. When we are sick, and cannot take food, the body is fed with this fat. The removal of it into the blood causes the sunken cheek, hollow eye, and prominent appearance of the bones, after a severe sickness.

72. When we look at this "harp of thousand strings," and notice the varied, rapid, complicated, yet accurate movements it performs in a single day, our thoughts are lost in wonder, in contemplating this superb and intricate machine, framed and finished by the divine Architect.

How are they separated from each other? Give an instance where this membrane may be seen. 70. How many layers of muscles generally around the bones, and what are they called? 71. How many muscles in the human body? Why are the limbs of a child more round and full than an aged person's? How is the body nourished when we cannot take food?

CHAPTER VII.

PHYSIOLOGY OF THE MUSCLES.

73. EVERY motion of the body is made by the contraction of the fibres of the muscles; from the awkward movement of the boy's first effort at penmanship, to the delicate and graceful sweeps of the pianist; from the firm, the stately tread of the soldier, to the light, fairy-like step of the *danseuse.*

Illustration. The muscles and tendons are to the bones what the ropes are to the sails and yards of a ship. By their action, the direction of the sails and yards is changed. So, by the action of the muscles, the position of the bones of the body is changed.

74. Each fibre of the several muscles receives from the brain, through the nervous filament appropriated to it, a certain influence called *nervous fluid*, or *stimulus.* It is this that induces contraction, while the suspension of this stimulus causes relaxation of the fibres.

75. Muscles remain contracted but a short time; then they relax, or lengthen, which is their rest. When the muscles are in a state of contraction, they are full, hard, and more prominent than when relaxed.

76. The alternate contraction and relaxation of the muscles may be shown by the following experiment: —

Experiment. Clasp the fore-arm about three inches below the elbow, then open and shut the fingers rapidly, and the

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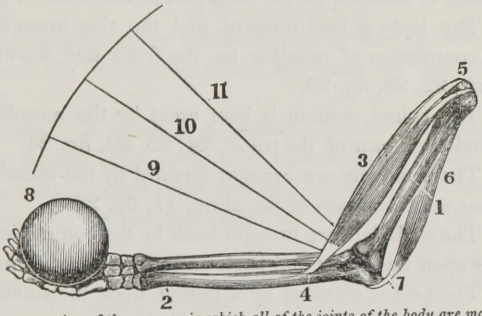
73—99. *Give the physiology of the muscles.* 73. How is every motion of the body produced? 74. With what is each muscular fibre supplied? What effect has this stimulus on the muscles? 75. Do muscles remain contracted a long time? What is their appearance when in a state of contraction? 76. How can the alternate contraction and relaxation of the muscles be shown?

swelling and relaxation of the muscles on the opposite sides of the arms, alternately with each other, will be felt corresponding with the movement of the fingers. While the fingers are bending, the inside muscles swell and the outside ones become flaccid; and, while the fingers are extending, the inside muscles relax and the outside ones swell. The alternate swelling and relaxation of opposing muscles may be felt in all the movements of the limbs.

Fig. 22.



A representation of the manner in which all of the joints of the body are moved.

Fig. 22. 1, The bone of the arm above the elbow. 2, One of the bones below the elbow. 3, The muscle that bends the elbow. This muscle is united, by a tendon, to the bone below the elbow, (4;) at the other extremity, to the bone above the elbow, (5.) 6, The muscle that extends the elbow. 7, Its attachment to the point of the elbow. 8, A weight in the hand, to be raised. The central part of the muscle (3) contracts, and its two ends are brought nearer together. The bones below the elbow are brought to the lines shown by 9, 10, 11. The weight is raised in the direction of the curved line. When the muscle (6) contracts, the muscle (3) relaxes, and the elbow is extended.

77. The eyebrows are elevated, or raised by the contraction of the muscles on the forehead, 1, fig. 23.

78. The eyes are closed by the contraction of the muscles that surround them, 2, fig. 23.

Explain fig. 22.

Note. Let the anatomy and physiology of the muscular system be reviewed, in form of topics, from figs. 23, 24, or from the outline anatomical plates 3 and 4.

79. The upper lip is elevated by the contraction of the muscles, 3, 4, 5, 6, fig. 23.

80. The mouth is closed by the contraction of a muscle that surrounds it, 7, fig. 23.

81. The lower lip is drawn down, or depressed, by the contraction of muscles on the lower part of the face, 8, fig. 23.

82. The head is bent forward, as in nodding, by the contraction of muscles on the front part of the neck, 9, fig. 23.

83. The chin is raised, and the head is brought erect by the contraction of muscles on the back part of the neck, 5, 6, fig. 24.

84. The body is bent forward, and the ribs brought down, by the contraction of muscles on the front and lower part of the trunk, 22, 23, fig. 23.

85. The spinal column is kept erect by the muscles at the lower and back part of the trunk, 24, 25, 26, fig. 24.

86. The shoulders are brought forward by the muscles upon the upper and front part of the chest, 11, fig. 23.

87. The shoulders are brought back by the contraction of the muscles upon the upper and back part of the chest, 7, fig. 24.

88. The arm is elevated by a muscle upon the shoulder, 10, fig. 23; and 8, fig. 24.

89. The arm is brought to the side by muscles, 11, fig. 23; and 24, fig. 24.

90. The elbow is bent by the contraction of the muscles on the upper and front side of the arm, 14, fig. 23.

91. The elbow is extended by a muscle on the back part of the arm, 10, fig. 24.

92. The wrist and fingers are bent by the muscles on the front part of the arm, below the elbow, 16, 18, fig. 23.

93. The muscles on the back part of the arm, below the elbow, extend the wrist and fingers, 21, 22, 23, fig. 24.

94. The muscles that bend the lower limbs, at the hip, are situated at the lower and front part of the trunk, and the upper and front part of the thigh, 25, 26, 27, 28, fig. 23.

95. The lower limbs are extended at the hips by the muscles on the lower and back part of the trunk, and the upper and back part of the thigh, 27, 28, fig. 24.

96. The muscles upon the front part of the thigh extend the leg at the knee, 29, 30, fig. 23.

97. The knee is bent by the muscles upon the back part of the thigh, 29, 30, fig. 24.

98. The muscles upon the fore part of the leg, below the knee, bend the foot at the ankle, and extend the toes, 34, 35, 36, fig. 23.

99. The muscles upon the back part of the leg, below the knee, extend the foot at the ankle, and bend the toes, 31, 32, 33, fig. 24.

Observation. It would be a profitable exercise for pupils to press their fingers upon prominent muscles, and, at the same time, vigorously contract them, not only to learn their situations, but their use; as the one that bends the arm, 14, fig. 23.

[Fig. 23. A front view of the muscles of the body. 1, The frontal swells of the occipito-frontalis. 2, The orbicularis palpebrarum. 3, The levator labii superioris alæque nasi. 4, The zygomaticus major. 5, The zygomaticus minor. 6, The masseter. 7, The orbicularis oris. 8, The depressor labii inferioris. 9, The platysma myoides. 10, The deltoid. 11, The pectoralis major. 12, The latissimus dorsi. 13, The serratus major anticus. 14, The biceps flexor cubiti. 15, The triceps extensor cubiti. 16, The supinator radii longus. 17, The pronator radii teres. 18, The extensor carpi radialis longior. 19, The extensor ossis metacarpi pollicis. 20, The annular ligament. 21, The palmar fascia. 22, The obliquus externus abdominis. 23, The linea alba. 24, The tensor vaginæ femoris. 26, The psoas magnus. 27, The abductor longus. 28, The sartorius. 29, The rectus femoris. 30, The vastus externus. 31, The vastus internus. 32, The tendo patellæ. 33, The gastrocnemius. 34, The tibialis anticus. 35, The tibia. 36, The tendons of the extensor communis.

Fig. 24. A back view of the muscles of the body. 1, The temporalis. 2, The occipito-frontalis. 3, The complexus. 4, The splenius. 5, The masseter. 6, The sterno-cleido mastoideus. 7, The trapezius. 8, The deltoid. 9, The infra spinatus. 10, The triceps extensor. 11, The teres minor. 12, The teres major. 13, The tendinous portion of the triceps. 14, The anterior edge of the triceps. 15, The supinator radii longus. 16, The pronator radii teres. 17, The extensor communis digitorum. 18, The extensor ossis metacarpi pollicis. 19, The extensor communis digitorum tendons. 20, The olecranon and insertion of the triceps. 21, The extensor carpi ulnaris. 22, The auricularis. 23, The extensor communis. 24, The latissimus dorsi. 25, Its tendinous origin. 26, The obliquus externus. 27, The gluteus medius. 28, The gluteus magnus. 29, The biceps flexor cruris. 30, The semi-tendinosus. 31, 32, The gastrocnemius. 33, The tendo-Achillis.]

Fig. 23.

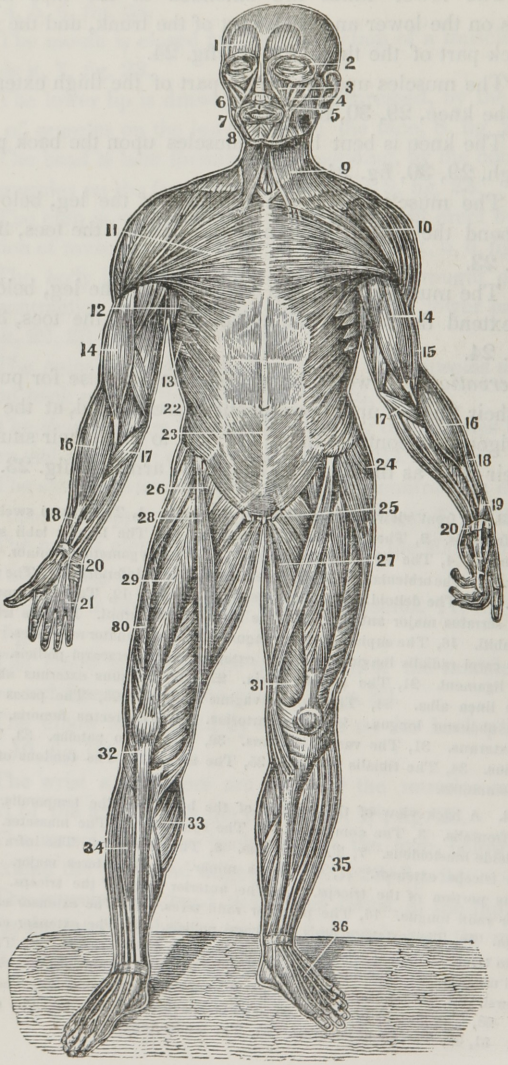

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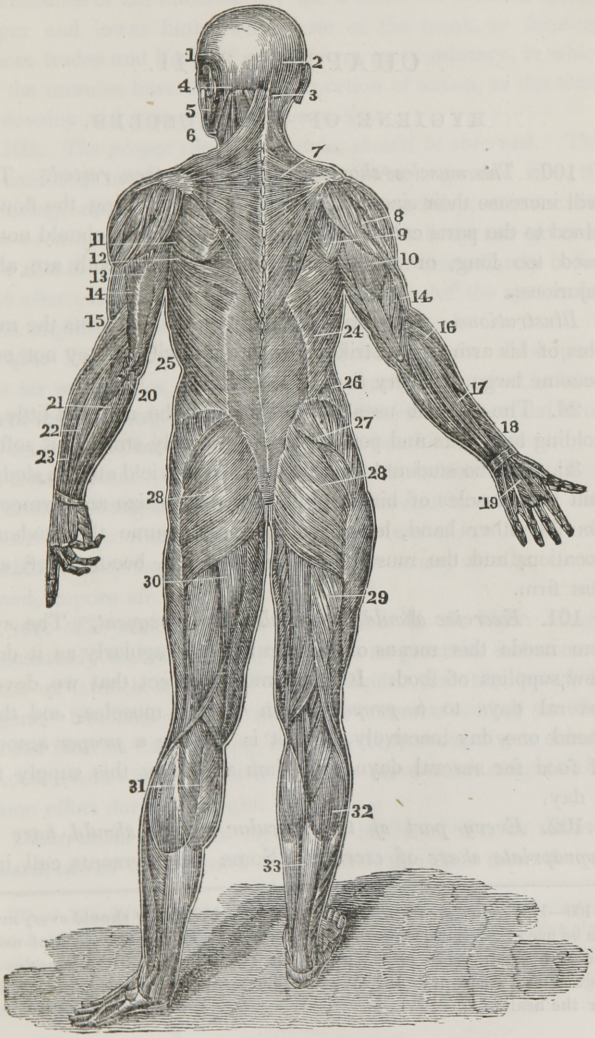
Fig. 24.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CHAPTER VIII.

HYGIENE OF THE MUSCLES.

100. *The muscles should be used and then rested.* This will increase their size and strength, by increasing the flow of blood to the parts called into action. A muscle should not be used too long, or remain at rest too long; both are alike injurious.

Illustrations. 1st. The blacksmith uses and rests the muscles of his arm when striking upon the anvil. They not only become large, but very firm and hard.

2d. The student uses the muscles of the arm but little, in holding his books and pen; they are not only small, but soft.

3d. Let the student leave his books, and wield an iron sledge, and the muscles of his arm will increase in size and firmness. On the other hand, let the blacksmith assume the student's vocation, and the muscles of his arm will become soft and less firm.

101. *Exercise should be regular and frequent.* The system needs this means of invigoration as regularly as it does new supplies of food. It is no more correct that we devote several days to a *proper* action of the muscles, and then spend one day inactively, than it is to take a *proper* amount of food for several days, and then withdraw this supply for a day.

102. *Every part of the muscular system should have its appropriate share of exercise.* Some employments call into

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100—118. *Give the hygiene of the muscles.* 100. Why should every muscle be used? What is injurious to muscles? How is the effect of using muscles illustrated? 101. Why should the exercise of the muscles be regular and frequent? 102. What employments and amusements are best for the health?

exercise the muscles of the upper limbs, as shoe-making; others the muscles of the lower limbs; while some the muscles of both upper and lower limbs, with those of the trunk, as farming. Those trades and kinds of exercise are most salutary, in which all the muscles have their due proportion of action, as this tends to develop and strengthen them equally.

103. *The proper time for exercise should be observed.* This is modified by many circumstances. As a general rule, the morning, when the air is pure and the ground dry, is better than the evening; for then, the powers of the body are greatest. We should avoid severe exercise and labor immediately before and after eating a full meal, for the energies of the system are then required to perform the digestive function.

104. *The muscles should be used in pure air.* The purer the air we breathe, the longer can the muscles be used in labor, walking, or sitting, without fatigue and injury; hence the benefit derived in thoroughly ventilating all inhabited rooms.

Observation. It is a common remark that sick persons will sit up longer when riding in a carriage, than in an easy chair in the room where they have lain sick. In the one instance, they breathe pure air, in the other, usually, a confined, impure air.

105. *The muscles should be exercised in the light.* Light, particularly that of the sun, exercises as great an influence on man as it does on plants. Both require the stimulus of this agent. Students should take their exercise during the day, rather than in the evening, and the farmer and the mechanic should avoid night toil, as it is much more exhausting than the same effort during daylight.

Illustrations. Plants that grow in the shade, as under a board, are of lighter color and more feeble than those that are

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Why? 103. What time, in general, is best for exercise? What should be avoided? 104. Why should the muscles be used in pure air? Give observation. 105. Why should students take their exercise in the daytime? What should farmers and mechanics avoid? Why? How is the influence of solar light illustrated?

exposed to the light of the sun. Persons that dwell in dark rooms, are paler and less vigorous than those who inhabit apartments well lighted, and exposed to solar light.

106. *Every muscle should move freely.* Compression by any means, lessens the size and strength of the muscle.

Illustration. Let a surgeon bandage a limb for some weeks, when a bone is broken, and when the bandage is removed, the limb will be found smaller than when the accident occurred. The compression by close dresses produces similar effects upon the muscles of the body.

107. *The state of the mind affects muscular contraction.* A person who is cheerful and happy will do more work, and with less fatigue, than one who is peevish and unhappy.

Illustration. A sportsman will pursue his game miles without fatigue, while his attendant, not having any mental stimulus, will become weary.

108. *The erect attitude lessens the exhaustion of the muscles.* A person will stand longer, walk farther, and do more work, when erect, than in a stooping posture; because the muscles of the back, in stooping, are in a state of tension, or stretching, to keep the head and trunk from falling forward. In the erect position, the head and trunk are nicely balanced and supported by the bones of the spinal column, and the muscles of the back are called but slightly into action.

Experiment. Hold in each hand a pail of water, or equal weights, in a stooping posture, as long as it can be done without much suffering and injury. Again, when the muscular pain has ceased, hold the same weights, for the same length of time, in an erect posture, and note the difference in the fatigue of the muscles.

Observation. The attitude of children in standing has been

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106. Why should every muscle move freely? How is the effect of compression illustrated? 107. Does the mind affect the action of the muscles? How is this illustrated? 108. What attitude lessens the exhaustion of the muscles? Why? How is the effect of position shown by experiment? What is said respecting the attitude of children?

much neglected both by parents and teachers. Let a child acquire the habit of inclining his head and shoulders, and the chest will become contracted, the muscles of the back enfeebled, and the deformity thus acquired will progress to advanced age.

Fig. 25.

Fig. 26.

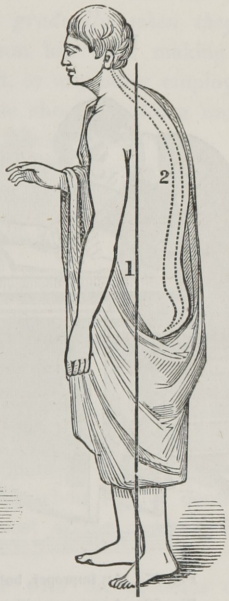

Fig. 25. 1, A perpendicular line from the centre of the feet to the upper extremity of the spinal column, where the head rests. 2, 2, 2, The spinal column, with its three natural curves. Here the head and body are balanced upon the spinal column and joints of the lower extremities, so that the muscles are not kept in a state of tension. This erect position of the body and head is always accompanied with straight lower limbs.

Fig. 26. 1, A perpendicular line from the centre of the feet. 2, Represents the unnatural curved spinal column, and its relative position to the perpendicular, (1.) The lower limbs are seen curved at the knee, and the body is stooping forward. While standing in this position, the muscles of the lower limbs and back are in continued tension, which exhausts and weakens them.

What is represented by figs. 25 and 26?

109. *While studying, drawing, writing, and sewing, the body should be kept erect.* This attitude favors a healthy action of the various organs of the body, and conduces to beauty and symmetry of form. On the contrary, narrow chests, "hollow stomachs," "round shoulders," and ill health, follow a violation of this rule.

Fig. 27 Fig. 28.

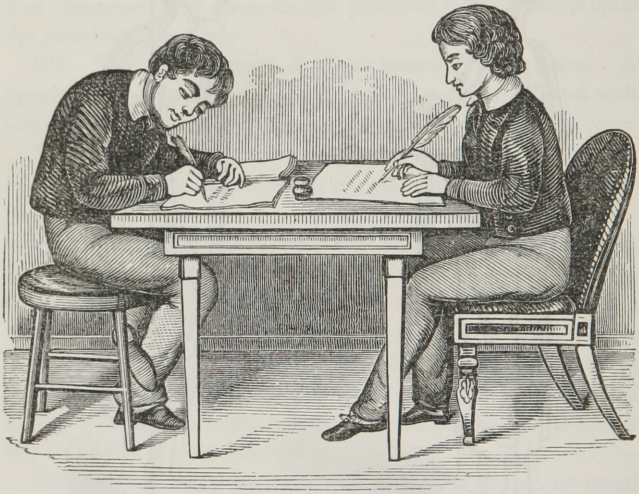

Fig. 27. An improper, but not an unusual position in sitting.
Fig. 28. A proper position in sitting.

110. *Muscles should be gradually called into action.* When the muscular system has been in a state of rest, it should not suddenly be called into vigorous action. On arising from a bed, lounge, or chair, the first movements of the limbs should be slow, and then, if necessary, gradually increased.

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109. What is one cause of narrow chests and round shoulders? 110. What caution is given in using the muscles when they have been in a state of rest? What does fig. 27 show? Fig. 28?

Observation. If a man has a certain amount of work to be performed in nine hours, and his muscles have been in a state of rest, he will do it with less fatigue by performing half the amount of the labor in five hours, and the remainder in four hours. The same principle should be regarded in driving horses and other beasts of burden.

111. *Muscles should be rested gradually, when they have been vigorously used.* If a person has been making great muscular exertion in cutting wood, or any other employment, instead of sitting down to rest, he should continue muscular action by some moderate labor, or amusement.

112. When the skin is covered with perspiration, (sweat,) from muscular action, avoid sitting down "to cool" in a current of air; rather put on more clothing, and continue to exercise moderately.

113. In cases when severe action of the muscles has been endured, bathing and rubbing the skin over the joints that have been used, are of much importance. This will prevent soreness of the muscles and stiffness of the joints.

114. *In labor, or exercise, the muscles should be relaxed.* In walking, dancing, and learning to write, there will be less fatigue, and the movements will be more graceful, when the muscles are slightly relaxed, than when rigidly contracted. The same principle applies to most of the mechanical employments.

Experiments. Attempt to bow with the muscles of the limbs and trunk rigid, and there will be a stiff bending of the body only at the hip-joint. On the other hand, attempt to bow with the muscles moderately relaxed; the ankle, the knee, and

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Give observation. Should the same principle be observed in driving horses? 111. How should muscles be rested when they have been vigorously used? 112. When the skin is covered with perspiration from muscular action, how should it be "cooled"? 113. How can soreness of the muscles be prevented? 114. In what state should be the muscles of the arm in writing or performing most employments? How is this principle shown by experiments?

the hip-joint will slightly bend, accompanied with an easy and graceful curve of the body.

115. When riding in cars and coaches, the system will not suffer so severely from the jar if the muscles are slightly relaxed. When riding over uneven places in roads, rising slightly upon the feet diminishes the shock occasioned by the sudden n otion of the carriage. The muscles, under such circumstances, are to the body what elastic springs are to a carriage.

116. In jumping or falling from a carriage, or any height, the shock to the organs of the body may be obviated in the three following ways. 1st. Let the muscles be relaxed, not rigid. 2d. Let the limbs be bent at the ankle, knee, and hips; the head should be thrown slightly forward, with the trunk a little stooping. 3d. Fall upon the toes, not the heel.

117. *Repetition of muscular action is necessary.* To render the action of the muscles complete and effective, they must be called into action repeatedly and at proper intervals. This education must be continued until not only each muscle, but every fibre of the muscle, is fully under the control of the will. In this way, persons become expert penmen, singers, and skilful in every employment.

118. In training the muscles for effective action, it is very important that correct movements be adopted at the commencement. If this is neglected, much power will be lost.

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115. What suggestion when riding in cars or coaches? 116. In jumping from a carriage, in how many ways can the shock to the organs of the body be obviated? Give the 1st. The 2d. The 3d. 117. How do persons become expert penmen, singers, or skilful in any employment? 118. What is necessary in training the muscles for effective action?

CHAPTER IX.

ANATOMY OF THE TEETH.

119. THE teeth are firmly fixed in the sockets of the upper and lower jaw. The first set, which appear in infancy, is called *tem'po-ra-ry*, or milk-teeth. They are twenty in number; ten in each jaw.

Fig. 29.

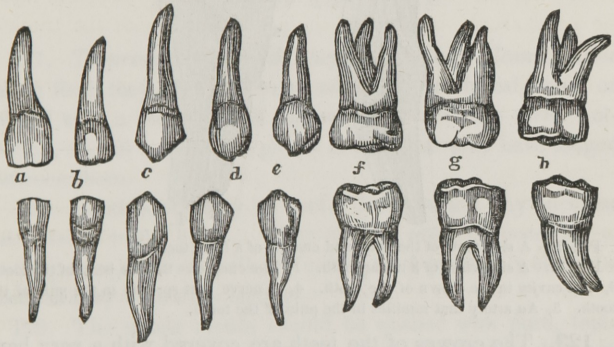

Fig. 29. The permanent teeth of the upper and lower jaw. *a*, *b*, The incisors. *c*, The cuspids. *d*, *e*, The bicuspids. *f*, *g*, The molars, (double teeth.) *h*, The wisdom teeth.

120. Between six and fourteen years of age, the temporary teeth are removed, and the second set appears, called *per'ma-nent* teeth. They number thirty-two, sixteen in each jaw.

121. The four front teeth in each jaw are called *in-ci'sors*,

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119—123. *Give the anatomy of the teeth.* 119. In what are the teeth placed? What is the first set called? How many in number? Describe fig. 29. 120. When are these teeth removed? What is the second set called? How many in each jaw? 121. What are the teeth in front called?

(cutting teeth;) the next tooth on each side, the *cus'pid*, (eye tooth;) the next two, *bi-cus'pids*, (small grinders;) the next two, *mo'lars*, (grinders.) The last one on each side of the jaw, is called a *wisdom tooth*, because it does not appear until a person is about twenty years old.

122. Each tooth is divided into two parts; namely, *crown* and *root*. The crown is that part which protrudes from the jaw-bone and gum. The root, or "fang," is placed in the sockets of the jaw.

Fig. 30. Fig. 31.

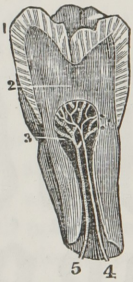

Fig. 30. A side view of the body and enamel of a front tooth.

Fig. 31. A side view of a molar tooth. 1, The enamel. 2, The body of the tooth 3, The cavity in the crown of the tooth. 4, A nerve that spreads in the pulp of the tooth. 5, An artery that ramifies in the pulp of the tooth.

123. The crowns of the teeth are covered with a very hard substance, called *en-am'el*. The roots consist of bony matter.

PHYSIOLOGY OF THE TEETH.

124. The use of the teeth is twofold. 1st. By a cutting and grinding movement, they divide the masses of food into

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The next? The next two? Those next the bicuspids? The last that appear in the jaw? 122. How is each tooth divided? Which part of the tooth is the crown? Which the root? 123. With what are the crowns of the teeth covered? Of what does the root consist? Describe fig. 31. 124—126. *Give the physiology of the teeth.* 124. What is one use of the teeth?

smaller pieces, so that they are more easily and readily changed in the stomach.

125. 2d. The teeth aid us in speaking with distinctness certain letters and words. An individual who has lost his front teeth cannot pronounce distinctly certain letters, called *dental.*

126. The teeth also give beauty to the lower part of the face. When they are removed, the lips and cheeks sink in, as is frequently seen in old age. Consequently, those simple observances that tend to the preservation of the teeth, are of practical interest to all persons.

HYGIENE OF THE TEETH.

127. *To preserve the teeth, they must be kept clean.* After eating food, they should be cleaned with a brush and water, or rubbed with a piece of soft flannel, to prevent the *tartar* collecting, and to remove the pieces of food that may have lodged between them.

128. Tooth-picks may be useful in removing any particles inaccessible to the brush. They may be made of bone, ivory, or the common goose-quill. Metallic tooth-picks should not be used, as they injure the enamel.

129. The whole mouth should be washed with pure, tepid water, at night, as well as in the morning, after which the teeth should be brushed upward and downward, both on the posterior and anterior surfaces. It may be beneficial to use refined soap once or twice every week, to remove any corroding substance that may exist around the teeth, care being taken to thoroughly rinse the mouth after its use.

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125. Give another use of these organs. 126. Do they contribute to the symmetry of the lower part of the face? 127—132. *Give the hygiene of the teeth.* 127. By what means can the teeth be preserved? 128. What is said of the use of tooth-picks? 129. How often should the teeth be brushed?

130. *Food or drink should not be taken into the mouth when very hot or very cold.* Sudden changes of temperature will crack the enamel, and, finally, produce decayed teeth.

Observation. On this account, smoking is pernicious, because the teeth are subjected to an alternate inhalation of both cold and warm air.

131. *Care should be taken, in childhood, that the temporary teeth be removed as soon as they become loose,* in order that the second set of teeth may present a regular and beautiful appearance. If a permanent tooth makes its appearance before the first is removed, or has become loose, the milk-tooth, although not loose, should be removed without delay.

132. If the teeth are crowded and irregular, in consequence of the jaw being narrow and short, or when they press so hard upon each other as to injure the enamel, remove one or more, to prevent their looking unsightly and irregular, and in a few months, the remaining teeth, with a little care, will fill the spaces.

Observations. 1st. It is not always necessary to have teeth extracted when they ache. The nerve may be diseased, and the tooth still be sound.

2d. When it is necessary to have decayed teeth filled, it is better for the health of the person and durability of the teeth, to have them filled with *gold foil.*

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130. What is the cause of decayed teeth? Why is smoking injurious to the teeth? 131. What remarks respecting the temporary teeth? 132. Give other remarks in regard to the temporary teeth. Give observation 1st. Observation 2d.

CHAPTER X.

DIGESTIVE ORGANS.

133. The food, whether animal or vegetable, has no resemblance to the bones, muscles, and other parts of the body to which it gives sustenance. It must undergo certain essential alterations before it can become a part of the different structures of the body. The first change is effected by the action of the *Digestive Organs.*

ANATOMY OF THE DIGESTIVE ORGANS.

Fig. 32.

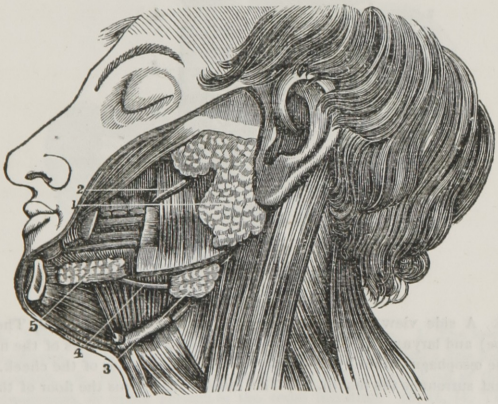

Fig. 32. A view of the salivary glands in their proper situations. 1, The parotid gland. 2, Its duct. 3, The submaxillary gland. 4, Its duct. 5, The sublingual gland, brought to view by the removal of a section of the lower jaw.

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133. Has animal or vegetable food any resemblance to the different parts of the body to which it gives sustenance? By what organs is the first change in the food effected? Describe fig. 32.

134. The DIGESTIVE ORGANS are the *Mouth*, *Teeth*, *Sal'i-va-ry Glands*, *Phar'ynx*, *Œ-soph'a-gus*, (gullet,) *Stomach*, *In-tes'tines*, (bowels,) *Lac'te-als*, (milk or chyle vessels,) *Tho-rac'ic Duct*, *Liv'er*, and the *Pan'cre-as*, (sweetbread.)

135. The MOUTH is an irregular cavity, which contains the teeth and the organs of taste.

136. The SALIVARY GLANDS* are six in number; three on each side of the jaw. They are called the *pa-rot'id*, the *sub-max'il-la-ry*, and the *sub-lin'gual*. (Fig. 32.)

137. The PHARYNX is a muscular, membranous sac, that leads to the œsophagus.

Fig. 33.

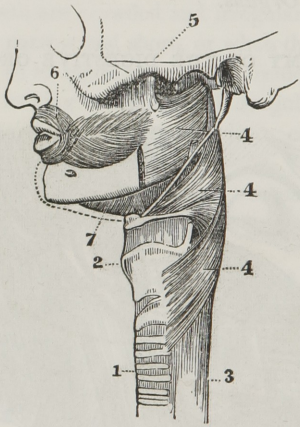

Fig. 33. A side view of the face, œsophagus, and trachea. 1, 2, The trachea (wind-pipe) and larynx. 3, The œsophagus. 4, 4, 4, The muscles of the upper portion of the œsophagus, forming the pharynx. 5, The muscles of the cheek. 6, The muscle that surrounds the mouth. 7, The muscle that forms the floor of the mouth.

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* See paragraph 234.

134—147. *Give the anatomy of the digestive organs.* 134. Name the digestive organs. 135. Describe the mouth. 136. Describe the salivary glands. 137. What is the pharynx? What does fig. 33 represent?

138. The ŒSOPHAGUS is a large, membranous tube, through which the food and drink pass into the stomach.

139. The STOMACH* is in the left side of the body, below the lungs and heart. It is composed of three coats, or membranes, which are thin and yielding. The external is called the *se'rous;* the middle, *mus'cu-lar;* the inner, *mu'cous.*

Illustration. The three coats of the stomach (anatomically) resemble *tripe,* which is a preparation of the largest stomach of the cow or ox. The outer coat is smooth and highly polished. The middle coat is composed of minute threads, which are arranged in two layers. The fibres of these layers cross each other. The inner coat is soft, and presents many folds, usually called "the honey-comb."

Fig. 34.

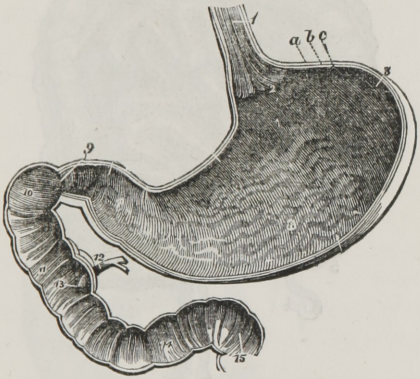

Fig. 34. The inner surface of the stomach and duodenum. 1, The lower portion of the œsophagus. 2, The opening through which the food is passed into the stomach. 3, The stomach. 9, The opening through which the food passes out of the stomach into the duodenum, or upper portion of the small intestine. 10, 11, 14, The duodenum. 12, 13, Ducts through which bile and pancreatic fluid pass into it. *a, b, c,* The three coats of the stomach.

* For situation of the stomach, &c., see fig. 53.

138. What is the œsophagus? 139. Where is the stomach situated? How many coats has it? Name them. What article prepared for food does the stomach resemble in structure? Explain fig. 34.

140. The INTESTINES, or alimentary canal, are divided into two parts, the *small* and *large*. The small intestine is about twenty-five feet in length. The upper and most important division is called the *Du-o-de'num*. The large intestine is about five feet in length. The largest division is called the *Co'lon*.

141. The DUODENUM (called by nurses the *second stomach*) is the most essential part of the small intestine. It is about twelve inches in length, and commences at the lower orifice of the stomach.

Fig. 35.

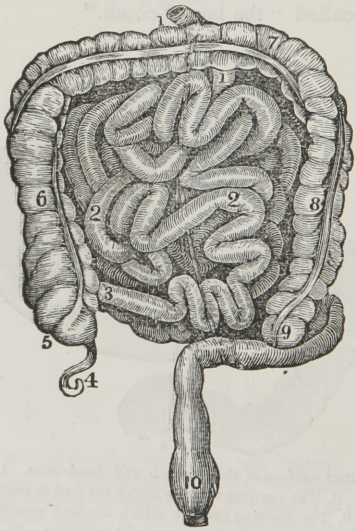

Fig. 35. 1, 1, The duodenum. 2 2, The small intestine. 3, The connection of the small and large intestine. 4, 5, 6, 7, 8, 9, 10, The large intestine. 6, 7, 8, 9, The colon.

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140. How are the intestines divided? What is the length of the small intestine? What is its largest division called? What is the length of the large intestine? What is its largest division called? 141 Describe the duodenum. Explain fig. 35.

142. The LACTEALS are minute vessels, which open upon the mucous surface of the small intestine. From the intestine they pass through small glands, (*mes-en-ter'ic*,) to the thoracic duct.

Fig. 36.

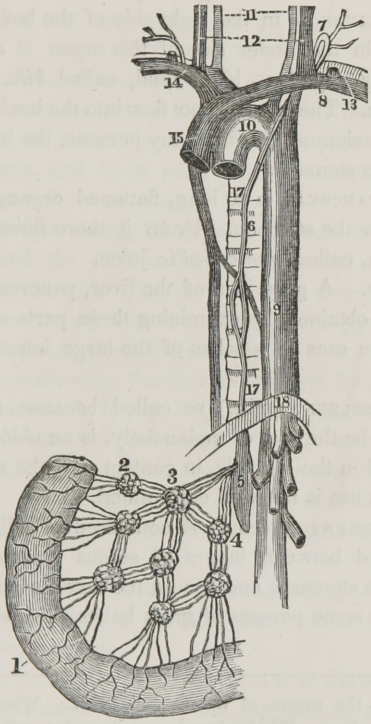

Fig. 36. A portion of the small intestine, lacteal vessels, mesenteric glands, and horacic duct. 1, The intestine. 2, 3, 4, Mesenteric glands, through which the lacteals pass to the thoracic duct. 5, 6, The thoracic duct. 7, The point in the neck where it turns down to enter the vein at 8. 9, 10, The aorta. 11, 12, Vessels of the neck. 13, 14, 15, The large veins that convey the blood and chyle to the heart. 17, 17, The spinal column. 18, The diaphragm, (midriff.)

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142. What are lacteals? Through what do they pass as they proceed to the thoracic duct? Describe fig. 36.

143. The THORACIC DUCT commences behind the liver, and ascends in front of the spinal column. At the lower part of the neck, it turns downward and forward, and pours its contents into the vein behind the collar-bone. (8, fig. 36.) This duct is equal in diameter to a goose-quill.

144. The LIVER is in the right side of the body, below the right lung. On the under side of this organ is a small sac, which contains a yellow, bitter fluid, called *bile*, (gall.)

Observation. The bile does not flow into the healthy stomach, but into the duodenum. With many persons, the imagination is *bilious*, not the stomach.

145. The PANCREAS is a long, flattened organ, situated behind and below the stomach. From it there flows a fluid into the duodenum, called *pan-cre-at'ic* juice.

Observation. A good idea of the liver, pancreas, and intestines can be obtained by examining these parts of a pig. In this animal, the sacs or pouches of the large intestine are well defined.

146. The SPLEEN, (milt,) so called because the ancients supposed it to be the seat of melancholy, is an oblong, flattened organ, situated in the left side, in contact with the stomach and pancreas. Its use is not well determined.

147. The OMENTUM (caul) is composed of adipose matter, (fat,) deposited between layers of serous membrane. It is attached to the stomach, and lies on the anterior surface of the intestines. In some persons of gross habits, this deposit is very great.

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143. Describe the course of the thoracic duct. What is its size? 144. Describe the liver. What is found upon its under surface? Give observation. 145. Describe the pancreas. How may an idea of the liver be obtained? 146. Describe the spleen. Is its use well known? 147. Describe the omentum.

CHAPTER XI.

PHYSIOLOGY OF THE DIGESTIVE ORGANS.

148. SUBSTANCES received into the stomach as food, must necessarily undergo many changes before they are fitted to form part of the animal body. The solid portions are reduced to a fluid state, and those parts that will nourish the body are separated from the waste material.

149. The first change in the food is made in the mouth, by the teeth, and the *sa-li'va* (spittle) from the salivary glands. The teeth divide, while the saliva moistens and softens the food, so that, when carried into the pharynx, it is passed, with ease, through the œsophagus into the stomach.

150. In swallowing, the food is pressed by the contraction of the muscles 5, 6, 7, (fig. 33,) into the pharynx, from which it is carried into the œsophagus, by the contraction of the muscles 4, 4, 4. As soon as the food is received into this tube, its muscular coat contracts upon it successively from above downward, and the alimentary ball is pressed onward into the stomach.

Observation. The process of swallowing, or deglutition, is easily observed, when a person passes either liquid or solid food into the stomach.

151. The next change in the food is in the stomach. The coats of the stomach contract, and the food is moved around, while, at the same time, a peculiar fluid is supplied by the

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148—159. *Give the use of the digestive organs.* 148. What is necessary before food can nourish the body? 149. Describe the first change in the food. 150. Give the process by which the food is passed into the stomach How may the process of swallowing be observed? 151. Where is the second change in the food effected? How is it done?

stomach, called *gastric juice*, which mixes with the food, and reduces it to a soft, pulpy mass, called *chyme*.

152. This pulpy, grayish substance is passed into the duodenum, and, by the action of the bile and pancreatic juice, it is changed into two parts—a milk-like substance, called *chyle;* and *re-sid'u-um*, or waste matter.

153. The chyle and residuum pass from the duodenum into the remaining portion of the small intestine, and are moved along by a worm-like action of its parts.

154. As these two substances are moved along the intestine, the chyle is sucked up by the lacteal vessels,* that pass through the small intestine, and the residuum is carried into the large intestine, and excreted from the system.

155. To recapitulate: In the adaptation of the food to the wants of the body, it is subjected to five different changes. 1st. It is changed in the mouth, by the action of the teeth and saliva. This is called *mastication.*

156. 2d. By the action of the stomach and gastric juice, it is changed into a pulpy, homogeneous mass. This is called *chymification.*

157. 3d. In the duodenum, the bile and pancreatic juice change the chyme into chyle. This is called *chylification.*

158. 4th. By the action of the lacteal vessels and thoracic duct, the chyle is poured into a vein behind the collar-bone, and passes through the heart to the lungs; here, by the action of the air, it becomes *blood.* (See Chap. XX.)

159. 5th. The separation and excretion of the residuum.

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* The chyle is changed by the lacteals and mesenteric glands, but the nature of this change is not, as yet, well defined or understood.

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152. What becomes of this pulpy substance? What change is effected in the duodenum? 153. Where do the chyle and residuum then pass? 154. What becomes of the chyle? Of the residuum? 155. Recapitulate the five changes in the digestive process.

Note. Let the pupil review the anatomy and physiology of the digestive organs, from figs. 36 and 37, or from outline anatomical plate 5.

Fig. 37.

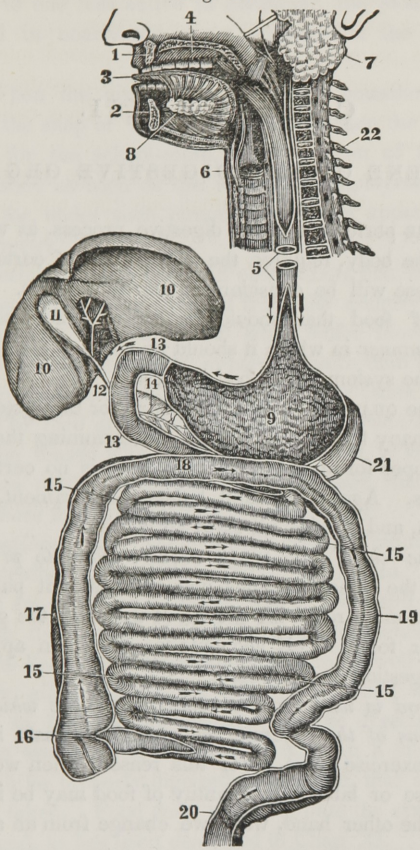

Fig. 37. An ideal view of the organs of digestion, opened nearly the whole length. 1, The upper jaw. 2, The lower jaw. 3, The tongue. 4, The roof of the mouth. 5, The œsophagus. 6, The trachea. 7, The parotid gland. 8, The sublingual gland. 9, The stomach. 10, 10, The liver. 11, The gall-cyst, or sac. 12, The duct that conveys the bile to the duodenum, (13, 13.) 14, The pancreas. 15, 15, 15, 15, The small intestine. 16, The opening of the small intestine into the large intestine. 17, 18, 19, 20, The large intestine. 21, The spleen. 22, The upper part of the spinal column.

CHAPTER XII.

HYGIENE OF THE DIGESTIVE ORGANS.

160. THE perfection of the digestive process, as well as the health of the body, requires the observance of certain conditions. These will be considered under four heads. 1st. The *quantity* of food that should be taken. 2d. Its *quality*. 3d. The *manner* in which it should be taken. 4th. The *condition* of the system when food is taken.

161. The QUANTITY of food necessary for the system varies. Although many things may aid us in determining the quantity of food proper for an individual, yet there is no certain guide in all cases. Age, occupation, habits, temperament, temperature, health, and disease, all exert an influence.

162. *The child and youth require food to promote the growth* of the bones, muscles, and the different parts of the body. The more rapid the growth of the child, the greater the demand for food. This accounts for the keen appetite and vigorous digestion in childhood.

163. *Food is necessary to repair the waste which attends the functions of the different organs.* The waste is greatest when we exercise most. For this reason, when we increase our exercise or labor, the quantity of food may be increased; while, on the other hand, when we change from an active em-

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160—186. *Give the hygiene of the digestive organs.* 160. What does the perfection of the digestive process require? 161. Can the quantity of food proper for an individual be determined in all cases? What exert an influence on the quantity necessary for the body? 162. At what age is the appetite keen and the digestion vigorous? Why? 163. Give another demand for food. When is the waste greatest? When should the amount of food be lessened?

ployment to one less active in character, the food should be diminished in nearly the same degree that the exercise is lessened.

164. When the girl leaves the active household employments for the shop of the dress-maker, — when the boy leaves the farm for the school-room, — the amount of food should be diminished as soon as the sedentary employment is commenced; for, under such circumstances, the appetite will not guide correctly.

Observation. It is a common observation, that in academies and colleges, the older students from the country, who have been accustomed to hard manual labor, suffer more frequently from defective digestion and impaired health than the younger and feebler students from the larger towns or cities.

165. *The food aids in supporting the warmth of the body.* This is the reason why the appetite for food is keener in the winter than in the summer. It follows, then, that the system requires more food in cold than in hot weather.

Observations. 1st. Well-clothed children require less food in cold weather than those thinly dressed. 2d. Flocks and herds that are sheltered in winter, will eat one third less than if exposed to the inclemency of the weather; hence it is true economy to keep the inferior animals warm, as well as children.

166. *In all instances, the quantity of food should have reference to the present condition of the digestive organs.* If they are weakened or diseased, so that but a small quantity of food can be properly digested or changed, that amount only should be taken. Food does not invigorate the system, except it is changed, as has been described in Chap. XI.

167. The QUALITY of the food best adapted to the wants of

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164. When will not the appetite guide correctly? What observation respecting those students that have been accustomed to hard manual labor? 165. Why is the appetite for food keener in the winter than in the summer? Give observation 1st. Observation 2d. 166. Why should the present condition of the digestive organs be regarded in reference to the quantity of food? 167. On what does the quality of food adapted to the wants of the system depend?

the system depends upon the season, climate, age, &c., of a person. Like the quantity necessary for an individual, there can be no fixed law.

168. *The kind of food which is eaten should be adapted to the distensible character of the stomach and alimentary canal.* Hence the food should contain nutritious and innutritious matter — nutritious, to promote the growth and repair the waste of the system; and innutritious, to distend both the stomach and alimentary canal. Consequently, hot flour bread, rich pies, and jellies, are not so good articles for food, as the unbolted wheat bread, ripe fruits, and berries.

169. *The influence of season and climate should be considered in selecting food.* Food of a highly stimulating character may be used almost with impunity, during the cold weather of a cold climate, but in the warm season, and in a warm climate, it would be very injurious. Animal food, being more stimulating than vegetable, can be eaten in the winter; but vegetable food should be used more freely in the spring and summer.

Observation. By abstaining from meats and stimulating drinks in warm weather, and living on nutritious, unstimulating food, the "season" or bowel complaints may be, in a great degree, prevented.

170. *The age of persons modifies the influence of food on the system.* The organs of a child are more sensitive and excitable than those of a person advanced in years. Therefore a vegetable diet would be most appropriate for a child, while stimulating animal food might be conducive to the health of an aged person.

171. The MANNER in which food should be taken is of much practical importance; upon it the health of the digestive organs depends.

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168. What should all substances used for food contain? Why? 169. Should the season of the year influence us in selecting food? Give observation. 170. What kind of food is adapted to the organs of the child? Why? What kind to a person advanced in life? Why? 171. What is said of the manner of taking food?

172. *Food should be taken at regular periods.* The interval between meals should be regulated by the kind of food, the age, health, exercise, and habits of the individual. Children require food more frequently than adults; yet, strict regularity and punctuality should be observed in regard to their times of eating.

173. *Food should not be taken too frequently.* If food is taken before the stomach has regained its tone and energy by repose, or before the digestion of the preceding meal has been completed, not only will the action of the stomach be imperfect, but the food partially digested becomes mixed with that last taken, inducing irritation or disease. In general, an adult should allow six hours to intervene between meals.

174. *Food should be well masticated, or chewed.* All solid food should be reduced to a state of comparative fineness, by the teeth, before it is swallowed; the gastric fluid of the stomach will then blend with it more readily, and act more vigorously in reducing it to chyme.

175. *Mastication should be moderate, not rapid;* for the salivary glands are excited to action in chewing, and some time must elapse before they can secrete saliva in sufficient quantities to moisten the food.

176. *Food should be masticated and swallowed without drink.* As the salivary glands supply fluid to moisten the dry food, the use of tea, coffee, water, or any other fluid, is not demanded by nature's laws while taking a meal.

Observation. Were it customary not to place drinks on the table until the solid food is eaten, the evil arising from drinking too much at meals would be obviated.

177. The CONDITION of the system should be regarded when food is taken.

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172. How should food be taken? How should the intervals between meals be regulated? What should be observed in giving food to children? 173. What is the effect if food is taken too frequently? 174. Why should food be well masticated? 175. Why should we not eat rapidly? 176. Why do we not require drink while chewing our food? 177. Should the condition of the system be regarded when food is taken?

178. *Food should not be taken immediately after severe exertion, either of the body or mind ;* for all organs in action require and receive more blood and nervous fluid, than when at rest.

Observation. The practice of students and accountants going immediately from severe mental labor to their meals, is a pernicious one, and a fruitful cause of indigestion and mental debility. The custom of farmers and mechanics hurrying from their toil to the dinner-table, "to save time," — which, to say the least, is poor economy, — does much to cause dyspepsia among these classes in community.

179. *Severe mental or physical labor should not be entered upon immediately after eating.* The amount of blood and nervous fluid supplied to the stomach and alimentary canal during the digestion of food is increased, and a deficiency consequently exists in other organs. If the blood is diverted from the stomach to the limbs or brain by active exertion, it will not only cause disease of the digestive organs, but chyle will not be formed, to nourish the system.

180. *Pure air is necessary to give a keen appetite and vigorous digestion.* The digestive organs not only need the stimulus of blood, but they absolutely need the influence of pure blood, which cannot exist in the system, except when we breathe pure air.

Illustration. A manufacturer stated before a committee of the British parliament, that he removed an arrangement for ventilating his mill, because he noticed that his men ate much more after his mill was ventilated than previous to admitting fresh air into the rooms. The apology for removing the ventilators was, that he could not *afford* to have them breathe pure air.

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178. Why should not food be taken after severe exertion? What is one cause of indigestion among students and accountants? What is said of farmers and mechanics hurrying from their toil to the dinner-table?
179. Why should not severe exertion be made immediately after eating?
180. What effect has pure air on digestion? Give illustration.

181. *Persons should abstain from eating, at least three hours before retiring for sleep.* It is no unusual occurrence for those persons who have eaten heartily immediately before retiring for sleep, to have unpleasant dreams, or to be aroused from their unquiet slumber by colic pains.

Illustration. A healthy farmer, who was in the habit of eating one fourth of a mince pie immediately before going to bed, became annoyed with unpleasant dreams, and, among the varied images of his fancy, he saw that of his deceased father. Becoming alarmed, he consulted a physician, who, after a patient hearing of the case, gravely advised him to eat *half* of a mince pie, assuring him that he would then see his grandfather.

182. *When the general system and digestive organs are enfeebled, mild, unstimulating food, in small quantities, should be given.* In the instance of a shipwrecked and famished mariner, or a patient recovering from disease, but a small quantity of nourishment should be given at a time.

183. Water and most fluids are removed from the stomach in a very few minutes, by the action of the veins. In instances of great feebleness, the body can be strengthened sooner by liquid than by solid food.

184. When travelling in coaches or cars, the stomach is not in a state to digest large quantities of food. When food is taken, it should be of the mildest character, and small in quantity.

185. To prevent disease, it is as necessary that the alimentary canal be evacuated regularly, as that we take food into the stomach at regular periods.

186. Sitting, standing, and walking erect, aid in keeping the digestive organs healthy.

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181. What is the effect of eating immediately before retiring for sleep? How is this illustrated in the case of a healthy farmer? 182. How should food be given when both the digestive organs and general system are enfeebled? 183. Which are introduced into the system soonest, fluids or solid food? 184. What is said in regard to food while we are travelling? 186. What position of the body aids digestion?

CHAPTER XIII.

THE CIRCULATORY ORGANS.

187. THE blood is distributed to every part of the system. There is no part so minute, that it does not receive this circulating fluid. This distribution is effected by the agency of the *Heart*, *Ar'te-ries*, *Veins*, and *Cap'il-la-ries*.

ANATOMY OF THE CIRCULATORY ORGANS.

188. The HEART is situated in the chest, between the lungs. (Fig. 53.) It is a double organ, or has two sides, called *right* and *left*, which are separated by a muscular *sep'tum*, or partition.

189. Each side of the heart has two cavities. The upper cavity is called the *au'ri-cle*, (deaf ear.) The lower cavity is called the *ven'tri-cle*. These cavities are separated from each other by folds of membrane, called *valves*. (Fig. 38.)

190. Between the auricle and ventricle of the right side of the heart, there are three valves, called *tri-cus'pid*. Between the auricle and ventricle of the left side of the heart, there are two valves, called *mi'tral*.

Observation. To obtain a clear idea of the heart and its valves, it is recommended to examine this part of an ox or calf. In order that each ventricle be opened without muti-

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187. What is said of the distribution of the blood? How is it effected? 188—196. *Give the anatomy of the circulatory organs.* 188. Describe the heart. 189. How many cavities has it? What is the upper cavity called? What is the lower cavity called? How are these cavities separated? 190. How many valves between the right auricle and ventricle, and what are they called? How many valves between the left auricle and ventricle, and what are they called? How can an idea of the heart be obtained?

lating the parts that compose its internal structure, cut on each side of the septum parallel to it. This may be easily found between the ventricles, as they differ in thickness.

191. The ARTERIES are the vessels that carry the blood from the heart. The right ventricle of the heart gives rise to the *pul'mo-na-ry* artery; the left ventricle to a large artery, called the *a-ort'a.* At the commencement of both of these vessels are valves, and from their shape, they are called *sem-i-lu'nar.*

Fig. 38.

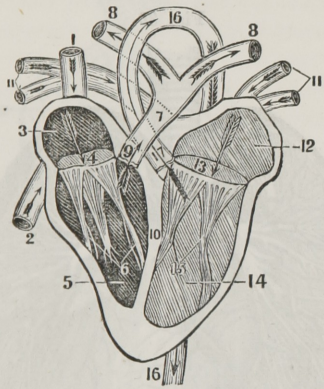

Fig. 38. 1, The descending vein. 2, The ascending vein. 3, The right auricle. 4, The opening between the right auricle and the right ventricle. 5, The right ventricle. 6, The tricuspid valves. 7, The pulmonary artery. 8, 8, The branches of the pulmonary artery that pass to the right and left lung. 9, The semilunar valves of the pulmonary artery. 10, The division between the two ventricles of the heart. 11, 11, The pulmonary veins. 12, The left auricle. 13, The opening between the left auricle and ventricle. 14, The left ventricle. 15, The mitral valves. 16, 16, The aorta. 17, The semilunar valves of the aorta.

Observation. The parts of the circulatory organs most liable to disease are the valves of the heart, particularly the mitral.

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191. What are arteries? Where does the pulmonary artery take its rise? The aorta? What valves at the commencement of these vessels? Describe fig. 38. What parts of the circulatory organs are most liable to disease?

When these membranous folds become ossified or ruptured, the blood regurgitates, and causes great distress in breathing.

192. The PULMONARY ARTERY commences in front of the aorta. It ascends obliquely to the under surface of the arch of the aorta, where it divides into two branches, one of which passes to the right, the other to the left lung. This artery conveys the dark-colored or "venous" blood to the lungs, and, with its corresponding veins, establishes the *pulmonic circulation.*

Fig. 39.

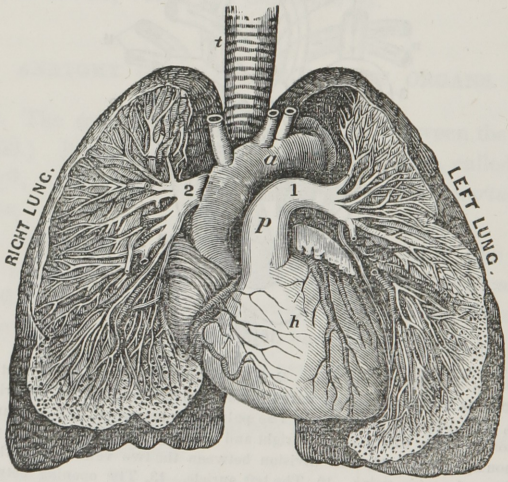

Fig. 39. *t*, The windpipe. *h*, The heart. *a*, The aorta. *p*, The pulmonary artery. 1, The branch of the pulmonary artery that divides in the left lung. 2, The branch that divides in the right lung.

The divisions of this artery continue to divide and subdivide, until they become no larger than hairs in size. These minute vessels pass over the air-cells, represented by small dark points around the margin of the lungs.

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192. Describe the pulmonary artery. What is the function of this artery? Explain fig. 39. What is said of the divisions of the pulmonary artery?

193. The AORTA proceeds from the left ventricle of the heart, and contains the pure or "arterial" blood. This vessel gives off branches, which divide and subdivide as they advance, until they are distributed to every part of the body. This artery, with its corresponding veins, establishes the *systemic circulation.*

Fig. 40.

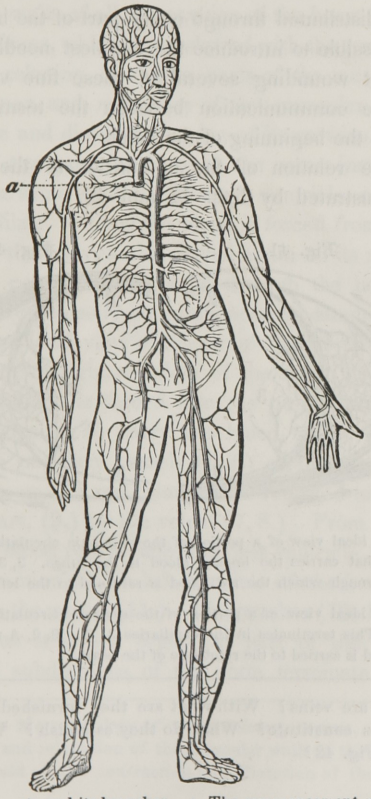

Fig. 40. The aorta and its branches. *a*, The commencement of the aorta.

193. Describe the aorta. What is represented by fig. 40?

194. The VEINS are the vessels which return the blood to the auricles of the heart, after it has been circulated by the arteries through the lungs and other parts of the body. At certain intervals, they are furnished with valves, which allow the blood to flow toward the heart only. In general, they are nearer the surface of the body than the arteries.

195. The CAPILLARIES constitute a microscopic net-work, and are so distributed through every part of the body as to render it impossible to introduce the smallest needle beneath the skin without wounding several of these fine vessels. They establish the communication between the termination of the arteries and the beginning of the veins.

196. The relation of the capillaries to the arteries and veins, is illustrated by figs. 41 and 42.

Fig. 41.

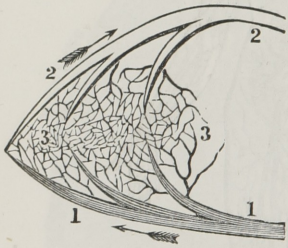

Fig. 42.

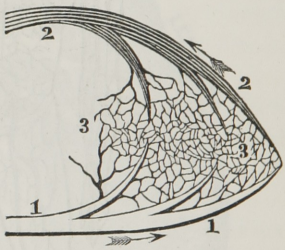

Fig. 41. An ideal view of a portion of the pulmonic circulation. 1, 1, A branch of the artery that carries the impure blood to the lungs. 3, 3, Capillary vessels. 2, 2, A vein through which the red blood is returned to the left side of the heart.

Fig. 42. An ideal view of a portion of the systemic circulation. 1, 1, A branch of the aorta. This terminates in the capillaries 3, 3. 2, 2, A vein through which the impure blood is carried to the right side of the heart.

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194. What are veins? With what are they furnished? 195. What do the capillaries constitute? What do they establish? What does fig. 41 represent? Fig. 42?

CHAPTER XIV.

PHYSIOLOGY OF THE CIRCULATORY ORGANS.

197. THE walls of all the cavities of the heart are composed of muscular fibres, which are endowed with the property of contracting and relaxing, like other parts of the muscular system. The contraction and relaxation of the muscular fibres of the heart increase and diminish the size of its cavities.

198. The two auricles dilate at the same instant, and also contract at the same instant. The two ventricles contract, while the auricles dilate. Thus the blood is forced from the heart to every part of the body, and received again on its return.

199. The course of the blood through the heart, arteries, and veins, may be easily comprehended by attention to fig. 43, which gives an ideal view of the circulation of the blood.

200. From the right ventricle of the heart, (2, fig. 43,) the dark, impure blood is forced into the pulmonary artery, (3;) and its branches (4, 5) carry the blood to the left and right lung. In the capillary vessels (6, 6) of the lungs, the blood becomes pure, or of a red color, and is returned to the left auricle of the heart, (9,) by the veins, (7, 8.) From the left auricle the pure blood passes into the left ventricle, (10.) By a forcible contraction of the left ventricle of the heart, the blood is thrown into the aorta, (11.) Its branches (12, 13, 13) carry the pure blood to every organ, or part of the body. The divisions and subdivisions of the aorta terminate in capillary

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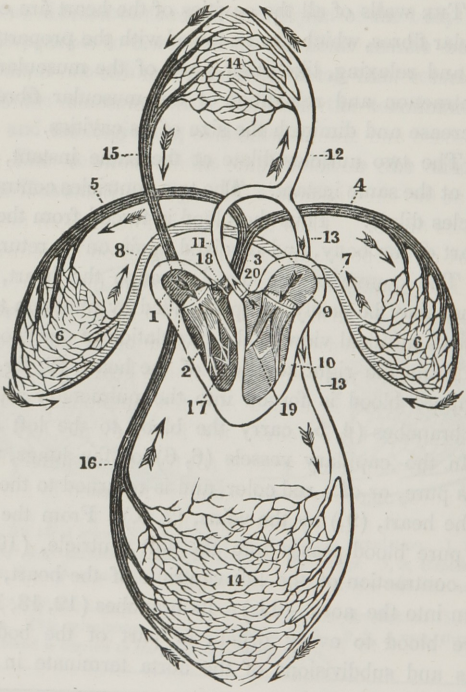
197—203. *Give the physiology of the circulatory organs.* 197. What do the contraction and relaxation of the muscular walls of the heart produce? 198. What is said of the contraction and dilatation of the auricles? Of the ventricles?

Note. From fig. 43, give the course of the blood through the heart, arteries, and veins, or from anatomical outline plates 6 and 7.

vessels, represented by 14, 14. In these hair-like vessels the blood becomes dark-colored, and is returned to the right auricle of the heart, (1,) by the *ve'na ca'va de-scen'dens* (15) and *ve'na ca'va as-cen'dens*, (16.) The tricuspid valves (17) prevent the reflow of the blood from the right ventricle to the right

Fig. 43.



auricle. The semilunar valves (18) prevent the blood passing from the pulmonary artery to the right ventricle. The mitral valves (19) prevent the flow of blood from the left ventricle to the left auricle. The semilunar valves (20) prevent the reflow of blood from the aorta to the left ventricle.

201. The heart aids in forcing the blood through the arteries, to the different parts of the body. Every time the heart contracts, there is a "pulse," or "pulsation," in the arteries.

Experiment. Apply the fingers upon the artery at the wrist, at two different points, about two inches apart; if the pressure be moderately made, the "pulse" will be felt at both points. Let the upper point be pressed firmly, and there will be no pulsation at the lower point; but make strong pressure upon the lower point only, and the pulsation will continue at the upper point; proving that the blood flows from the heart, in the arteries, to different parts of the system.

202. The frequency of the pulse varies according to the age, sex, and degree of health. In adults, it is usually from seventy to seventy-five "beats" in a minute.

203. There is no pulsation in the veins, and the return of the blood to the heart through them can be shown by the following experiments.

Experiments. 1st. Press firmly on one of the veins upon the back of the hand, carrying the pressure toward the fingers; for a moment the vein will disappear. On removing the pressure of the finger, it will reappear, from the blood rushing in from below.

2d. If a tape be tied around the arm above the elbow, the veins below will become larger and more prominent, and also a greater number will be brought in view. At this time, apply the finger at the wrist, and the pulsation of the arteries still continues, showing that the blood is constantly flowing from the heart, through the arteries, into the veins; and the increased size of the veins shows that the pressure of the tape prevents its flowing back to the heart.

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201. What causes the "pulse," or "pulsation," in the arteries? How is it proved that the blood flows from the heart in the arteries? 202. What varies the frequency of the pulse? 203. Is there pulsation in the veins? How is it proved, by experiment 1st, that the blood is returned to the heart by the veins? By experiment 2d?

CHAPTER XV.

HYGIENE OF THE CIRCULATORY ORGANS.

204. *The clothing should be loosely worn.* To have good health, the blood must circulate freely. Consequently, no article of apparel should be worn so as to prevent a free flow of blood through every organ of the body.

205. Strings, bands, or belts, however narrow, should not be worn so tightly as to cause an indentation of the skin of the trunk, or extremities.

Observations. 1st. Inelastic bands, worn upon the lower extremities, are a frequent cause of enlarged veins and painful limbs. 2d. The fulness and the crimson tint of the face, giddiness, fainting, and many derangements in the functions of different organs, are produced by pressure upon the blood-vessels of the trunk.

206. *The skin should be kept clean, and every part of an equal temperature.* These conditions favor free and vigorous circulation.

Observation. When intending to ride in a cold day, wash the face, hands, and feet, in cold water, and rub them smartly with a coarse towel. This is far better than to take spirits into the stomach, to keep the extremities warm.

207. *Muscular exercise is important in maintaining a*

204—214. *Give the hygiene of the circulatory organs.* 204. Why should the clothing be loosely worn? 205. What is said of bands or belts? What is the effect of wearing inelastic bands upon the lower extremities? What is a frequent cause of giddiness, faintness, and derangement of the functions of many organs? 206. In what condition should the skin be kept? Give observation. 207. What is the effect of muscular exercise upon the circulation of blood?

healthy circulation. The muscles, when used, force the blood more rapidly to and from the heart.

Illustration. The coach-driver and teamster throw their arms around their bodies to warm them, when cold; because the muscles that are called into action in swinging the arms, force a greater quantity of blood into the chilled parts, and more heat is produced.

208. Idle men and women, who complain of cold feet, and take "warming bitters" to quicken the blood, would find themselves warmer and more invigorated by calling the muscles into action in the mechanic's shop, or the kitchen, or in some active employment.

Observation. In cold weather, when travelling in cars, the feet will not become chilled so readily when standing as when sitting. Again, the feet will be warmer by allowing them to swing, instead of being supported the whole time, because the muscles, called into action in swinging them, increase the circulation of the blood.

209. *The quality and quantity of the blood modify the action of the heart and blood-vessels.* If this fluid is abundant and pure, the circulatory vessels act with more energy than when it is deficient in quantity or defective in quality.

Illustrations. 1st. In an athletic man, whose heart beats forcibly, and whose pulse is strong, if a considerable quantity of blood is drawn from a vein, as in bleeding, the heart will beat feebly, and the pulse will become weak.

2d. When the blood is made impure by inhaling vitiated air, the action of the heart and arteries is diminished, which produces an effect similar to that which takes place when blood is drawn from a vein.

210. When large blood-vessels are wounded or cut, the

Give illustration. 208. What is better for cold feet and hands than "warming bitters"? Give observation. 209. What effect have the quantity and quality of the blood upon the circulatory vessels? Give illustration 1st. Illustration 2d. 210. What is necessary when large blood-vessels are wounded or cut?

flow of blood must be immediately stopped, or the person will soon die. If a large artery is wounded, the blood will be thrown out in jets, or jerks, every time the pulse beats. The flow of blood can be stopped until a surgeon arrives, either by compressing the vessel between the wound and the heart, or by compressing the end of the divided artery in the wound.

Fig. 44. Fig. 45.

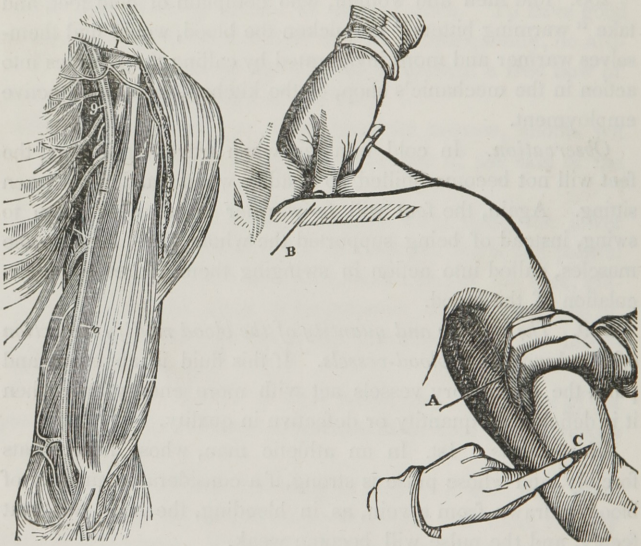

Fig. 44. The track of the large artery of the arm. 1, The collar-bone. 9, 10, The large artery of the arm.

Fig. 45. B, The manner of compressing the artery near the collar-bone. A, The manner of compressing the large artery of the arm, with the fingers. C, The manner of compressing the divided extremity of an artery in the wound, with a finger.

211. After making compression with the fingers, as described and illustrated, take a piece of cloth or handkerchief, twist it cornerwise, and tie a hard knot midway between the two ends.

What is shown by fig. 44? By fig. 45? 211. What is to be done after compressing the wound, as before described?

This knot should be placed over the artery, between the wound and the heart, and the ends carried around the limb and loosely tied. A stick, five or six inches long, should be placed under the handkerchief, which should be twisted until the knot has made sufficient compression on the artery to allow the removal of the fingers without a return of bleeding. Continue the compression until a surgeon can be called.

Fig. 46.

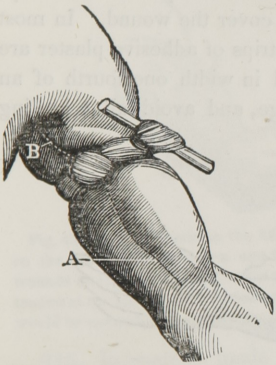

Fig. 47.

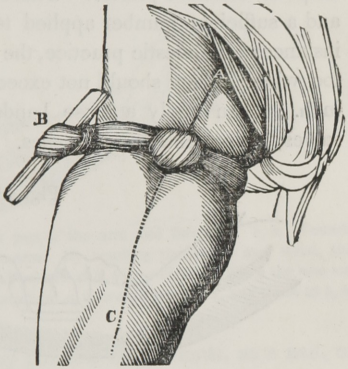

Fig. 46. The method of applying the knotted handkerchief to make compression on this artery. A, B, The track of the large artery of the arm.

Fig. 47. A, C, The track of the large artery of the thigh. B, The method of applying the knotted handkerchief to compress this artery.

Observation. When an artery of the arm is cut, elevating the wounded limb above the head will tend to arrest the flow of blood. In a wound of a lower limb, raise the foot, so that it shall be higher than the hip, until the bleeding ceases.

Illustration. On one occasion, the distinguished Dr. Nathan Smith was called to a person who had divided one of the large arteries below the knee. After trying in vain to find the bleeding vessel, so as to secure it, he caused the foot to be elevated

What is shown by figs. 46, 47? Give observation. Relate a simple operation by Dr. Nathan Smith.

higher than the hip. At the first instant, the blood was forced from the wound about twelve inches; in a minute, it was diminished to three or four; and, in a short time, the bleeding ceased. This Dr. S. called his "*great*" operation; and it was truly great in *simplicity* and *science*.

212. In "flesh wounds," when no large blood-vessel is divided, wash the part with cold water, and, when bleeding has ceased, draw the wound together, and retain it with narrow strips of adhesive plaster. These should be put on smoothly, and a sufficient number applied to cover the wound. In most instances of domestic practice, the strips of adhesive plaster are too wide. They should not exceed in width one fourth of an inch. Then apply a loose bandage, and avoid all "healing salves," ointments, and washes.

Fig. 48.

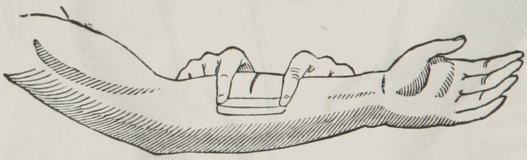

Fig. 48. The manner in which strips of adhesive plaster are applied to wounds.

213. The union of the divided parts is effected by the action of the divided blood-vessels, and not by salves and ointments. The only object of the dressing is to keep the parts together, and protect the wound from air and impurities. *Nature*, in all cases of wounds, performs her own cure. Such simple incisions do not generally require a second dressing, and should not be opened till the parts are healed. In removing the dressing from a wound, both ends of the strips of plaster should be raised and drawn toward the incision. The liability of the wound re-opening is thus diminished.

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212. How should "flesh wounds" be dressed? 213. How is the union of the divided parts effected? What should be avoided? How should the strips of plaster be removed from a wound?

214. The proper position of the limbs favors the union of wounds. If the wound be upon the front part of the leg, between the knee and ankle, extending the knee and bending the ankle will aid its closing. If the wound be upon the back part of the leg, by extending the foot and bending the knee, the gaping of the wound will be diminished. When wounds occur upon the trunk, let the position of the person be regarded.

Fig. 49.

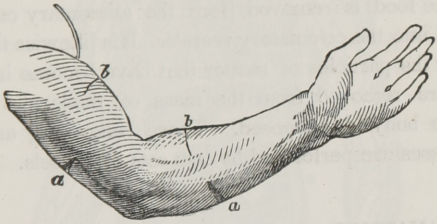

Fig. 49. *a*, *a*, Wounds on the back part of the arm and fore-arm. *b*, *b*, Wounds on the front part of the arm and fore-arm. By bending the elbow and wrist, the wounds at *a*, *a*, are opened, while the wounds at *b*, *b*, are closed. Were the arm extended at the elbow and wrist, the wounds at *a*, *a*, would be closed, and those at *b*, *b*, would be opened.

215. In wounds made by pointed instruments, as a nail, or in lacerated wounds, as those made by forcing a blunt instrument, as a hook, into the soft parts, there will be no direct and immediate union. In these cases, apply a soothing poultice, as one made of linseed meal, and also keep the limb still. It is judicious to consult a physician immediately, in punctured or lacerated wounds, because they often induce the most dangerous diseases.

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214. Does the proper position of the limbs favor the union of wounds?
215. How should punctured and lacerated wounds be dressed?

CHAPTER XVI.

ABSORPTION.

216. ABSORPTION is the process by which the nutrient portion of the food is removed from the alimentary canal to be conveyed into the circulatory vessels. It is likewise the process by which the particles of matter that have become injurious or useless, are removed from the mass of fluids and solids of which the body is composed. These renovating and removing processes are performed by two sets of vessels.

ANATOMY OF THE LYMPHATIC VESSELS.

217. The vessels that act exclusively for the growth and renovation of the system, are found only in the alimentary canal. They are called *lac'te-als.**

218. The vessels whose sole function is to remove particles of matter already deposited, are called *lym-phat'ics.* The radicals, or commencement of the veins, in many, and it may be in all parts of the body, perform the office of absorption.

Fig. 50. A representation of the lymphatic vessels and glands. 1, 2, 3, 4, 5, 6, The lymphatic vessels and glands of the lower limbs. 7, Lymphatic glands. 8, The commencement of the thoracic duct. 9, The lymphatics of the kidney. 10, Of the stomach. 11, Of the liver. 12, 12, The lungs. 13, 14, 15, The lymphatics and glands of the arm. 16, 17, 18, Of the face and neck. 19, 20, Large veins. 21, The thoracic duct. 26, The lymphatics of the heart.

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* See paragraph 142.

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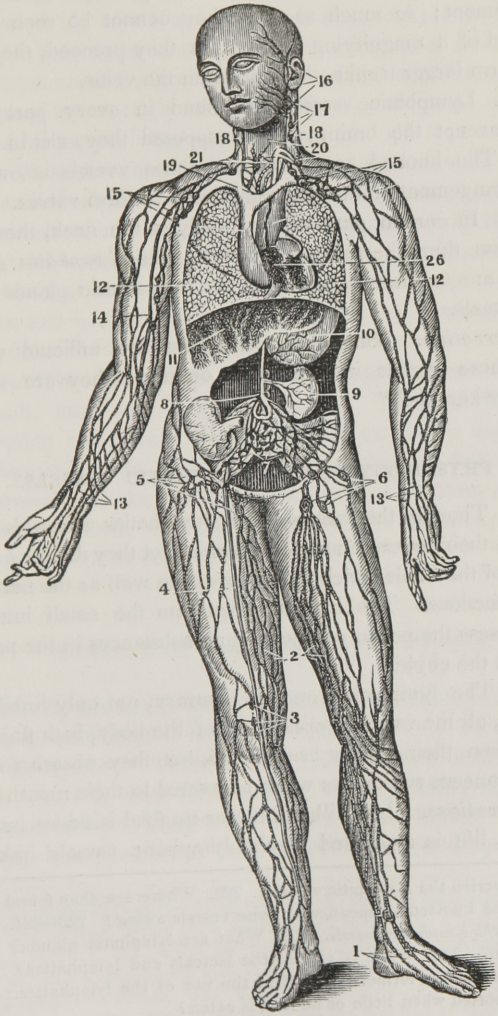
216. What is absorption? 217. What are those vessels called that act exclusively for the growth and renovation of the body? 218—221. *Give the anatomy of the lymphatic vessels.* 218. Name those vessels that remove the atoms already deposited. What other vessels perform the office of absorption? What does fig. 50 represent?

Fig. 50.



219. The LYMPHATIC VESSELS are very minute at their commencement; so much so, that they cannot be seen without the aid of a magnifying glass. As they proceed, they unite and form larger trunks, that open into the veins.

220. Lymphatic vessels are found in every part of the body, except the brain, yet, it is supposed they exist in this organ. The knotted appearance of these vessels is owing to the arrangement of their internal coats, to form valves.

221. In certain parts of the body, as the neck, these vessels pass through small, soft bodies, called *lymphatic glands*, which are to these vessels what the mesenteric glands are to the lacteals.

Observation. Sometimes, when we are afflicted with a cold, these glands in the neck enlarge; they are usually called "kernels."

PHYSIOLOGY OF THE LYMPHATIC VESSELS.

222. Though the lacteals and lymphatics resemble each other in their structure and termination, yet they differ as to the nature of the fluids which they convey, as well as the nature of their functions. The lacteals open into the small intestine, and possess the power of rejecting all substances in the passing food but the chyle.

223. The lymphatics, on the contrary, not only imbibe, or suck up, all the various constituents of the body, both fluid and solid, when their vitality has ceased, but they absorb foreign and extraneous substances when presented to their mouths.

Observations. 1st. When little or no food is taken into the stomach, life is supported by the lymphatic vessels imbibing

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219. Describe the lymphatic vessels. 220. Where are they found? To what is the knotted appearance of these vessels owing? 222—224. *Give the use of the lymphatic vessels.* 221. What are lymphatic glands? Give observation. 222. What is said of the lacteals and lymphatics? Give the function of the former. 223. Give the use of the lymphatics. How is life supported when little or no food is eaten?

the fat, and reconveying it into the circulatory vessels. It is the removal of this substance which causes the emaciation of the face and limbs of a person recovering from a fever. In consumption, the extreme attenuation of the limbs is caused by the absorption, not only of the fat, but also of the muscles and more solid parts of the body.

2d. Animals which live in a half torpid state during the winter, derive their nourishment from the same source. In other words, we may say the starving animal lives for a time upon itself, eating up, by internal absorption, such parts of the body as can be spared, under urgent necessity, to feed these organs, and continue those functions that are absolutely essential to life.

224. The most important absorbing surfaces are the stomach, intestines, lungs, and skin. Through the lungs, absorption is not only very great, but extremely rapid.

Illustration. In inhaling sulphuric ether, or letheon, it is introduced into the vessels of the lungs in the form of vapor, and through them it is rapidly conveyed to the brain, and thus influences the nervous system.

HYGIENE OF THE LYMPHATIC VESSELS.

225. By the action of the lymphatics, substances of an injurious, as well as of a beneficial character may be conveyed into the system. These vessels, under certain conditions, are more active in their office than at other periods; and it is of practical utility to know what influences their action.

226. *The function of these vessels is increased by moisture,*

What causes the extreme attenuation of the limbs in consumption? How do those animals derive their nourishment that live in a half torpid state during winter? 224. What are the most important absorbing surfaces? How is letheon introduced into the system? 225—229. *Give the hygiene of the lymphatic vessels.* 225. What is said respecting the action of the lymphatic vessels? 226. What influences the function of these vessels?

and lessened by an inactive state of the lacteals. Observation shows that the ill-fed, and those persons that live in marshy districts, contract contagious diseases more readily than those individuals who are well fed, and breathe a dry and pure air.

227. *The skin and the apparel of nurses and watchers should be clean, and as free of perspiration as possible.* The air of the sick-room should also be dry. The observance of these conditions tends to prevent the absorption of the poisonous matter of contagious diseases, as small-pox, measles, &c.

Observation. When we have been visiting, or attending on a sick person, it is judicious to change the apparel worn in the sick-room, and also give the skin a thorough bathing. The outside garments, also, should be aired, as poisonous matter may have penetrated the meshes of the cloth.

228. *The stomach should be supplied with food of a nutrient and digestible character, in proper quantities, and at stated periods.* The chyle formed from the food stimulates the lacteals to activity, which activity is attended with an inactive state of the lymphatics of the skin and lungs. Thus due attention should be given to the food of the attendants on the sick, and the children of the family.

Observation. Many individuals, to prevent contracting disease that may be communicated from one person to another, use tobacco, either chewed or smoked; and sometimes alcohol, with decoctions of bitter herbs. These substances do not diminish, but tend to increase the activity of the lymphatics. Thus they make use of the means by which the poisonous matter formed in the system of the diseased person, may be more readily conveyed into their own.

What does observation show? 227. Why should the skin and apparel of nurses and watchers be as free of perspiration as possible? What suggestion when we have been visiting or attending on the sick? 228. Why should the stomach be supplied with food of a nutrient and digestible character? What is said of the use of alcohol or tobacco, in preventing the introduction of the poisonous matter of contagious diseases?

229. *Absorption by the skin is most vigorous when the external layer is removed by vesication, or blistering.* Then, external applications, as ointments, are brought in immediate contact with the orifices, or mouths, of the lymphatics of the skin, and by them rapidly imbibed and circulated through the system. The same results follow, if the skin is only punctured.

Observation. 1st. In case of an accidental wound, it is best immediately to bathe the part thoroughly in pure water, and to avoid all irritating applications. In some instances, it would be well to apply *lunar caustic* immediately.

2d. When shrouding dead bodies, or removing the skin from animals that have died of disease, it would be well to lubricate the hands with olive-oil or lard. This affords protection to the minute portions of the skin from which the external layer may be removed.

3d. In all cases where there is an ulcer, or sore, the part should be covered with something impervious to fluids, as court-plaster, before exposing the system to any animal, vegetable, or mineral poison.

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229. When is absorption by the skin most vigorous? Give observation 1st. Observation 2d. Observation 3d

CHAPTER XVII.

SECRETION.

230. In the human body are found many fluids and solids of dissimilar appearance and character. These are produced by the action of organs called *Se'cre-to-ry*. Some of these organs are of simple structure, while others are very complicated in their arrangement.

ANATOMY OF THE SECRETORY ORGANS.

231. The SECRETORY ORGANS are of three kinds, namely the *Ex-ha'lents*, *Fol'li-cles*, and the *Glands*.

232. The EXHALENTS are supposed to be terminations of the arteries, or capillaries. They are of two kinds, external and internal. The latter terminate on the surfaces within the body, and the former upon the outside.

Fig. 51.

Fig. 51. A secretory follicle. An artery is seen, which supplies the material for its secretion. Follicles are also supplied with veins and organic nerves.

233. The FOLLICLES are small bags, or sacs, in the deeper layer of the skin and mucous membrane. The pores seen on the skin are the outlets of these bodies.

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230. How are the fluids and solids of the body produced? 231—234. *Give the anatomy of the secretory organs.* 231. Name the secretory organs. 232. Describe the exhalents. What does fig. 51 represent? 233. Define follicles.

234. The GLANDS are the chief agents of secretion in the body. They are formed of minute arteries, veins, and tubes, wound together. These organs vary in size from a mustard-seed to that of the liver, which weighs from two to four pounds. Every gland, however minute, has a small duct for collecting and carrying off the secreted fluid.

PHYSIOLOGY OF THE SECRETORY ORGANS.

235. SECRETION is one of the most obscure and mysterious functions of the body. It has the same meaning (physiologically) as *separation.* Not only is the process by which substances are separated from the blood, called *secretion*, but the same term is also applied to substances thus separated.

Fig. 52.

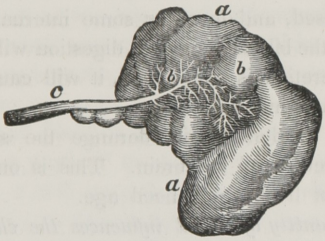

Fig. 52. *a, a,* A secretory gland. *b, b,* Minute ducts that are spread through the glands. These coalesce to form the main duct, *c.*

236. All the fluids of the body are derived from the blood, and this element, when distributed to the different glands and follicles, is similar in composition and character; but the fluids secreted by them, vary in appearance in a remarkable degree. The office of the glands is principally to form different secre-

234. What is said of the glands? Explain fig. 52. 235—237. *Give the physiology of the secretory organs.* 235. What is secretion? 236. From what are all the fluids of the body derived? What is the principal office of the glands?

tions. Thus the salivary glands secrete the insipid saliva; the liver, the yellow, ropy bile; and the kidneys, the acrid urine.

237. When any substance which is not demanded for nutrition, or does not give nourishment to the system, is taken up by the lymphatic vessels and conveyed into the blood, it is discharged by secretions.

Illustration. A few years since, a poor inebriate was carried to a London hospital in a state of intoxication. He lived but a few hours. On examining his brain, nearly half a gill of fluid, strongly impregnated with gin, was found in the cavities of this organ. This was secreted from the vessels of the brain.

HYGIENE OF THE SECRETORY ORGANS.

238. *Unless the secretions are regularly maintained, disease will be the ultimate result.* Let the secretions from the skin be suppressed, and fever or some internal inflammation will follow. If the bile is impeded, digestion will be impaired. If any other secretion is suppressed, it will cause a derangement of the various internal organs.

Observation. Ardent spirits derange the secretions, and change the structure of the brain. This is one reason why inebriates do not live to advanced age.

239. *The quantity of blood influences the character of the secretions.* If it is lessened to any great extent, the secretions will be lessened, as well as changed in character.

Illustration. When a person has lost a considerable quantity of blood, there is a sensation of thirst in the throat, attended with a cold, pale, dry skin. When reaction comes on, the

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237. What becomes of those substances which are taken up by the lymphatics, and do not nourish the body? How is this illustrated? 238—241. *Give the hygiene of the secretory organs.* 238. What is the effect on the system if the secretions are not regularly maintained? What is a reason that inebriates do not live to an advanced age? 239. What effect on the secretions when the quantity of blood is lessened? How is this illustrated?

perspiration is cold, attended with nausea, and sometimes vomiting.

240. *The amount of action modifies the condition of the secretory organs.* When a secretory organ is excessively stimulated, its vigor and energy are reduced. The subsequent debility may be so great as to suppress or destroy its functional power.

Illustrations. 1st. In those sections of the country where flax is spun on a "foot-wheel," the spinners sometimes moisten the thread with saliva. This seems to operate economically for a time, but debility of the salivary organs soon follows, and they are incapable of supplying saliva sufficient to moisten the food, producing, in a short time, disease of the digestive organs.

2d. The habit of continual spitting, which attends the chewing of tobacco and gums, induces debility, not only of the salivary glands, but of the system generally.

241. The secretions are much influenced by mental emotions. If we smell savory food, there will be an increased flow of saliva; if we hear the intelligence of the death of a cherished friend, the tear will quickly course down the cheek.

Observation. Such is the nice sympathy which exists between different parts of the body, that in the evenings of the warm season, a chill upon the impressible skin that suppresses the perspiration, is frequently followed by a diarrhœa, dysentery, or cholera morbus. These can be prevented by avoiding the chill. An efficient means of relief, is, immediately to restore the skin to its proper action.

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240. What is the effect if a secretory organ is excessively stimulated? How is this effect illustrated by the use of the salivary glands? 241. Does the state of the mind influence the secretions? What is said of the sympathy between different parts of the body?

CHAPTER XVIII.

NUTRITION.

242. THE BLOOD is the nutritive fluid of animals. It is composed of two parts — a watery fluid, called *se'rum*, and a solid portion, called *co-ag'u-lum*, (clot.)

Observation. That portion of the serum which remains fluid after coagulation by heat has taken place, is called *se-ros'i-ty.* It is more abundant in the blood of old, than in that of young animals; and it forms the "red gravy" in roasted meats.

243. The blood is not necessarily red. It may be white, as in the fish; transparent, as in the insect; or yellowish, as in the reptile. There is no animal in which the blood is red in all parts of the body. The ligaments and tendons, in man, are not supplied with red, but with white blood.

244. NUTRITION is the vital act by which the different parts of the body renew the materials of which they are composed. Digestion, circulation, absorption, and respiration, are but separate links in the chain of nutrition, which would be destroyed by the absence of any one of them.

245. The nutritive process is a kind of secretion, by which particles of matter are separated from the blood, and conveyed with wonderful accuracy to the appropriate textures, or parts of the body.

246. The function of the nutrient vessels antagonize those of absorption; while one system is constructing, with beautiful

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242. What is the nutritive fluid of animals? Of what is it composed? What forms the red gravy in roasted meat? 243. What is said of the color of the blood? 244—248. *What remarks respecting nutrition?* 244. What is nutrition? 245. What is said of the nutritive process? 246. What can you say of the function of the nutrient vessels?

precision, the animal frame, the other is diligently employed in pulling down this complicated structure. But amid this simultaneous renovation and decay, the form and beauty of the organs are preserved.

Observation This ever-changing state of the body is shown by giving animals colored matter, mixed with their food, which in a short time tinges their bones with the same color as the matter introduced. Let it be withdrawn, and in a few days the bones will assume their former color — evidently from the effects of absorption. The changeful state of the body is further shown, by the losses to which it is subjected; by the necessity of aliment; by the emaciation which follows abstinence from food.

247. The renewal of every part of the body is not perfected merely by the passage of the blood through the arteries of the systemic circulation, but by the smallest capillary vessels, called the *nutrient arteries.*

248. "As the blood goes the round of the circulation, the nutrient capillary vessels select and secrete those parts which are similar to the nature of the structure, and the other portions pass on; so that every part takes up and converts to its own use the very principles which it requires for its growth; or, in other words, as the vital current approaches each organ, the particles appropriate to it feel its attractive force, — obey it, — quit the stream, — mingle with the substance of its texture, — and are changed into its own true and proper nature."

Illustration. When a bone is broken, or a nerve wounded, minute vessels shoot out from the living parts, and immediately commence their operations, by depositing bony matter, where it is required to unite fractured bones, and nervous substance to heal the wounded nerve.

Give a proof of the ever-changing state of the body. Give other instances illustrative of the changeful state of the body. 247. By what vessels is the renewal of every part of the body perfected? 248. What is said of the office of the nutrient capillary vessels? When a bone is fractured, by what process is it healed?

Fig. 53.

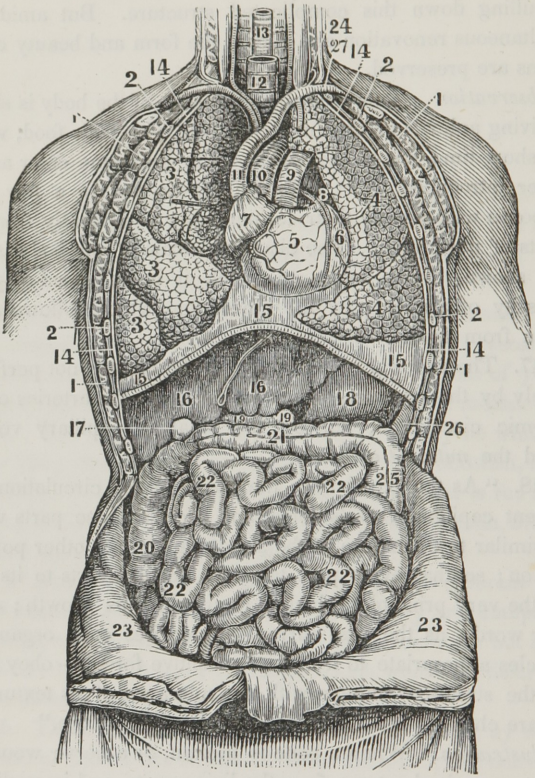

Fig. 53. A front view of the organs within the chest and abdomen. 1, 1, 1, 1, The muscles of the chest. 2, 2, 2, 2, The ribs. 3, 3, 3, The upper, middle, and lower lobes of the right lung. 4, 4, The lobes of the left lung. 5, The right ventricle of the heart. 6, The left ventricle. 7, The right auricle of the heart. 8, The left auricle. 9, The pulmonary artery. 10, The aorta. 11, The vena cava descendens. 12, The trachea. 13, The œsophagus. 14, 14, 14, 14, The pleura. 15, 15, 15, The diaphragm. 16, 16, The right and left lobe of the liver. 17, The gall-cyst. 18, The stomach. 26, The spleen. 19, 19, The duodenum. 20, The ascending colon. 21, The transverse colon. 25, The descending colon. 22, 22, 22, 22, The small intestines. 23, 23, The abdominal walls turned down. 24, The thoracic duct, opening into the left subclavian vein, (27.)

CHAPTER XIX.

THE RESPIRATORY ORGANS.

249. THE nutrient portion of the food is poured into the vein at the lower part of the neck, and is carried to the right cavities of the heart. The fluid in these cavities consists of the chyle mixed with the venous blood. Neither of these two elements is fitted to promote the growth or repair the waste of the body. They must be subjected to a process, by which the first can be converted into blood, and the second freed of its impurities, (carbonic acid and water.) This is effected by the *Respiratory Organs.*

ANATOMY OF THE RESPIRATORY ORGANS.

250. The ORGANS OF RESPIRATION are the *Lungs*, (lights;) the *Tra'che-a*, (wind-pipe;) the *Bronch'i-a*, (subdivisions of the trachea;) and the *Air Ves'i-cles*, (air-cells at the extremities of the bronchia.) The *Di'a-phragm*, (midriff;) ribs, and several muscles, also aid in the respiratory process.

251. The LUNGS are conical organs, one on each side of the chest, embracing the heart, and separated from each other by a membranous partition. The color of the lungs is a pinkish gray, mottled, and variously marked with black. They are composed of air-cells and tubes, beside many small blood-vessels.

252. Each lung is surrounded by a membrane, called the

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249. What fluids are conveyed into the right cavities of the heart? What is necessary before they can be adapted to the wants of the body? By what organs are these changes effected? 250—256. *Give the anatomy of the respiratory organs.* 250. Name the respiratory organs. What organs also aid in the respiratory process? 251. Describe the lungs. 252. Describe the pleura.

pleu'ra, which not only surrounds these organs, but is reflected upon the walls of the chest. The lungs, however, are on the outside of the pleura, in the same way as the head is on the outside of a cap doubled upon itself.

Observation. When this membrane, that covers the lungs, and also lines the chest, is inflamed, the disease is called "pleurisy."

253. The TRACHEA is situated in the front part of the neck, and extends from the mouth to the lungs. It is composed of cartilaginous rings, which are very elastic.

254. The BRONCHIA are the divisions of the trachea at its lower extremity, behind the upper part of the heart. One branch passes to the right lung, and the other to the left. These branches, upon entering the lung, divide into an almost infinity of smaller branches.

Illustration. The trachea may be compared to the trunk of a tree; the bronchia to two large branches; the subdivisions of the bronchia to the branchlets and twigs; the air-cells to the buds seen on the twigs in the spring.

255. The AIR-CELLS are very small sacs, or bladders, at the end of the minute divisions of the bronchia. Their walls are extremely thin, the interior of which, as well as the trachea and bronchia, are lined by mucous membrane. These cells are variable in size, and are most numerous in the middle and lower part of the lungs.

Observation. When the mucous membrane of a few of the larger branches of the wind-pipe is slightly inflamed, it is called a "cold;" when the inflammation is greater, and extends to the lesser air-tubes, it is called bronchitis. Coughing is a violent expulsory effort, by which air is suddenly forced through the bronchia and trachea to remove offending matter.

What is the disease called when this membrane is inflamed? 253. Describe the trachea. 254. What are the bronchia? To what may the trachea and branches be compared? 255. Describe the air-cells. Where are they the most numerous? Mention some diseases of the membrane that lines the bronchia.

Observation. The structure of the trachea and lungs may be illustrated by taking these parts of a calf or sheep, and inflating the bronchial tubes by forcing air into the wind-pipe with a pipe or quill. The internal structure may then be seen by opening the different parts.

Fig. 54.

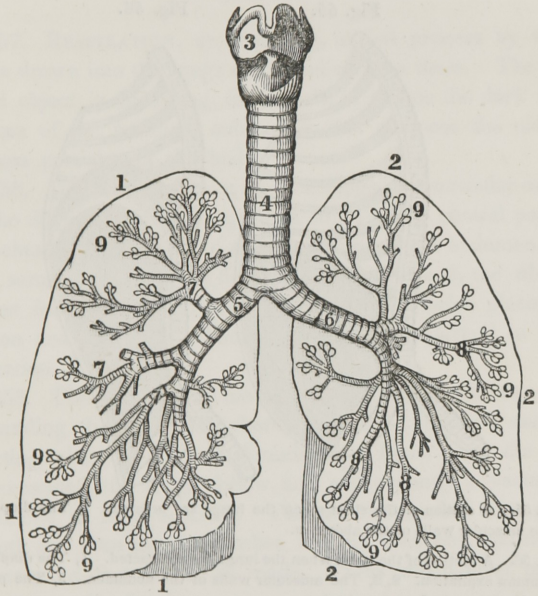

Fig. 54. A representation of the larynx, trachea, bronchia, and air-cells. 1, 1, 1, An outline of the right lung. 2, 2, 2, An outline of the left lung. 3, The larynx. 4, The trachea. 5, The right bronchial tube. 6, The left bronchial tube. 7, 7, 7, 8, 8, 8, Bronchial tubes of right and left lung. 9, 9, 9, 9, 9, 9, Air-cells.

256. The DIAPHRAGM is a flexible, circular partition, that separates the respiratory from the digestive organs, and the chest

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How can the structure of the trachea and lungs be illustrated? 256. Describe the diaphragm.

from the abdomen. Its margin is attached to the spinal column, the sternum, and cartilages of the lower ribs. In a state of repose, its centre rises into the chest in the form of an arch. When air is forcibly expelled from the lungs, its upper point reaches as high as the fourth rib. It is depressed as low as the seventh rib, when air is drawn into the lungs.

Fig. 55. Fig. 56.

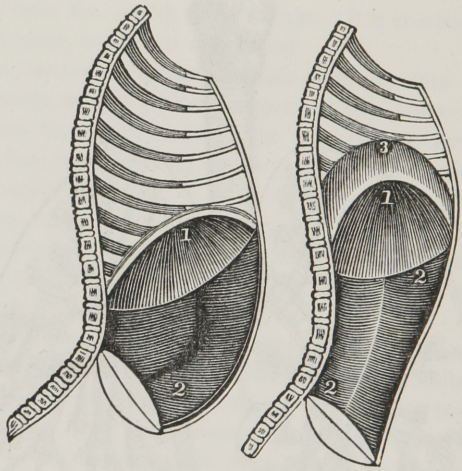

Fig. 55. A section of the chest when the lungs are inflated. 1, The diaphragm. 2, The muscular walls of the abdomen.

Fig. 56. A section of the chest when the lungs are contracted. 1, The diaphragm, in common expiration. 2, 2, The muscular walls of the abdomen. 3, The position of the diaphragm in forced expiration.

These engravings show the diaphragm to be more convex, and the walls of the abdomen more flattened, when the lungs are collapsed, than when they are inflated.

What is its form when not in action? How high does its central portion rise in forced expiration? How low does it descend when air is drawn into the lungs? What do figs. 55 and 56 illustrate?

CHAPTER XX.

PHYSIOLOGY OF THE RESPIRATORY ORGANS.

257. Respiration, or breathing, is that process by which air is drawn into the lungs and expelled from them. The principal object in breathing, in animals, is to free the dark blood of one of the principal substances that compose the old and useless particles of the body.

258. When air is drawn into the lungs, the muscular margin of the diaphragm contracts, which depresses its central portion; the chest is then enlarged at the expense of the abdomen. At the same time that the diaphragm is depressed, the ribs are thrust forward and upward by means of muscles placed between and on them. Thus the chest is enlarged in every direction.

259. The lungs follow the variations of capacity in the chest, expanding their air-cells when the latter is enlarged, and contracting when the chest is diminished. Thus, when the chest is expanded, the lungs follow, and consequently a vacuum is produced in their air-cells. The air then rushes through the mouth and nose into the trachea and its branches, and fills the vacuum as fast as it is made. This mechanical process constitutes *inspiration.*

260. After the expansion of the chest, the muscles that elevated the ribs relax, together with the diaphragm. The elasticity of the cartilages of the ribs depresses them, and the

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257—266. *Give the use of the respiratory organs.* 257. What is respiration? What is the principal object in breathing? 258. Describe how the chest is enlarged in respiration? 259. Do the lungs follow the variations of capacity in the chest? What constitutes inspiration? 260. How is the air expelled from the lungs?

cavity of the chest is diminished, attended by the expulsion of a portion of the air from the lungs. At the same time, the muscles that form the front walls of the abdominal cavity, contract and press the alimentary canal, stomach, and liver, upward against the diaphragm; this, being relaxed, yields to the pressure, rises upward, and presses upon the lungs, which retreat before it, and another portion of air is expelled from these organs. This process is called *expiration.*

Fig. 57.

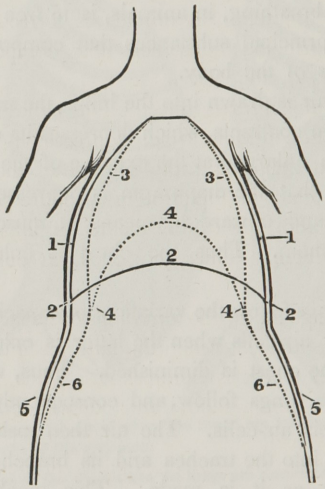

Fig. 57. A front view of the chest and abdomen in respiration. 1, 1, The position of the walls of the chest in inspiration. 2, 2, 2, The position of the diaphragm in inspiration. 3, 3, The position of the walls of the chest in expiration. 4, 4, 4, The position of the diaphragm in expiration. 5, 5, The position of the walls of the abdomen in inspiration. 6, 6, The position of the walls of the abdomen in expiration.

261. Thus it is obvious that the enlargement of the chest, or inspiration, is produced in two ways—1st. By the depres-

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What does this constitute? Explain fig. 57. 261. In how many ways is the chest enlarged? Name them.

sion of the central, arched portion of the diaphragm. 2d. By the elevation of the ribs. On the contrary, the contraction of the chest, or expiration, is produced by the depression of the ribs, and elevation of the central part of the diaphragm. These movements are successive during life, and constitute *respiration.*

Experiment. Place the ear upon the chest of a person, and a murmuring sound will be heard, somewhat like the soft sighings of the wind through forest trees. This sound is caused by the air rushing in and out of the lungs, and is peculiarly distinct in the child.

262. As before mentioned, the dark, impure blood, that passes from the heart to the lungs, is unfit to sustain the vital action of the various organs of the body. Its impurities must be removed. When this is done, the blood loses its blackish red color, and becomes of a bright scarlet red.

263. The dark color of the blood is owing to the presence of carbonic gas. This is formed in the blood-vessels by the union of carbon (the principal element of the dead, waste atoms) and oxygen.

264. There is also, mixed with the dark blood, hydrogen, which, when united with oxygen, forms water. Both carbon and hydrogen are supplied to the blood through the food. They are carried out of the system not only by the lungs, but by the skin and other organs.

Observation. The presence of carbonic acid and watery vapor in the expired air, can be proved by the following experiments. 1st. Breathe into lime-water, and in a few minutes it will become of a milk-white color. This is owing to the carbonic acid of the breath uniting with the lime, forming the *carbonate of lime.*

How is it contracted? What do these successive movements constitute? Give an experiment. 262. What change must be made in the blood before it can sustain life? 263. To what is the dark color of the blood owing? Where is this gas formed? 264. What element beside carbon is found in the blood? What does it form when united with oxygen?

2d. Breathe upon a cold, dry mirror, for a few minutes, and it will be covered with moisture. This is condensed vapor from the lungs. In warm weather, this watery vapor is invisible in the expired air; but, in a cold, dry morning in winter, the successive jets of vapor issuing from the mouth and nose are sufficiently obvious.

265. Atmospheric air, or that which fills the air-cells of the lungs, is composed of two gases, *ox'y-gen* and *ni'tro-gen*. Oxygen has the property of supporting life, while nitrogen alone would destroy it. But combined with the former gas, it serves to neutralize the otherwise irritating action of the oxygen.

Fig. 58.

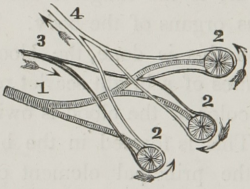

Fig. 58. 1, A bronchial tube divided into three branches. 2, 2, 2, Air-cells. 3, Branches of the pulmonary artery, that spread over the air-cells. Through the pulmonary artery, the dark, impure blood is carried to the air-cells of the lungs. 4, Branches of the pulmonary vein, that commence at the minute terminations of the pulmonary artery. Through the pulmonary vein, the red blood is returned to the heart.

266. We will now pass to the change which the air effects when it comes in contact with the blood in the lungs. As the impure blood is passing in the minute vessels over the air-cells, the oxygen passes through the extreme thin coats of the air-cells and blood-vessels, and unites with the blood. At the same time, the carbonic acid and watery vapor leave the blood, and pass through the coats of the blood-vessels and air-cells, and mix with the air in the cells. These are expelled from the air-

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How are these elements supplied to the blood? How may the presence of carbonic acid in the expired air be proved? The presence of watery vapor? 265. Of what is the air composed? What property has oxygen? Has nitrogen? 266. Explain how the blood is changed by the action of the air.

cells every time we breathe. This interchange of gases produces the change in the color of the blood.

Experiment. To show that gases may be interchanged through membranes, fill a bladder with dark blood drawn from any animal. Tie the bladder closely, and suspend it in the air. In a few hours, the blood next the membrane will have become of a bright red color. This is owing to the oxygen from the air passing through the bladder, and uniting with the blood, while the carbonic acid has escaped through the membrane.

Fig. 59.

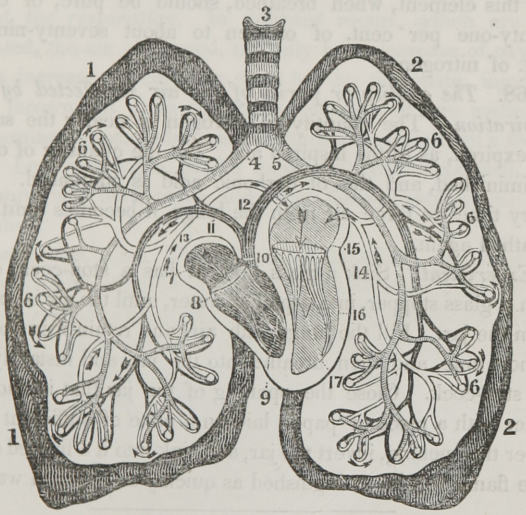

Fig. 59. An ideal view of the pulmonary circulation. 1, 1, The right lung. 2, 2, The left lung. 3, The trachea. 4, The right bronchial tube. 5, The left bronchial tube. 6, 6, 6, 6, Air-cells. 7, The right auricle. 8, The right ventricle. 9, The tricuspid valves. 10, The pulmonary artery. 11, The branch to the right lung. 12, The branch to the left lung. 13, The right pulmonary vein. 14, The left pulmonary vein. 15, The left auricle. 16, The left ventricle. 17, The mitral valves.

Note. Let a review of the anatomy and physiology of the respiratory organs be given from figs. 53, 59, or from outline anatomical plates 5 and 7.

CHAPTER XXI.

HYGIENE OF THE RESPIRATORY ORGANS.

267. For man to enjoy the highest degree of health, it is necessary that the impure "venous" blood be properly changed. As this is effected in the lungs by the action of the air, it follows that this element, when breathed, should be pure, or contain twenty-one per cent. of oxygen to about seventy-nine per cent. of nitrogen.

268. *The quality or purity of the air is affected by every respiration.* The quantity of nitrogen is nearly the same in the expired, as in the inspired air. But the quantity of oxygen is diminished, and that of carbonic acid is increased. Thus, every time we force air from the lungs, it becomes unfit to be breathed again.

Experiment. Sink a glass jar that has a stop-cock, or one with a glass stopper, into a pail of water, until the air is expelled from the jar. Fill the lungs with air, and retain it in the chest a short time, and then breathe into the jar, and instantly close the stop-cock. Close the opening of the jar that is under the water with a piece of paper laid on a plate of sufficient size to cover the opening, invert the jar, and sink into it a lighted candle. The flame will be extinguished as quickly as if put in water.*

* As a substitute for a jar with a stop-cock, take a piece of lead pipe bent in the form of a siphon, and insert it in the mouth of a reversed jar. This experiment is as conclusive whether the air is inhaled once only, or breathed many times.

267—285. *Give the hygiene of the respiratory organs.* 267. What is necessary that man may enjoy the highest degree of health? What proportion of oxygen and nitrogen should the inspired air contain? 268. What is the difference between inspired and expired air? How can this difference be shown?

Remove the carbonic acid by inverting the jar, and place a lighted candle in it, and the flame will be as clear as when out of the jar.

Observation. It is familiarly known that a taper will not burn where carbonic acid exists in any considerable quantity, or when there is a marked deficiency of oxygen. From this originated the judicious practice of sinking a lighted candle into a well or pit before descending into it. If the flame is extinguished, respiration cannot there be maintained, and life would be sacrificed should a person venture in until the noxious air is removed.

269. *Air, in which lamps will not burn with brilliancy, is unfitted for respiration.* In crowded rooms, which are not ventilated, the air is vitiated, not only by a decrease of oxygen and an increase of carbonic acid, but by the waste, injurious atoms thrown out from the lungs and skin of the audience. The burning lamps, under such circumstances, emit but a feeble light. Let the oxygen gas be more and more expended, and the lamps will burn more and more feebly, until nearly extinguished.

Illustrations. 1st. The effects of breathing the same air again and again, are well illustrated by an incident that occurred in one of our halls of learning. A large audience had assembled in an ill-ventilated room, to listen to a lecture; soon the lamps burned so dimly that the speaker and audience were nearly enveloped in darkness. The oppression, dizziness, and faintness, experienced by many of the audience, induced them to leave; and in a few minutes after, the lamps were observed to rekindle, owing to the exchange of pure air on opening the door, which supplied to them oxygen.

2d. The "Black Hole of Calcutta" received its name from the fact, that one hundred and forty-six Englishmen were shut

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Why should a lighted candle be sunk in a well or pit before a person descends into it? 269. How is the air of crowded, unventilated rooms vitiated? What effect has such air upon the burning lamps? Give an incident that illustrates the effects of impure air upon burning lamps.

up in a room eighteen feet square, with only two small windows on the same side to admit air. On opening this dungeon, ten hours after their imprisonment, only twenty-three were alive. The others had died from breathing impure air, that contained animal matter from their own bodies.

270. *Churches, concert-halls, and school-rooms should be well ventilated.* If they are not, the persons assembled in them will be restless, and complain of languor, and perhaps headache. These unpleasant sensations are caused by a want of pure air, to give an adequate supply of oxygen to the lungs.

Observation. In all school-rooms, where there is not adequate ventilation, it is advisable to have a recess of five or ten minutes each hour. During this time, let the pupils breathe fresh air, and open the doors and windows, so that the air of the room shall be completely changed.

271. *While occupying a room, we are insensible to the gradual vitiation of the air.* This is the result of the diminished sensibility of the nervous system, and gradual adaptation of the organs to blood of a less stimulating character.

272. *In the construction of every inhabited room, there should be adequate means of ventilation, as well as warming.* No room is well ventilated, unless as much pure air is brought into it, as the occupants vitiate at every respiration. This can be effected by making an aperture in the ceiling of the room, or by constructing a ventilating flue in the chimney. This should be in contact with the flues for the escape of smoke, but separated from them by a thin brick partition.

273. Provision should also be made, by which pure air may be constantly coming into the room, as the crevices of the

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Of the effects of breathing impure air. 270. Why should churches and school-rooms be well ventilated? What suggestion when a school-room is not well ventilated? 271. Why are we insensible of the vitiation of the air of the room in which we are seated? 272. What is very important in the construction of every inhabited room? How can a room be well ventilated? 273. Should provision be made to have pure air introduced into a room?

doors and windows are not sufficient. There should be an aperture at or near the floor, to connect with the outer walls of the building or external air.

274. The sick-room, particularly, should be so arranged that the impure air may escape, and pure air be constantly coming into the room. Curtains around the bed, and the sheet over the face, are injurious. The effect is similar to that produced by sleeping in a small, unventilated room.

275. The change that is effected in the blood while passing through the lungs, not only depends upon the purity of the air, but the amount inspired. The quantity varies according to the size of the chest, and the movement of the ribs and diaphragm.

Fig. 60.

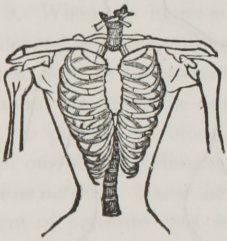

Fig. 61.

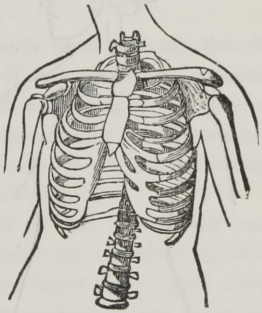

Fig. 60. The skeleton of a deformed chest.

Fig. 61. The skeleton of a well-formed chest.

276. *The size of the chest and lungs can be diminished by moderate and continued pressure.* This is most easily done in infancy, when the cartilages and ribs are very pliant; yet it can be effected at more advanced periods of life.

Observations. 1st. The Chinese, by compressing the feet of female children, prevent their growth; so that the foot of a

274. What rooms particularly should be well ventilated? Why are curtains around a bed injurious? 275. What varies the amount of air received into the lungs? 276. How can the size of the chest be diminished? What does fig. 60 represent? Fig. 61? Give observation 1st.

Chinese belle is not larger than the foot of an American girl of five years.

2d. The American women *compress their chests*, to prevent their growth; so that the chest of an *American belle* is not larger than the chest of a Chinese girl of five years. Which country, in this respect, exhibits the greater intelligence?

3d. The chest can be deformed by making the linings of the waists of the dresses tight, as well as by corsets. Tight vests, upon the same principle, are also injurious.

Fig. 62. Fig. 63.

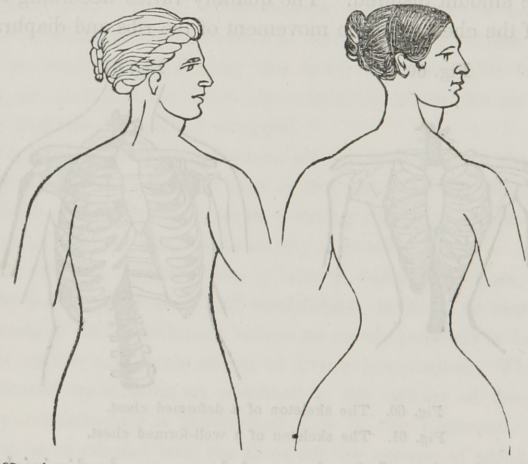

Fig. 62. A correct outline of the Venus de Medici, the *beau ideal* of female symmetry.

Fig. 63. An outline of a well-corseted modern beauty. One has an artificial, insect waist; the other, a natural waist. One has sloping shoulders, while the shoulders of the other are comparatively elevated, square, and angular. The proportion of the corseted female below the waist, is also a departure from the symmetry of nature.

277. In children, who have never worn close garments, the circumference of the chest is generally about equal to that of

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Give observation 2d. How may the chest be deformed as given by observation 3d? 277. What is the size of the chest of a child that has always worn loose clothing?

the body at the hips; and similar proportions would exist through life, if there were no improper pressure of the clothing. Those persons that have large, full chests, particularly at the lower part, are not so liable to diseases of the lungs, as those who have narrow, contracted chests.

278. A contracted chest, caused either by injudicious dressing, or by any other means, can be enlarged, although the person is thirty years of age, by permitting the muscles that elevate the ribs and diaphragm to perform their proper function.

Observation. Scholars, and persons who sit much of the time, should frequently, during the day, breathe full and deep, so that the smallest air-cells may be fully filled with air. While exercising the lungs, the shoulders should be thrown back and the head held erect.

279. When the lungs are properly filled with air, the chest is enlarged in every direction. If any article of apparel is worn so tight as to prevent the full expansion of the chest and abdomen, the lungs, in consequence, do not receive air sufficient to purify the blood. The penalty for thus violating a law of our being, is disease and suffering.

Observation. Many individuals do not realize the small amount of pressure that will prevent the enlargement of the chest. This can be shown by drawing a tape tightly around the lower part of the chest of a vigorous adult, and confining it with the thumb and finger. Then endeavor fully to inflate the lungs, and the movement of the ribs will be much restricted.

280. *The position in standing and sitting influences the movement of the ribs and diaphragm.* When the shoulders are thrown back, and when a person stands or sits erect, the dia-

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What persons are most free from diseases of the lungs? 278. Can narrow, contracted chests be enlarged? How? What practice is recommended to scholars and sedentary persons? 279. What is the effect if the apparel is worn so tight as to prevent the full expansion of the chest? How can the amount of pressure necessary to prevent the enlargement of the chest be shown? 280. Show the effect of position on the movement of the ribs and diaphragm.

phragm and ribs have more freedom of motion, and the abdominal muscles act more efficiently; thus the lungs have broader range of movement, than when the shoulders incline forward, and the body is stooping.

281. *The state of the mind exercises a great influence upon respiration.* If we are depressed by grief, or feel anxious about friends or property, the diaphragm and muscles that elevate the ribs will not contract with the same energy as when the mind is influenced by joy, mirth, and other enlivening emotions. Consequently, our breathing is not as frequent and full in the former as in the latter condition.

282. *To recover persons apparently drowned*, it is necessary to press the chest, suddenly and forcibly, downward and backward, and instantly discontinue the pressure. Repeat this without intermission, until a pair of bellows can be procured. When the bellows are obtained, introduce the nozzle well upon the base of the tongue, and surround the mouth and nose with a towel or handkerchief, to close them. Let another person press upon the projecting part of the neck, called "Adam's apple," while air is introduced into the lungs through the bellows. Then press upon the chest, to force the air from the lungs, to imitate natural breathing.

283. Continue the use of the bellows, and forcing the air out of the chest, for an hour at least, unless signs of natural breathing come on. Wrap the body in warm, dry blankets, and place it near the fire, to preserve the natural warmth, as well as to impart artificial heat. Every thing, however, is secondary to filling the lungs with air. Avoid all friction until breathing is restored. Send for medical aid immediately.

284. *In cases of apparent death from hanging or strangling*, the knot should be untied or cut immediately; then use artificial respiration, or breathing, as directed in apparent death

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281. Does the state of the mind influence our breathing? 282. How should persons apparently drowned be treated? 284. How should apparent death from strangling be managed?

from drowning. In asphyxia from electricity, (lightning,) artificial respiration should be resorted to.

Observation. It is a common impression, in many sections of the country, that the law will not allow the removal of the cord from the neck of a body found suspended, unless the coroner be present. It is therefore proper to say, that no such delay is necessary, and that no time should be lost in attempting to resuscitate the strangled person.

285. When life is apparently suspended, from breathing carbonic acid gas, the person should be carried into the open air. The head and shoulders should be slightly elevated, the face and chest should be sponged or sprinkled with cold water, or cold vinegar and water. Apply friction to the skin, with a coarse cloth or flesh-brush, and resort to artificial respiration.

Observation. 1st. Many persons have died from breathing carbonic acid that was formed by burning charcoal in an open pan or portable furnace, for the purpose of warming their sleeping-rooms.

2d. In resuscitating persons apparently dead from the already mentioned causes, if a pair of bellows cannot be procured immediately, let their lungs be inflated by air expelled from the lungs of some person present. To have the expired air as pure as possible, the person should quickly inflate his lungs, and instantly expel the air into those of the asphyxiated person. *Place the patient in pure air, admit attendants only into the apartment, and send for a physician without delay.*

What treatment should be adopted in asphyxia from lightning? What is said of the impression, common in some sections of the country, when a body is found suspended? 285. What should be done when carbonic acid has been inhaled? What sad results frequently follow the burning of charcoal in a close room? Give the 2d observation.

CHAPTER XXII.

ANIMAL HEAT.

286. The true sources of animal heat are still imperfectly known. We see certain phenomena, but the causes are hidden from our view. Its regular production, to a certain degree, is essential both to animal and vegetable life.

287. The temperature of the human body is about ninety-eight degrees, whether we examine it in the Icelander in his snowy hut, or the Negro under an equatorial sun.

288. To enable man to maintain an equilibrium of temperature under such extremes of heat and cold, naturally suggests two inquiries. 1st. By what organs is animal heat generated? 2d. By what means is its uniformity maintained?

289. In combustion, or burning of wood, coal, oil, &c., the oxygen of the atmosphere unites with the carbon and hydrogen of these substances, and carbonic acid and watery vapor are produced. This process is attended with the disengagement of heat.

290. The quantity of heat disengaged in combustion is always in proportion to the amount of carbon and hydrogen consumed; thus a piece of wood weighing one pound, in burning slowly, would give out the same quantity of heat as a pound of shavings of the same wood, in burning rapidly. Upon the principle of combustion, the production of animal heat may be understood.

286—296. *What is said respecting animal heat?* 286. Is the true source of animal heat known? 287. What is the temperature of the human body? 288. What inquiries are naturally suggested? 289. What takes place in the combustion, or burning of wood, oil, &c.? 290. Upon what does the quantity of heat disengaged in combustion depend? How is this illustrated?

291. As before mentioned, the food contains carbon and hydrogen. These exist in the chyle. The old and waste atoms of the body, likewise, contain the same elements. It is now supposed that the oxygen of the inspired air enters the capillary vessels of the lungs, and mingles with the blood, with which it is carried to the heart, and from thence to the nutrient capillary vessels of every part of the system.

292. In the capillary vessels, the oxygen of the arterial blood unites with the carbon and hydrogen of the waste atoms, (which are conveyed into the blood by the lymphatics,) and carbonic acid and water are formed.

293. This change of state among the particles of bodies is attended with the disengagement of heat. The carbonic acid and water are returned to the lungs in the blood, and carried out of the body by the expired air. The inference is, that heat is generated in every part of the body.

294. Our next inquiry is, by what means is the uniformity of temperature in the body maintained? It has been ascertained that the principal agent in keeping the body at a uniform temperature, is the immense evaporation that takes place from the skin and lungs.

295. When cold air comes in contact with these membranes, heat is given off to restore the equilibrium. The quantity depends somewhat on the rapidity of the change of air. And this is greatest when we are in a current of dry air, or a brisk wind is blowing upon us.

296. The skin, in an ordinary state, is constantly giving out a watery fluid, which is converted into vapor and carried off by the surrounding air. To effect this, heat is taken from the system, and the conversion of the perspiration into vapor

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291. From what source are the carbon and hydrogen in the body derived? The oxygen? 292. Show how heat may be produced in every part of the body. 294. What is the principal agent by which a uniform temperature of the body is maintained? 295. What is the effect when cold air comes in contact with these membranes? When is the greatest amount of heat given off? 296. How is the surplus heat of the body removed.

conveys a large proportion of the surplus heat from the body · and in consequence, the temperature is maintained at ninety-eight degrees.

Observations. 1st. In all ages and climes, it has been observed, that the increased temperature of the skin and system in fevers, is abated as soon as free perspiration is restored.

2d. In damp, close weather, as during the sultry days of August, we feel a disagreeable sensation of heat, because the saturation of the air by moisture prevents the escape of heat through the lungs and skin.

HYGIENE OF ANIMAL HEAT.

297. The amount of heat generated in the human system depends upon the quantity and quality of the food, age, exercise, the amount and character of the inspired air, condition of the brain, skin, and general system.

298. *Animal heat is modified by the proportion of carbon which the food contains, and by the quantity consumed.* As the kind of fuel that contains the greatest amount of combustible material gives off the most heat when burned, so those articles of food that contain the greatest quantity of carbon produce the most heat when converted into blood.

299. *Age is another influence that modifies the generation of animal heat.* The vital forces of the child being feeble, less heat is generated in its system than in that of an adult. Hence the young child, and the enfeebled, aged person, need more clothing than the vigorous individual of middle age.

What has been observed in all ages and climes? Why do we feel a disagreeable sensation of heat in the sultry days of August? 297—304. *Give the hygiene of animal heat.* 297. On what does the amount of heat generated in the human system depend? 298. What element of the food influences the generation of heat? 299. Does age modify the generation of heat? What persons need the most clothing?

300. *Exercise is an influence that modifies the generation of animal heat.* Whatever increases the flow of blood in the system, increases also the deposition of new atoms of matter, and the removal of the waste particles. This change among the particles of matter is attended with an elevation of temperature. For this reason, a person in action is warmer than in a state of repose.

301. *The amount and character of the air which is breathed, modify the heat of the system.* In the generation of heat in a stove, air, or oxygen, is as essential as the wood or coal. It is equally so in the production of animal heat. The oxygen of the inspired air should be in proportion to the carbon and hydrogen to be consumed. This requires capacious lungs, together with free movements of the ribs and diaphragm.

302. *The condition of the brain and nervous system affects the generation of animal heat.* If the mind is aroused from fear, the breathing becomes slow, and a chilliness pervades the body, particularly the extremities; while, on the other hand, joyous and agreeable emotions quicken the circulation of the blood, and this increases the generation of heat.

303. During sleep, when the brain is partially inactive, less heat is generated than when awake. This is one reason why an individual who sleeps in the same clothing that was adequate to prevent chills while awake, contracts a cold, unless he throws over him an additional covering.

304. *The system suffers less when the change of temperature is gradual.* The change in the production of heat, as well as in the evaporation of fluids from the system, is gradual, when not influenced by foreign causes. By this means, the body is enabled to endure tropical heat and polar cold.

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300. What effect has exercise on animal heat? 301. To what should the oxygen of the inspired air be proportional? 302. Mention the effects of some of the emotions on animal heat. 303. Why do we need more clothing when asleep than when awake? 304. How is the body enabled to endure tropical heat and polar cold?

CHAPTER XXIII.

THE VOICE.

305. THE beautiful mechanism of the vocal instrument, which produces every variety of sound, from a harsh, unmelodious tone, to a soft, sweet, flute-like sound, can never be imitated by art. It has been compared, by many physiologists, to a wind, reed, and stringed instrument. This inimitable, yet simple instrument, is the *Lar'ynx.*

ANATOMY OF THE VOCAL ORGANS.

306. The LARYNX (Adam's apple) is a kind of cartilaginous tube, which, taken as a whole, has the general form of a hollow reversed cone, with its base upward toward the tongue, in the shape of an expanded triangle.

307. It is composed of several pieces of cartilage, that not only connect with each other, but with the tongue, lower jaw, and trachea.

308. There are stretched across the cavity formed by these cartilages, four folds of membrane, two on each side, called *vocal cords.*

309. The space between the cords on each side is called the *glot'tis*, or chink of the glottis. The cavity between the upper and lower vocal cords is called the ventricle of the larynx.

305—310. *Give the anatomy of the vocal organs.* 305. What is said of the structure of the vocal instrument? What instruments have physiologists compared it with? What is the vocal instrument called? 306. Describe the larynx. 307. Of what is it composed? 308. Describe the vocal cords. 309. What is the space between these cords called?

310. Behind the base of the tongue, is a piece of cartilage, resembling a leaf of parsley, called the *ep-i-glot'tis.* The duty of this sentinel is to keep the food and drink from passing into the air-passage, or trachea.

PHYSIOLOGY OF THE VOCAL ORGANS.

311. In the formation of the voice, each part already described performs an important office. The cartilages give form and stability to the larynx, and by the action of muscles attached to them, the width of the glottis is varied.

Fig. 62.

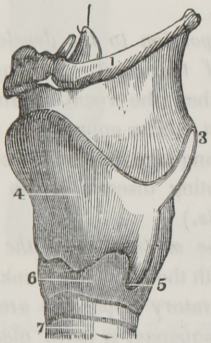

Fig. 63.

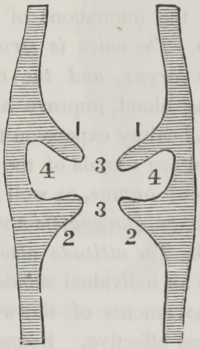

Fig. 62. A side view of the cartilages of the larynx. 1, The bone at the root of the tongue. 3, 4, 5, 6, Cartilages of the larynx. 7, The trachea.

Fig. 63. A section of the larynx. 1, 1, The upper vocal cords. 2, 2, The lower vocal cords. 3, 3, The glottis. 4, 4, The ventricles of the larynx.

312. When air is forcibly driven from the lungs through the glottis, it causes a vibration, or trembling of the vocal cords. This produces *sound ;* and it is varied by the tongue, the teeth, and the lips.

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310. Where is the epiglottis situated? 311, 313. *Give the function of the vocal organs.* 311. Of what use are the cartilages of the larynx? What does fig. 62 represent? Fig. 63? 312. How is sound produced?

313. The size of the larynx, the capacity and health of the lungs, the condition of the throat and nasal passages, the elevation and depression of the chin and tongue, and the state of the mind, influence the modulations of sound.

HYGIENE OF THE VOCAL ORGANS.

314. Common observation shows that the voice can be changed and modified by the habits; sailors, smiths, and others, who are engaged in noisy occupations, exert their vocal organs more strongly than those of more quiet pursuits. This not only affects the structure of the vocal organs, but varies the intonations of the voice.

315. *The voice is strong in proportion to the development of the larynx, and the capacity of the chest.* Singing and reading aloud, improve and strengthen the vocal organs, and give a healthy expansion to the chest. The enunciation of the elementary sounds of the English language, aids in developing the vocal organs, as well as preventing disease of the throat and lungs, (*laryngitis* and *bronchitis.*)

316. *The attitude also affects the modulation of the voice.* When an individual stands or sits with the head and trunk erect, the movements of the whole respiratory apparatus are most free and effective. Sound, in consequence, is more clear and distinct.

Experiment. Read with the head bowed forward and the chin depressed; then read with the head erect and the chin elevated, and the difference in the movement of the vocal organs, together with the difference in the voice, will be manifest.

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313. What influences the modulation of sound? 314—321. *Give the hygiene of the vocal organs.* 314. What does observation show in reference to the voice? 315. How may the voice be strengthened? 316. What effect has the erect attitude upon the modulations of the voice? State the experiment.

Fig. 64.

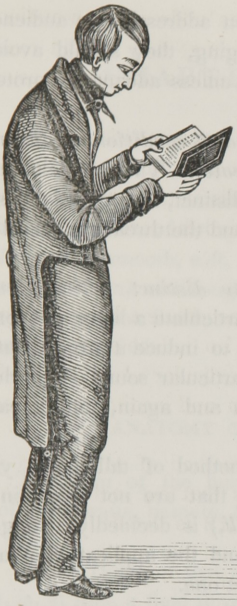

Fig. 65.

Fig. 64. An improper position, but one not unfrequently seen in some of our common schools, and in some of our public speakers.

Fig. 65. The proper position for reading, speaking, and singing.

317. *The muscles of the neck should not be compressed.* If the muscles of the neck and larynx are compressed by a high cravat, or other close dressing, not only will the free and forcible use of these parts be impeded, but the tones, instead of being clear and varied, will be feeble and ineffective.

Observations. 1st. The loss of voice which is prevalent among public speakers, may be ascribed in part to the in-

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What is represented by fig. 64? By fig. 65? 317. Why should not the muscles of the neck be compressed? What is a common cause of loss of voice?

judicious dressing of the neck, and improper position when standing.

2d. When individuals have been addressing an audience in a warm room, or engaged in singing, they should avoid all impressions of a cold atmosphere, unless adequately protected by an extra garment.

318. *The opening of the jaws, and condition of the nasal passages and throat, modify the voice.* The enunciation of words is rendered more or less distinct, in proportion as the jaws are separated in speaking, and the throat and nasal passages are free from obstruction.

319. *Repetition is essential to distinct articulation of words.* In teaching a child to articulate a letter or word, in the first instance, make an effort to induce a proper state of the vocal organs by which the particular sound is produced. Repeat the letter or word again and again, until it can be uttered with accuracy.

Observation. The drawling method of talking to young children, as well as using words that are not found in any written language, (called *baby talk*,) is decidedly wrong. A child will pronounce and understand the application of a correct word as quickly as an incorrect one.

320. When foreign bodies, such as cherry-stones, buttons, &c., get into the throat, they cause excessive irritation, and sometimes death. It is not necessary to ascertain which passage the foreign body is in, for the immediate treatment ought in either case to be the same.

321. Some person should place one hand on the front of the chest of the sufferer, and, with the other, give two or three smart blows upon the back, allowing a few seconds to intervene between them.

Give 2d observation. 318. Does the condition of the throat and nasal passages modify the voice? 319. Is repetition essential to distinct articulation? What method is suggested in teaching a child to articulate letters or words? Give observation. 320. What should be done when foreign bodies get into the throat?

CHAPTER XXIV.

THE SKIN.

322. THE skin is a membranous covering, enveloping the bones and other parts of the system. In youth, and in females particularly, it is smooth, soft, and elastic. In middle age, and in males, it is firm, and rough to the touch. In old age, in persons who are emaciated, and about the flexions of the joints, it is thrown into folds.

ANATOMY OF THE SKIN.

323. The skin of the human body is composed of two layers of membrane, namely, the *cu'ti-cle*, and the *cu'tis ve'ra*, or true skin.

324. The CUTICLE, or that part of the skin which is seen by the eye, is, at first, a fluid thrown out by the blood-vessels over the internal layer of this membrane.

325. While layers of this fluid are continually forming on the upper surface of the true skin, the external layers of the fluid become dry, and resemble small scales.

Illustrations. The cuticle is that part of the skin which is raised by a blister. Sometimes from disease, as erysipelas, or fever, it comes off from the surface of the body in pieces of considerable size.

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322. What is the skin? Mention its different appearances in its different conditions in the human frame. 323—336. *Give the anatomy of the skin.* 323. How many layers of membrane has the skin? What are they called? 324. How is the cuticle first formed? 325. What is the appearance of the external layers? Give illustration.

326. The arrangement of the cuticle, in different parts of the human body, is worthy of notice. Where feeling is most acute, the cuticle is delicate and thin. Where there is motion, as over the joints, it is lax and movable. Where it is in constant use, it becomes harder and thicker.

Illustration. The soles of the feet and the palms of the hands afford good examples of the cuticle thickened by use.

327. This part of the skin has no blood-vessels or nerves; consequently, a needle may be passed under it, to some extent, and cause no pain, nor will any blood ooze from it.

Fig. 66.

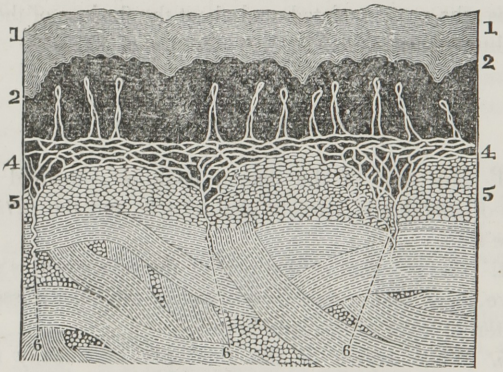

Fig. 66. 1, 1, The cuticle. 2, 2, The colored layer of the cuticle. 4, 4, The net-work of nerves. 5, 5, The true skin. 6, 6, 6, Three nerves that divide to form the net-work, (4, 4.)

328. The cuticle, when clean, looks like a thin shaving of soft, clear horn; but when filled with dust and other foul matter, it becomes dark-colored.

Observation. The hair and nails, also the hoofs of animals,

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326. Mention the arrangement of the cuticle in different parts of the body. What parts of the body afford examples of the cuticle thickened by use? 327. Has the cuticle blood-vessels or nerves? 328. What is the general appearance of the cuticle? Give observation.

are appendages of the skin. They are so connected with the cuticle, that by scalding they come off with this tissue.

329. In the inner and newly-formed layers of the cuticle, there exists a peculiar kind of paint. This colored layer, in the Negro, is black; in the Indian, copper-colored; in the European, it is very light, differing, however, in different persons.

330. The CUTIS VERA, or true skin, is so called, because it is the most essential of the two layers of the skin. It contains several sets of vessels, namely, *Arteries*, *Veins*, and *Lymphatics*. Beside these vessels, there are found both *Oil* and *Perspiratory* (sweat) *Glands*, and *Nerves*.

331. The ARTERIES and VEINS form a net-work upon the surface of the true skin; hence, cut any part of this layer of the skin, and it will bleed. By the arteries the skin is nourished.

Observation. When this layer of the skin is destroyed by cuts or burns, it is never formed again, and produces scars which do not disappear.

332. The NERVES, like the blood-vessels, are very numerous, for no part of the skin can be pricked or cut without giving pain. The minute extremities of these nerves, together with the capillary vessels, form small, conical prominences, called *pa-pil'læ*. (Fig. 68.)

Observation. These prominences can be seen in the palm of the hand and sole of the foot. On the ends of the fingers they are curiously arranged; some in concentric ovals; others pursue a serpentine course.

333. The LYMPHATICS are those small vessels which open upon the inner layers of the cuticle. These vessels are called

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329. What is found in the inner and newly-formed layers of the cuticle? What color is it in the Negro? Indian? European? 330. Why is the cutis vera so called? What does it contain? What vessels exist in this layer beside the last mentioned? 331. What do the arteries and veins form upon the true skin? By what vessel is the skin supplied with blood? What is formed when the true skin is destroyed by cuts or burns? 332. What is said of the nerves of the true skin? How are the papillæ formed? Where may they be seen? 333. What are the lymphatics of the skin?

into action when ointments are rubbed on the skin; and also in vaccination, to prevent the small-pox.

334. The PERSPIRATORY APPARATUS consists of minute tubes, which pass inward through the cuticle, and terminate in the deeper meshes of the true skin. In their course, each little tube forms a beautiful spiral coil; and, on arriving at its destination, coils upon itself in such a way as to constitute an oval-shaped, or globular ball, called the *perspiratory gland.*

335. The OIL-GLANDS are small bodies embedded in the true skin. They connect with the surface of the skin by small tubes, which traverse the cuticle. In some parts these glands are wanting; in others, where their office is most needful, they are abundant; as on the nose, the head, and the ears.

Fig. 67.

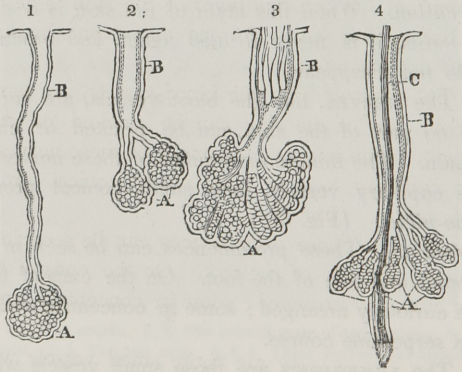

Fig. 67. 1, 2, 3, Oil-glands and tubes from different parts of the body. A, A, A, Glands. B, B, B, The ducts of these glands. 4, An oil-gland, and tube from the scalp. The glands (A) form a cluster around the tube of the hair, (C.) These ducts open into the sheath of the hair, (B.) The figures, from 1 to 4, are magnified thirty-eight diameters.

Observation. When there is an unnatural accumulation of oil in the tubes, it produces the "worm," or "grub."

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334. Of what does the perspiratory apparatus consist? 335. Describe the oil-glands. What is said of their distribution? Explain fig. 67. What does an unnatural accumulation of this oily matter produce?

CHAPTER XXV.

PHYSIOLOGY OF THE SKIN.

336. THE skin invests the whole of the external surface of the body, following all its prominences and curves, and gives protection to all the organs it encloses, while each of its several parts has a distinct use.

337. The cuticle is insensible, and serves as a sheath of protection to the highly sensitive skin (cutis vera) situated beneath it. The latter feels; but the former blunts the impression which occasions feeling.

338. The cuticle, also, prevents disease, by impeding the evaporation of the fluids of the true skin, and the absorption of the poisonous vapors, which necessarily attend various employments. It, however, affords protection to the system only when unbroken, and then to the greatest degree, when covered with a proper amount of oily secretion from the oil-glands.

339. The nerves of the skin are the organs of the sense of touch and feeling. Through them we receive many impressions that increase our pleasures; as, the grateful sensations imparted by the cooling breeze in a warm day. In consequence of their sensitiveness, we are individually protected, by being warned of the nearness of destructive agents.

340. A large proportion of the waste of the body passes through the outlets of the skin; some portions in the form of oil, others in the form of watery vapor and carbonic acid.

336—346. *Give the physiology of the skin.* 336. What is said of the skin? 337. Mention a function of the cuticle. 338. Give another use of the cuticle. 339. Of what use are the nerves of the skin? 340. Through what membrane does a large proportion of the waste atoms of the body pass?

341. The oily fluid with which the skin is bedewed, is separated from the blood by means of the oil-glands. This secretion is spread over those parts of the skin most exposed to the changes of temperature and moisture. The action of these glands renders the skin soft, and it is also one source by which the blood is purified.

342. The perspiratory glands separate from the blood the perspiration, or sweat. There are more than two thousand of these glands, with ducts, in every square inch of skin, and more than five million of them in this natural covering of the body.

Fig. 68.

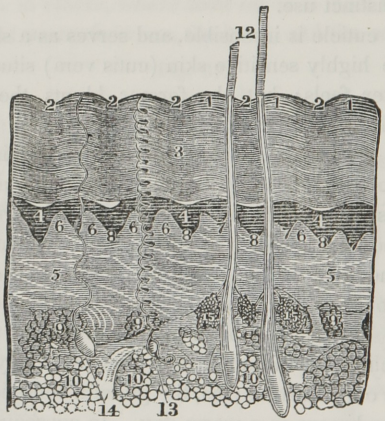

Fig. 68. 1, 1, The lines or ridges of the cuticle, cut perpendicularly. 2, 2, 2, 2, 2, The furrows or wrinkles of the same. 3, The cuticle. 4, 4, The colored layer of the cuticle. 5, 5, The cutis vera. 6, 6, 6, 6, 6, The papillæ, each of which answers to the lines on the external surface of the skin. 7, 7, Small furrows between the papillæ. 8, 8, 8, 8, The deeper furrows between each couple of the papillæ. 9, 9, Cells filled with fat. 10, 10, 10, The adipose layer, with numerous fat vesicles. 12, Two hairs. 13, A perspiratory gland, with its spiral duct. 14, Another perspiratory gland, with a duct less spiral. 15, 15, Oil-glands with ducts opening into the sheath of the hair, (12.)

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341. What is the use of the oil-glands? 342. What is the use of the perspiratory glands? How many of these glands with ducts upon every square inch of skin?

343. In health, these glands are in constant action, and the skin is moist. When this moisture cannot be seen, it is called *insensible* perspiration. When it can be seen in drops, it is called *sensible* perspiration.

Experiment. Put the hand into a cold, dry, glass jar, or any glass vessel, and wind around the wrist and mouth of the jar a handkerchief. In a few minutes, the inside of the jar will be covered with moisture from the hand.

344. The function of these glands is very necessary to health. During twenty-four hours, from twenty to thirty ounces of waste, useless matter passes out of the body by these ducts, or through the pores of the skin.

345. If perspiration is suppressed from disorder of the skin or cold, the whole of this injurious matter is circulated through the system by the blood, disturbing the action of the lungs, stomach, and other organs.

346. Many cases of chronic coughs, headache, dyspepsia, and diarrhœa, originate in this way. If any one organ of the system has been weakened, this organ is more susceptible of disease than others. In persons whose lungs are weak or diseased, a chill will immediately cause an irritation and often inflammation of these organs. If an individual is predisposed to stiffness of the joints and rheumatic pains, a chill will affect these diseased parts.

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343. When is perspiration called insensible? When sensible? 344. How many ounces of waste matter pass through the skin in twenty-four hours? 345. What is the effect if perspiration is "checked"? 346. What is the result if any organ of the body is weakened or diseased?

Note. Let the anatomy and physiology of the skin be reviewed from fig 68, or from anatomical outline plate 9.

CHAPTER XXVI.

HYGIENE OF THE SKIN.

347. THE sensibility of the skin, and the activity of the oil and perspiratory glands, are modified by the condition of the cuticle, the temperature of the skin and body, the purity and warmth of the air, and the character of the light to which the body is exposed.

348. To maintain a healthy action of every part of this membrane, attention to *clothing*, *bathing*, *light*, and *air*, is of great practical importance.

349. CLOTHING, in itself, does not bestow heat, but is chiefly useful in preventing the escape of heat from the body, and in defending it from the temperature of the atmosphere. In selecting and applying clothing to our persons, the following suggestions should be observed.

350. *The material for clothing should be a bad conductor of heat;* that is, it should have little tendency to conduct, or remove heat from the body. This depends on the property possessed by the material in retaining atmospheric air in its meshes.

351. *Moisture renders clothing a good conductor of heat* Thus all articles of apparel should not only be non-conductors of heat, but should not possess the property of absorbing and retaining moisture.

347—373. *Give the hygiene of the skin.* 347. What influences modify the action of the oil and perspiratory glands? 348. To what must attention be given to maintain a healthy action of the skin? 349. Does clothing bestow heat? What is its use? 350. Mention a property that the material for clothing should possess? 351. What property in the selection of clothing should we avoid?

352. *Woollen cloth* retains more air in its meshes than any other article except furs, and it absorbs but very little moisture. Consequently, it is an excellent article for clothing.

353. *Cotton* contains less air in its meshes than woollen, but much more than linen. In texture, it is smoother than wool, and less liable to irritate the skin. This fabric absorbs moisture in a small degree. In all respects, it is well adapted for garments worn next the skin.

354. *The clothing should be of a porous character.* The skin is not only an important agent in separating from the blood those impurities that otherwise would oppress the system and occasion death, but it exercises great influence in respiration. Consequently, the apparel should be made of a material that will permit the air to pass through its meshes.

355. *The clothing should be not only porous, but fitted loosely.* The garments should retain a layer of air between them and the body. Every one is practically aware that a loose dress is much warmer than one which fits closely; that a loose glove, boot or shoe, afford greater warmth than those of smaller dimensions.

356. *More clothing is necessary when a vital organ is diseased.* When vital organs, as the lungs, heart, &c., are diseased, less heat is generated in the body. For this reason, in consumption, dyspepsia, and even headache, the skin is pale and the extremities cold.

357. *More clothing is required in the evening than during the day.* In the evening we have less vital energy, and, therefore, less heat is generated in the system, than in the early part of the day; beside, the atmosphere is damp, the skin has become moist from perspiration, and heat, in consequence, is rapidly removed from the body. For this reason, when re-

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352. Give the properties of woollen cloth. 353. What are the qualities of cotton as an article of dress? 354. Why should the material for clothing be porous? 355. Why should garments be fitted loosely? 356. Why do we need more clothing when the lungs or brain is diseased? 357. Why do we need more clothing in the evening than during the day?

turning from crowded assemblies, we should be provided with an extra garment.

358. *A person of active habits requires less clothing than one of sedentary employments;* for exercise increases the circulation of the blood, which is always attended with the disengagement of a greater quantity of heat; consequently, an increase of warmth is felt throughout the system.

359. *An excessive, as well as an insufficient, amount of clothing is alike injurious.* The custom of wearing an undue amount on some parts of the body, and leaving exposed the arms and upper part of the chest, cannot be too highly censured.

360. *The clothing should be kept clean.* No article of apparel is entirely free from absorption; even wool and cotton possess it in a small degree. They take up a portion of the perspired fluids, and thus the fibres of the cloth become covered with the waste matter contained in the perspiration. A neglect of a frequent change of apparel, is one cause of disease with many persons, particularly the poorer classes in the community.

361. *The clothing in which we sleep, as well as beds and bed-clothes, should be aired every day.* If this is not done, the moist bedding will cause a chill, and the perspired matter may be carried into the system of the next occupant. Many diseases are thus contracted.

362. *When the clothing has become wet, it is best to change it immediately.* The skin should then be rubbed with a dry, crash towel, until reaction, indicated by redness, is produced. If the garments are not changed, the person should exercise moderately, so that sufficient heat may continue to be generated in the system to dry the clothing and skin without a chill.

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358. Why does the active laborer require less clothing than a person of sedentary employment? 359. Is too much as well as too little clothing injurious? 360. Why should the clothing be kept clean? What arises from neglect of a frequent change of apparel? 361. Why should beds and bed-clothes that are used be aired every day? 362. What is necessary when the clothing has become wet?

363. *Changes of dress, from thick to thin, should always be made in the morning*, for then the vital powers are in full play. Sudden changes in wearing apparel, as well as in food and general habits, are attended with hazard; and this is proportionate to the weakness or exhaustion of the body when the change is made.

364. BATHING is necessary, in order that the perspirable matter may pass freely through the "pores" of the skin. The whole body should be bathed frequently, as perspiration is not confined to the face and hands.

365. Cold water—or water at about seventy degrees in summer, and eighty degrees in winter—is more strengthening to the system than water that is warmer.

366. *No person should bathe when the body is fatigued, either by mental or physical labor, or immediately after a meal.* The best time for bathing, particularly for sick persons, is about two hours after breakfast. Persons in health may bathe in the morning, or in the evening.

367. The sponge bath is, perhaps, the simplest and best method of bathing. In this but a small portion of the surface of the skin is exposed to the air, and the brisk rubbing that immediately follows the wet sponge, prevents a chill of the skin. No colds would be contracted in bathing, if persons would wipe dry, and use friction with a coarse towel or flesh-brush, until redness or warmth of the skin is produced.

368. The AIR is an agent of importance in the functions of the skin. It imparts to this membrane oxygen, and receives from it carbonic acid. It also removes from it a large portion of the perspiration and the more fluid portions of the oily matter. In order that the air may accomplish these ends, it is

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363. When should changes in dress from thick to thin be made? Why? 364. What is said of the necessity of bathing? 365. What temperature of water is best for the system? 366. When should persons not bathe? When is the best time for bathing? 367. What method is the simplest for bathing? How are colds prevented when bathing? 368. What is said of the influence of the air on the functions of the skin?

necessary that it come in contact with the body. This is one of the many reasons why we should wear loose and porous clothing.

369. LIGHT exercises a salutary influence upon the skin. Thus we see, that those individuals who labor in low, damp, dark rooms, are pale and sickly. The light, permeating the skin, not only exercises a salutary influence upon this membrane, but upon the blood, and, through this fluid, upon the whole system.

370. This established fact shows how important it is that school-houses, mechanics' shops, kitchens, and sitting-rooms, be not only well ventilated, but favorably situated to receive light. For the same reasons, the kitchen and the sitting-room, which are the apartments most used by ladies, should be selected from the most pleasant and well-lighted rooms in the house.

371. When any portion of the skin has been frozen, apply ice, snow, or cold water. The fire and a warm room should be avoided. If the frozen parts blister, treat them as you would burns.

372. In scalds and burns, when there is no blister, or if one is formed, and the external skin is not broken, apply cold water, as long as the smarting pain continues. After the pain has subsided, cover the blistered part with a patch of cotton or linen cloth, on which is spread lard and bees-wax.

373. If the external skin is removed, apply lime-water mixed with "sweet oil," fresh cream, or lard and bees-wax. When the dressings are applied, they should not be removed until they become dry and hard.

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369. Show the effect of light on the skin. 370. What is said of the selection of those rooms that are the most used? 371. What should be applied when the skin is frozen? What should be avoided? 372. In scalds or burns, what is necessary if a blister is formed? 373. What is necessary if the external skin is removed? How often should the dressings be removed?

CHAPTER XXVII.

THE NERVOUS SYSTEM.

374. In the preceding chapters, the structure and use of the bones and muscles have been explained, the process by which the food is converted into chyle and mixed with the blood, together with the manner by which this fluid is conveyed to every part of the body, has been described.

375. It has also been shown, that lymphatic absorption commences as soon as nutrition is completed, and conveys the useless, worn-out particles of the different parts back into the circulating fluid; while the respiratory organs and secretory glands perform the work of preparing the waste atoms to be conveyed from the body. These functions must succeed each other in proper order; and such is the mutual dependence of these processes, that a medium of communication is necessary from one organ to another. This is effected by means of the *Nervous System.*

ANATOMY OF THE NERVOUS SYSTEM.

376. The NERVOUS SYSTEM is composed of the *Brain*, *Cranial Nerves*, *Spinal Cord*, *Spinal Nerves*, and the *Sympathetic Nerve.*

377. The BRAIN is a pulpy organ within the skull-bones. The upper and front portion is called the *Cer'e-brum.* The lower portion, situated at the back part of the skull, is called the *Cer-e-bel'lum.*

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374. What has been described in the preceding chapters? 375. What has also been shown? 376—388. *Give the anatomy of the nervous system.* 376. Of what is the nervous system composed? 377. Describe the brain.

378. The CEREBRUM, or larger portion of the brain, is composed of a whitish substance, with an irregular border of gray matter around its edges.

379. The CEREBELLUM is also composed of white and gray matter, but the latter constitutes the largest portion. The white matter is so arranged, that when cut vertically, the appearance of the trunk and branches of a tree (*ar'bor vi'tæ*) is presented.

Fig. 69.

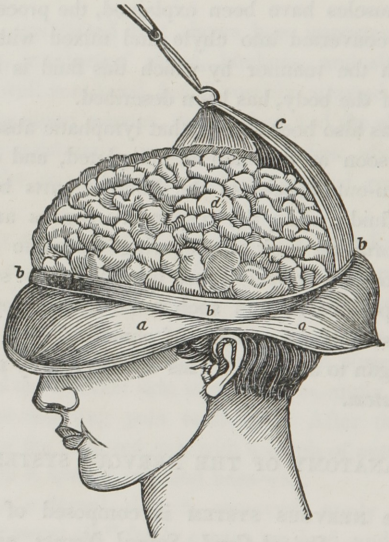

Fig. 69. *a, a,* The scalp turned down. *b, b, b,* The cut edges of the bones of the skull. *c,* The external membrane of the brain suspended by a hook. *d,* The left side of the brain, showing its convolutions.

380. The brain is surrounded by three membranes. The external membrane is thick and firm; the middle membrane is thin, and looks somewhat like a spider's web; the inner membrane consists of a net-work of blood-vessels.

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378. Describe the cerebrum. 379. Describe the cerebellum. 380. What is said of the membranes of the brain? What does fig. 69 represent?

381. On removing the upper part of the skull-bones and membranes, the brain presents an undulating, folded appearance. These ridges are called *con-vo-lu'tions.*

382. The SPINAL CORD is composed of a whitish substance, similar to that of the brain. It is covered with a sheath, or membrane, and extends from the brain through the whole length of the spinal column. The upper portion, within the skull-bones, is called the *me-dul'la ob-lon-ga'ta.*

Fig. 70.

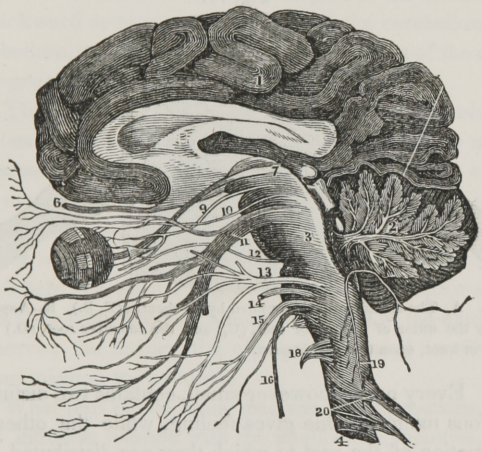

Fig. 70. A section of the brain and spinal cord, showing the relation of the cranial nerves to these organs. 1, The cerebrum. 2, The cerebellum, with its arbor vitæ represented. 3, The medulla oblongata. 4, The spinal cord. 6, The first pair, or nerve of smell. 7, The second pair, or nerve of sight. 9, 10, 12, The third, fourth, and sixth pairs of nerves. These pass to the muscles of the eye. 11, The fifth pair, or nerve of taste, and also the sensitive nerve of the teeth. 13, The seventh pair. This passes to the muscles of the face. 14, The eighth pair, or nerve of hearing. 15, 16, 18, 19, The ninth, tenth, eleventh and twelfth pairs. These pass to the tongue, larynx, and neck. 20, Two spinal nerves.

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381. What is the appearance of the brain when the skull-bones and membranes are removed? What are they called? 382. Describe the spinal cord. What is the medulla oblongata? Explain fig. 70.

383. The NERVES are small, white cords, that pass from the brain and spinal cord. They are distributed to every part of the human system.

384. The CRANIAL nerves, that connect with the base of the brain, are arranged in twelve pairs. They are generally distributed to the parts about the face.

385. The SPINAL nerves, that connect with the spinal cord, are arranged in thirty-one pairs, each arising by two roots; an anterior, or *motor* root; and a posterior, or *sensitive* root.

Fig. 71.

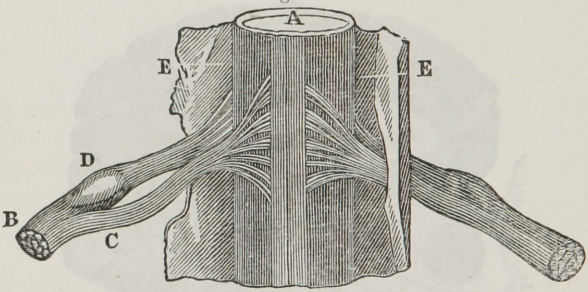

Fig. 71. A, The spinal cord, surrounded by its sheath, (E, E.) B, A spinal nerve, formed by the union of the motor root, (C,) and the sensitive root, (D.) At D, the ganglion, or knot, upon this root is seen.

386. Every nerve, however small, contains two distinct cords of nervous matter. One gives feeling, while the other is used in the motion of the part to which they are distributed.

387. The SYMPATHETIC nerve consists of a series of *gan'gli-a*, or knots, extending each side of the spinal column, forming a chain its whole length. It communicates with both the cranial and spinal nerves, and likewise distributes branches to all the internal organs.

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383. What are nerves? 384. What is said of the cranial nerves? 385. What is said respecting the spinal nerves? 386. What does every nerve contain? Describe fig. 71. 387. Describe the sympathetic nerve.

CHAPTER XXVIII.

PHYSIOLOGY OF THE NERVOUS SYSTEM.

388. THE brain is the organ of the *mind*. To the cerebrum, or large brain, the faculties of *thinking*, *memory*, and *the will*, are ascribed. In the human body, this part of the brain extends so far backward as to cover the whole of the cerebellum. To the cerebellum, or little brain, is ascribed the seat of the *animal*, or *lower propensities*.

389. The brain is the seat of *sensation*. It perceives the impressions made on all parts of the body, through the medium of the sensitive nerves. That the impressions of external objects, made on these nerves, be communicated to the brain, where sensation is perceived, it is necessary that they be not diseased or injured.

390. There is a plain distinction between sensations and impressions; the latter are the changes produced in the extremities of the nerve; the former, the changes produced in the brain and communicated to the mind.

391. What part of the brain receives the impressions, or has the most intimate relation with the intellectual faculties, is unknown. Some portions, however, are of greater importance than others. Pieces of both the white and gray matter, have been removed by injuries without impairing the intellect or destroying life.

388—394. *Give the functions of the brain.* 388. What is said of the brain? What is ascribed to the cerebrum? To the cerebellum? 389. Where is sensation perceived? Through what medium are the impressions of external objects conveyed to the brain? 390. What is the difference between sensations and impressions? 391. Is it known what part of the brain has the most intimate relation with the intellectual faculties?

392. This organ, although it takes cognizance of every sensation, is, of itself, but slightly sensible. It may be cut or removed without pain, and the individual, at the same time, retain his consciousness. The medulla oblongata, unlike the brain, is highly sensitive; if slightly punctured, convulsions follow; if much injured, respiration, or breathing, immediately ceases

393. The brain is the seat of the *will.* The contraction, or movement of the muscles, is caused by an influence sent from the brain by the act of the mind, or the will. The medium of communication from this organ to the muscles, is the motor nerves. If the brain is in a state of repose, the muscles are at rest; if, by an act of the will, the brain sends a portion of nervous influence to a muscle, it immediately contracts, and those parts to which the muscle is attached, move.

394. The sympathetic nerve, although it confers neither sensibility nor power of movement, yet it gives vitality, or life, to all the important parts of the system. Every portion of the body is, to a certain extent, under its influence, as filaments from this system of nerves accompany the blood-vessels throughout their course. This establishes a union, or sympathy, with the different organs of the body.

Illustration. When the brain is jarred by a blow, nausea and vomiting follow. Again, when food is taken that irritates the nerves of the stomach, it produces headache, from the sympathy of the brain with the stomach, through this system of nerves.

Fig. 72. A back view of the brain and spinal cord. 1, The cerebrum. 2, The cerebellum. 3, The spinal cord. 4, Nerves of the face. 5, The brachial plexus, or union of nerves. 6, 7, 8, 9, Nerves of the arm. 10, Nerves that pass under the ribs. 11, The lumbar plexus of nerves. 12, The sacral plexus of nerves. 13, 14, 15, 16, Nerves of the lower limbs.

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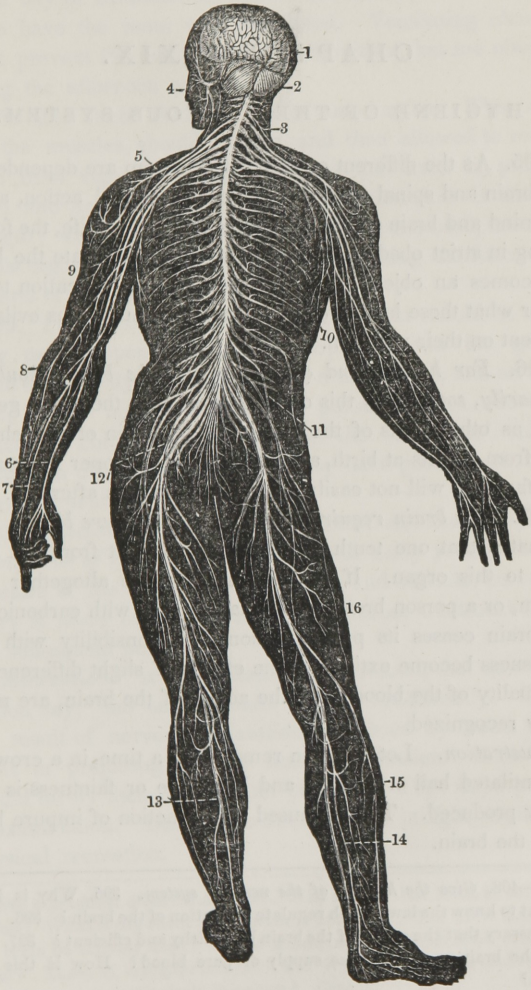
392. What is said of the sensibility of this organ? Of the medulla oblongata? 393. Describe how the contraction of a muscle is effected. 394. What is said of the sympathetic nerve? Explain fig. 72.

Note. Let the anatomy and physiology of the nervous system be reviewed from fig. 72, or anatomical outline plate 8.

Fig. 72.



CHAPTER XXIX.

HYGIENE OF THE NERVOUS SYSTEM.

395. As the different organs of the system are dependent on the brain and spinal cord for efficient functional action, and as the mind and brain are closely connected during life, the former acting in strict obedience to the laws which regulate the latter, it becomes an object of great importance in education to discover what these laws are, and escape the numerous evils consequent on their violation.

396. *For healthy and efficient action, the brain should be, primarily, sound;* as this organ is subject to the same general laws as other parts of the body. If the brain of the child is free from defects at birth, and acquires no improper impressions in infancy, it will not easily become diseased in after life.

397. *The brain requires a due supply of pure blood.* It is estimated that one tenth of all the blood sent from the heart goes to this organ. If the arterial blood be altogether withdrawn, or a person breathes air that is filled with carbonic gas, the brain ceases its proper action, and sensibility with consciousness become extinct. The effects of slight differences in the quality of the blood upon the action of the brain, are not so easily recognized.

Illustration. Let a person remain, for a time, in a crowded, ill-ventilated hall or church, and headache or faintness is generally produced. This is caused by the action of impure blood upon the brain.

395—408. *Give the hygiene of the nervous system.* 395. Why is it important to know the laws which regulate the action of the brain? 396. What is necessary that the action of the brain be healthy and efficient? 397. Why does the brain require a due supply of pure blood? How is this illustrated?

Observation. If a school-teacher wishes to have his pupils, on the day of examination, appear creditably, he will be careful to have the room well ventilated. Ventilating churches might prevent the inattention and sleepiness that are observed during the afternoon service.

398. *The brain should be called into action.* This organ, like the muscles, should be used, and then allowed to rest, or cease from vigorous thought. When the brain is properly called into action by moderate study, it increases in size and strength; while, on the other hand, if it is not used, the action of this organ is enfeebled, thereby diminishing the function of all parts of the body.

399. The number of hours that the brain should be vigorously used, depends on its development, and the general health of the body. The child with a large brain and an active mind, should not be induced to pursue studies above the capacity of children generally. On the other hand, children of sluggish minds, particularly if they have good health, should be incited to study.

400. *Excessive and continued mental exertion is injurious at any time of life;* but in infancy and early youth, when the structure of the brain is still immature and delicate, permanent injury is more easily produced by incorrect treatment than at any subsequent period.

Observation. It is no unusual occurrence, that on "examination day," the best scholars appear indifferently. This is the result of nervous exhaustion, produced by extra mental effort in preparing for the final examination. Such pupils should divert their minds from study, for a few days previous to examination. During this time, indulge in light reading and physical recreation.

Give a practical observation. 398. Why should the brain be called into action? What is the effect if the brain is not used? 399. How long should the brain be actively used? What is said respecting the child with a large brain? Those of sluggish minds? 400. When is excessive and continued mental exertion particularly injurious? Give observation.

401. *We should not enter upon continued mental exertion, or arouse deep feeling, immediately after a full meal.* Such is the connection between the mind and body, that even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring soon after eating, will impede digestion, and cause the stomach to loathe the masticated food.

402. *We should engage in intense study in the early part of the day.* Studies that require close application should be pursued in the morning. The evening should be devoted to entertaining conversation, music, and light reading. This will fit the system of the student for quiet and refreshing sleep.

Observation. The idea of gathering wisdom by burning the "midnight oil" is more poetical than profitable. The best time to use the brain is during the day.

403. *Those whose employment is arduous, and the growing child, need more sleep than the idler or the adult.* As sleep is the natural repose of all organs, it follows that the more all the organs of the system are employed, the more repose they require. The organs of the child, beside sustaining their proper functions, are busy in promoting its growth. This nutritive process is attended with a certain degree of exhaustion.

404. *The condition of the brain is modified by changing the action of the mind.* If we think intensely of a subject, the face will become flushed, and dizziness or pain of the head will be induced. Change our thoughts to something of a more trifling character, and these peculiar sensations will cease.

405. *The brain can exercise its full power upon only one object at a time.* If its energies are directed to two or more operations, neither will receive that full power of exertion that it would, if only one object had engaged the mind.

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401. Why should we not arouse deep feeling immediately after a full meal? 402. When should we engage in intense study? Give observation. 403. What persons require the most sleep? 404. Show how the action of the mind modifies the condition of the brain. 405. Why cannot the brain exercise its full powers on more than one object at a time?

406. *Regularity is of great importance in calling the brain into action.* Let us take our dinner at a certain hour for several successive weeks, and we at last find our appetites indicating its approach with the greatest regularity. The same is true of the nervous system; call it into action at regular periods, and without previous thought, we enter upon that mode of action when the time approaches. The formation of "habits" are promoted by this principle.

407. *Repetition is necessary to make a durable impression on the mind.* Repetition of mental action is as important as repetition of muscular action. It is by this means that thoughts are durably impressed upon the brain. This principle has been too much neglected in the moral and intellectual education of children.

408. In injuries of the brain, the person is generally insensible, the extremities are pale and cold, the pulse feeble, and the breathing is less frequent and full. When these symptoms exist, the patient should be placed in pure air. Friction, with dry warmth, should be applied to the extremities, to restore proper circulation in the blood-vessels. There should be no bleeding until the skin of the extremities becomes warm.

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406. Should the brain be called into action at regular periods? 407. Why is repetition of mental action necessary? 408. What is the effect on the system when the brain is injured? What is necessary to be done when such symptoms exist?

CHAPTER XXX.

SENSE OF TOUCH.

409. SENSATION is an impression made upon the mind through the medium of the senses. There are five senses, namely, *Touch*, *Taste*, *Smell*, *Hearing*, and *Vision*.

410. TOUCH is the sense that enables us to tell whether a body is rough or smooth, cold or hot, sharp or blunt. This sense and feeling reside in the nerves of the skin.

411. The nerves that contribute to the sense of touch, proceed from the anterior half of the spinal cord. Where sensation is most acute, we find the greatest number of nervous filaments, and those of the largest size, as at the ends of the fingers and lips.

Observation. The sense of touch varies in different persons, and also in individuals of different ages. Thus the sensibilities of the child are more acute than those of the adult.

412. This sense is modified by the condition of the brain and nerves, by the quantity and quality of the blood supplied to the skin; by the thickness of the cuticle; and by cultivation.

Observation. Blind persons, by whom the beauties of the external world cannot be seen, cultivate this sense to such a degree that they can distinguish objects with great accuracy; and the rapidity with which they read books prepared for their use, is a convincing proof of the niceness and extent to which the cultivation of this sense can be carried.

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409. Through what medium are sensations received? Name the senses. 410—412. *What is said of the sense of touch?* 410. What is touch? 411. Why is sensation acute at the ends of the fingers and lips? What is said respecting the sense of touch in different persons? 412. What modify this sense? What is said of blind persons?

SENSE OF TASTE.

413. TASTE is the sense by which we perceive the flavor or relish of a thing. The tongue is the principal organ of taste, though the sides of the cheeks, and upper part of the throat, share in this function.

414. The surface of the tongue is thickly studded with papillæ, or points; these give this organ a velvety appearance. To these points the *gust'a-to-ry*, or nerve of taste, is distributed.

Fig. 73.

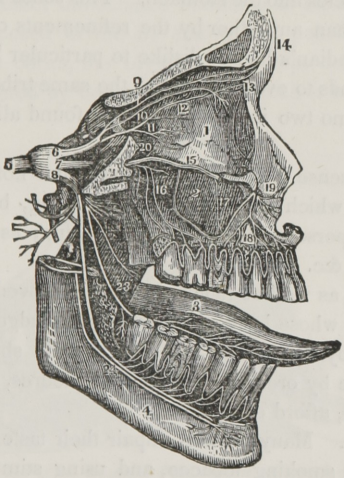

Fig. 73. The distribution of the fifth pair of nerves. 1, The orbit for the eye. 2, The upper jaw. 3, The tongue. 4, The lower jaw. 5, The fifth pair of nerves. 6, The first branch of this nerve, that passes to the eye. 9, 10, 11, 12, 13, 14, Divisions of this branch. 7, The second branch that passes to the teeth of the upper jaw. 15, 16, 17, 18, 19, 20, Divisions of this branch. 8, The third branch that is distributed to the tongue and teeth of the lower jaw. 23, The division of this branch, called *gustatory*. 24, The division that is distributed to the teeth of the lower jaw.

413—419. *What is said respecting the sense of taste?* 413. Define taste. What is the principal organ of taste? 414. Where is the nerve of taste distributed? Explain fig. 73.

Observation. By applying strong acids, as vinegar, to the tongue, with a hair-pencil, these points will become curiously lengthened.

415. Substances, to be tasted, must be either naturally fluid, or partially dissolved by the saliva. When fluids are taken into the mouth, the papillæ dilate and erect themselves, and the particular sensation excited is carried to the brain by the nerve of taste. But if dry, solid food is taken, it must be acted upon by the saliva before the impression is perceived.

416. The use of taste is to guide men and animals in the selection of their food, and to warn them against the introduction of injurious articles into the stomach. This sense has been made to vary more than any other by the refinements of social life.

417. The Indian's like or dislike to particular kinds of food, generally extends to every person of the same tribe; but among civilized men, no two individuals can be found alike in all their tastes.

418. This sense is modified by habit, and not unfrequently those articles which at first were disgusting, become highly agreeable, by persevering in the use of them; as in learning to chew tobacco, &c.

419. Taste, as well as touch, may be improved in acuteness. Those persons whose business leads them to judge of the quality of an article by their taste, can discriminate shades of flavor not perceivable by ordinary persons. Epicures, and tasters of wines and teas, afford examples.

Observation. Many persons impair their taste by bad habits, as chewing or smoking tobacco, and using stimulating drinks, &c. These indulgences lessen the sensibility of the nerve, and destroy the natural relish for food.

How can these points upon the tongue be seen? 415. How must substances be, in order to be tasted? Show how the taste of substances is perceived by the brain. 416. What is the use of taste? What is said of the difference among persons as regards taste? 418. What effect has habit on this sense? 419. What effect has cultivation? Give illustrative examples. How may the taste be impaired?

SENSE OF SMELL.

420. SMELL is the sense that enables us to discern the odor, or scent, of a thing. This sense is located in the air passages of the nose.

421. The air passages, or nostrils, are lined by mucous membrane, which is continuous with the skin externally, and with the lining membrane of other cavities which communicate with them. To this membrane the *ol-fact'o-ry*, or nerve of smell, is distributed.

422. To protect the delicate filaments of the nerve of smell, thus freely exposed to the air and to the painful stimulus of sharp, pungent odors, the membrane is kept constantly moist by a fluid secreted by the glands, with which it is provided.

Fig. 74.

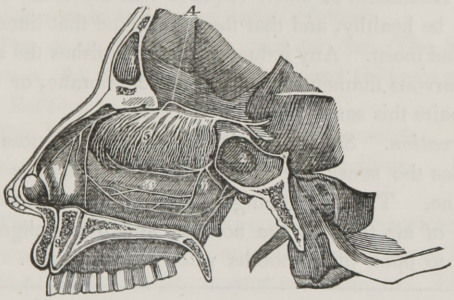

Fig. 74. A side view of the passages of the nostrils, and the distribution of the first pair of nerves. 4, The olfactory nerve. 5, The fine and curious divisions of this nerve on the membrane of the nose.

423. When substances are presented to the nose, the air that is passing through the nostrils brings the odoriferous parti-

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420—427. *What is said in reference to smell?* 420. What is smell? Where is this sense located? 421. Describe the air passages of the nose. 422. How are the filaments of the nerve of smell protected from pungent odors? What does fig. 74 represent? 423. How is the odor of substances carried to the brain?

cles of matter in contact with the filaments of the nerve of smell, that are spread upon the membrane that lines the air passages, and the impression is then carried to the brain.

424. This sense is closely connected with that of taste, and aids man, as well as the inferior animals, in selecting proper food. It also gives us pleasure by the inhalation of agreeable odors.

425. The sense of smell, like taste and touch, may be improved by cultivation. Thus the North American Indians can easily distinguish different tribes, and different persons of the same tribe, by the odor of their bodies.

426. This sense is seen to be remarkably acute in the dog; he will trace his master's footsteps through thickly-crowded streets, and distinguish them from thousands of others; he will track the hare over the ground for miles, guided only by the odor that it leaves in its flight.

427. Acuteness of smell requires that the brain and nerve of smell be healthy, and that the membrane that lines the nose be thin and moist. Any influence that diminishes the sensibility of the nervous filaments, thickens the membrane, or renders it dry, impairs this sense.

Observation. *Snuff*, when introduced into the nose, not only diminishes the sensibility of the nerve, but thickens the lining membrane. This thickening of the membrane obstructs the passage of air through the nostrils, and thus obliges "snuff-takers" to open their mouths when they breathe.

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424. What is the use of this sense? 425. What is said of this sense among the North American Indians? 426. In the dog? 427. What does acuteness of smell require? What will impair this sense? What effect has snuff upon the nasal organ?

CHAPTER XXXI.

SENSE OF VISION.

428. THIS sense contributes more to the enjoyment and happiness of man than any of the other senses. By it, we perceive the form, color, size, and position of objects that surround us. The beautiful organ of vision, or sight, is the *Eye.*

ANATOMY OF THE ORGANS OF VISION.

429. The EYE is shaped like a globe, and is placed in a cavity in front of the skull. The sides of the globes are composed of three *coats*, or membranes. The interior of the globe is filled with certain substances called *Hu'mors.*

430. The COATS are three in number: 1st. The *Scle-rot'ic* and *Corn'e-a.* 2d. The *Cho'roid*, *Iris*, and *Cil'ia-ry processes.* 3d. The *Ret'i-na.*

431. The HUMORS are also three in number: 1st. The *A'que-ous*, or watery. 2d. The *Crys'tal-line.* 3d. The *Vit're-ous*, or glassy.

432. The SCLEROTIC coat is firm, and its color white; hence, it is frequently called the "white of the eye." From its toughness, it forms the principal support to this organ. This membrane, with the cornea in front, encloses the eye.

433. The CORNEA is the transparent part of the eye in front, which projects more than the rest of the globe. It is shaped like the crystal of a watch, and, in health, gives the eye its sparkling brilliancy.

428—449. *Give the structure of the different parts of the eye.* 429. Describe the eye. 430. Name the coats of the eye. 431. Name the humors of the eye. 432. Describe the sclerotic coat. 433. Where is the cornea situated?

434. The CHOROID coat is of a dark color upon its inner surface. It contains a great number of blood-vessels, which give nourishment to different parts of the eye.

435. The IRIS is situated a short distance behind the cornea. It is the most delicate of all the muscles of the body. This part gives the blue, gray, or black color to the eye.

436. In the centre of the iris is an opening called the *pu'pil*,* which enlarges or contracts, according to the quantity of light that falls upon the eye.

Fig. 75.

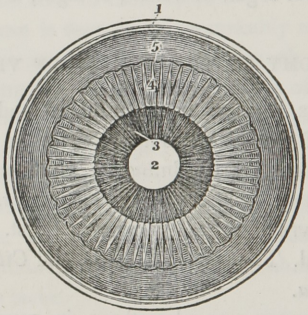

Fig. 75. A section of the eye, seen from within. 1, The divided edge of the three coats. 2, The pupil. 3, The iris. 4, The ciliary processes. 5, The scolloped border of the retina.

437. On viewing the part of the eye near the pupil, small lines, of a lighter color, will be seen passing to the outer part of the iris; these are called *ciliary processes*. They are about sixty in number.

438. The RETINA is the innermost coat of the eye. It is

* From *pu'pa*, Latin, a babe; because it reflects the diminished image of the person who looks upon it.

434. Describe the choroid coat. 435. Where is the iris situated? What is said of this coat? 436. Where is the pupil of the eye? Explain fig. 75. 437. Describe the ciliary processes. 438. Give the structure of the innermost coat of the eye.

formed, in part, by an expansion of the optic nerve over the bottom of the eye, where the sense of vision is first received.

439. The AQUEOUS humor occupies the space between the cornea and crystalline humor, both before and behind the iris.

440. The CRYSTALLINE humor (lens) lies behind the aqueous humor and pupil. Its form is different on the two sides. When boiled, it may be separated into layers like those of an onion.

Observations. 1st. The lens in the eye of a fish is round, like a globe, and when boiled, it may be separated into layers, resembling those of the human eye.

Fig. 76.

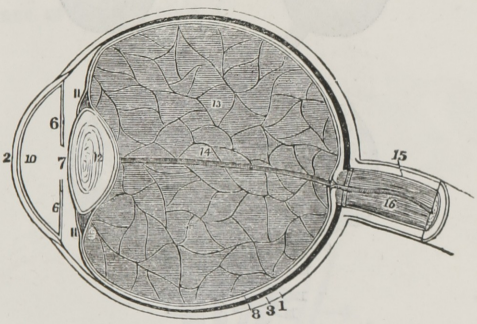

Fig. 76. A section of the globe of the eye. 1, The sclerotic coat. 2, The cornea. This connects with the sclerotic coat by a bevelled edge. 3, The choroid coat. 6, 6, The iris. 7, The pupil. 8, The retina. 10, 11, 11, Chambers, or cavities of the eye that contain the aqueous humor. 12, The crystalline lens. 13, The vitreous humor. 15, The optic nerve. 14, 16, One of the arteries of the eye.

2d. When the crystalline lens, or the membrane which surrounds it, is changed in structure, so as to prevent the rays of light passing to the retina, the affection is called a *cataract.*

441. The VITREOUS humor is situated in the back part of

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439. Where is the aqueous humor found? 440. The crystalline humor? How can the structure of this lens be seen? Explain fig. 76. 441. Where is the vitreous humor situated?

the eye. It occupies more than two thirds of the whole interior of the globe of the eye.

Observation. The structure of this organ can be seen, by first freezing the eye of a sheep, or an ox; it then can be cut in various directions, and each part separately examined.

442. The OPTIC NERVE, or nerve of vision, extends from the brain to the back part of the eye, where it expands on a portion of the choroid coat. On this expansion the image of objects are first formed.

Fig. 77.

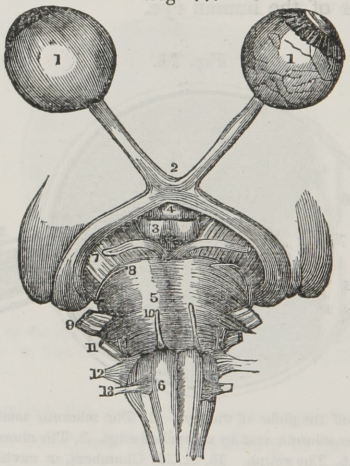

Fig. 77. The second pair of nerves. 1, 1, The globe of the eye. The one on the left is perfect, but the sclerotic coat has been removed from the one on the right, to show the retina. 2, The crossing of the optic nerve. 3, 4, The brain. 5, 6, The commencement of the spinal cord. 7, 8, 9, 10, 11, 12, 13, The cranial nerves.

443. The EYEBROWS and EYELIDS protect the eye from too strong impressions of light, and also prevent particles of dust and perspiration from falling into it.

How can the structure of the eye be seen? 442. What is said of the optic nerve? What is represented by fig. 77? 443. What is the use of the eyebrows and eyelids?

444. The EYELASHES are attached to the eyelids; and when the eye is closed, they interlace, and thus prevent particles of matter from injuring this delicate organ. They add very greatly to the expression of the eye.

445. The eyelids not only protect the eye, by closing it in front, from too brilliant rays of light and from dust, but distribute equally over the globe of the eye a watery fluid secreted by glands, with which they are provided.

446. Beside this, there is another fluid, (tears,) secreted by the *lach'ry-mal*, or tear-gland, above the eye. The tears flow to the eye by several minute ducts. As this fluid passes over the eye, the small atoms of dust are swept away, by the process of "winking," and with the tears pass into two ducts at the inner corner of both eyelids.

Fig. 78.

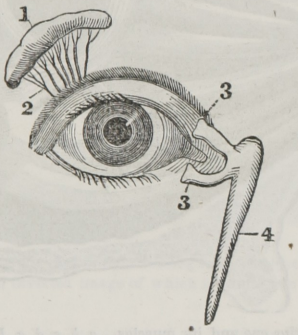

Fig. 78. 1, The tear-gland. 2, The ducts that pass from this gland to the eye 3, 3, Ducts at the inner corner of the eyelids. 4, The duct that opens into the nose.

447. These small ducts usually convey the tears away as quickly as they are formed; but when the eye is irritated, or the mind

444. What is the use of the eyelashes? 445. Give another use of these protecting parts of the eye. 446. Where are tears formed? What is the use of tears? What does fig. 78 represent? 447. What is the effect when the eye is irritated?

affected by various emotions, they flow to the eye too rapidly to be conveyed to the nose, and they then course down the cheek.

448. The ORBIT, or bony cavity, in which the globe of the eye is placed, is lined with a thick cushion of fat, in order that the eye may move in all directions, with perfect freedom and without friction.

449. The eye is moved by six muscles, one extremity of which is attached to the bones of the orbit; the other extremity to the globe of the eye.

Fig. 79.

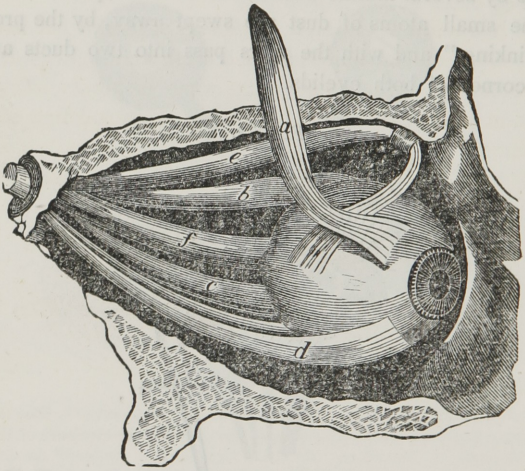

Fig. 79. A view of the eye and its muscles. *a*, *b*, *c*, *d*, *e*, Five of these muscles. *f*, The optic nerve. The bone is seen above and below the eye.

Observation. If the external muscle is too short, the eye is turned out, producing the "wall eye." If the internal muscle is contracted, the eye is turned inward toward the nose. It is then called a "cross eye."

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448. How are the movements of the eye facilitated? 449. How many muscles move the eye? What is the effect if the external muscle is contracted? The internal muscle?

CHAPTER XXXII.

PHYSIOLOGY OF THE ORGANS OF VISION.

450. As the eye is strictly an optical instrument, it is necessary to know the laws that regulate the transmission of light, before the use of the different parts of this organ can be understood.

451. It is a law of optics, that the rays of light, while passing through the same medium, proceed in straight lines; but that they are turned out of their course when they pass from one medium to another of different density. They are then said to be *refracted.*

Fig. 80.

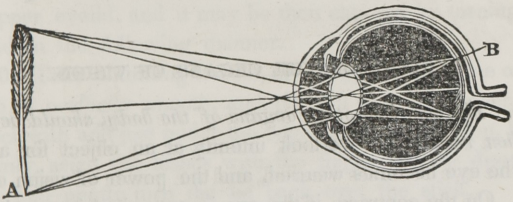

Fig. 80. The course of the rays of light coming from an object and passing through the eye. A, A pen, an inverted image of which is painted on the retina of the eye, at B.

452. Another law is, that the rays of light, as they become more distant from the luminous body, diverge, or extend farther from each other. We would also add, that the rays of light from an object, in passing through the eye, cross each other. Hence, the image of the object is inverted on the retina.

450—454. *Give the physiology of the organs of vision.* 450. What is necessary before the use of the different parts of the eye can be understood? 451. Give the first law in reference to light. What is represented by fig. 80? 452. The second law. Why is the image of objects inverted on the retina?

453. We will now pass to the use of the different parts of the eye. The eyebrows, eyelids, and eyelashes, are protecting organs to this delicate instrument; while the coats give form and protection to the more delicate parts within.

454. The transparent cornea and humors are mediums of different density; so that the direction of the rays of light that leave the object at which we look, are refracted and form upon the retina a small, but clear image of that object. The impression of the image upon the retina, is then carried to the brain by the optic nerve.

Observations. 1st. When the cornea and crystalline lens become flattened, as in old age, the image is formed beyond the retina. This defect is remedied by wearing *convex* glasses.

2d. When the cornea and crystalline lens are too convex, an image of the object will be formed before the retina. This defect of the eye is called *near*-sightedness. To give such persons longer vision, it is necessary to wear *concave* glasses.

HYGIENE OF THE ORGANS OF VISION.

455. *The eye, like other organs of the body, should be used, and then rested.* If we look intently at an object for a long time, the eye becomes wearied, and the power of vision diminished. On the contrary, if the eye is not called into action, its functions are enfeebled.

456. *Sudden transitions of light should be avoided.* The iris enlarges or contracts, as the light that falls upon the eye is faint or strong; but the change is not instantaneous. Hence the

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453. What parts of the eye are used to protect this delicate organ? To give it form? 454. What is said of the use of the cornea and humors? When do persons need convex glasses? When concave? 455—461. *Give the hygiene of the organs of vision.* 455. How should the eye be used? What is the effect of using the eye too long? Of not calling it into action? 456. What should be avoided in using the eye?

Note. Review the anatomy and physiology of the eye from fig. 76, or from anatomical outline plate 10.

imperfect vision in passing from a strong to a dim light, and the overwhelming sensation experienced on going from a dimly lighted room to one brilliantly lighted.

457. *As far as possible, avoid all oblique positions of the eye, when viewing objects.* If the eye is turned obliquely in viewing objects, it may produce an unnatural contraction of the muscle called into action. This contraction of the muscle is called *strabismus*, or cross-eye.

458. *Children should be trained to use the eye upon objects at different distances.* This is necessary, in order that the vision may be correct when objects at various distances are viewed, as the eye accommodates itself to receive impressions from objects remote as well as near.

459. When particles of dust get upon the eye, the individual should be placed before a strong light, the lids held open, and the particles removed with the corner of a fine linen or silk handkerchief. Sometimes the substance is concealed under the upper eyelid, and it may be then exposed by turning back the lid in the following manner.

460. Take a knitting-needle, or small, slender piece of stick, which is perfectly smooth, and place it over the upper lid, in contact with and just under the edge of the orbit; then, holding it firmly, seize the lashes with the fingers of the disengaged hand, and gently turn the lid back over the stick.

461. Too many trials ought not to be made, if unsuccessful, as much inflammation may be induced; but a surgeon ought to be consulted as soon as possible. Eye-stones ought never to be placed in the eye, as they often cause more irritation than the evil which they are intended to remedy.

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457. What should be avoided in viewing objects? 458. Why should we view objects at different distances? 459. What should be done when particles of dust get upon the eye? 460. How can particles of dust be removed from the upper eyelid? 461. What should be avoided?

CHAPTER XXXIII.

SENSE OF HEARING.

462. THE sense of hearing is next in importance to that of vision. Through this sense we are enabled to perceive sounds, that not only subserve to our comfort and pleasure, but are instrumental to our intellectual enjoyments. The organ of hearing, or the *Ear*, is one of the most complicated in the human body.

ANATOMY OF THE ORGANS OF HEARING.

463. The EAR is composed of three parts: 1st. The *Exter'nal* ear. 2d. The *Tym'pan-um*, or middle ear. 3d. The *Lab'y-rinth*, or internal ear.

464. The EXTERNAL ear presents many ridges and furrows, arising from the folds of the cartilage that form it. A funnel-shaped tube extends from the external to the middle ear.

Observation. Many animals have small muscles that move the external ear, in order to catch sounds from every direction. The hare, rabbit, and horse, afford good examples.

465. At the internal extremity of the tube, is a thin, semi-transparent membrane, that separates the external from the middle ear. It is called *mem'bra-na tym'pan-i*, or drum of the ear. This and the bitter wax found around the hairs in the tube, prevent insects from entering the head.

466. The MIDDLE ear is connected with the internal and

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462. What is said of the sense of hearing? 463—476. *Give the anatomy of the organs of hearing.* 463. Name the parts of the ear. 464. Describe the external ear. What is said of the ears of horses, rabbits, &c.? 465. Describe the drum of the ear. 466. How is the middle ear connected with the internal cavity?

most important cavity, by four small bones, which are the most delicate and beautifully shaped bones in the body. These are so arranged, as to form a chain from the drum of the ear to the labyrinth.

467. From the middle ear, a tube opens into the back part of the throat, called *Eu-sta'chi-an*, which admits air into this part of the ear. If this tube is closed by disease of the throat, hearing is impaired.

Fig. 81.

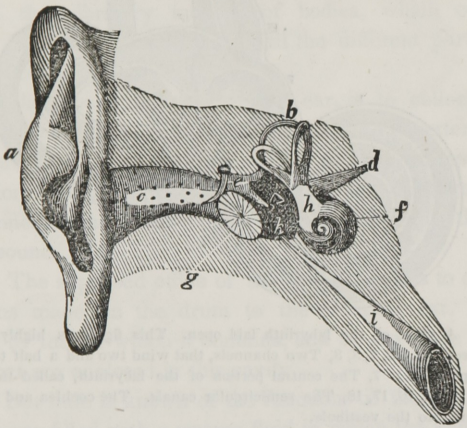

Fig. 81. *a*, The external ear. *c*, The tube that leads to the middle ear. *g*, The drum of the ear. *e*, *h*, The middle ear. *b*, *f*, *h*, The internal ear. *i*, The tube that leads to the throat. *d*, The auditory nerve.

468. The INTERNAL ear is very intricate, and the uses of its various parts are not well known. It is called the labyrinth, from its many windings. This part of the ear is composed of a three-cornered cavity, called the *ves'ti-bule*, the *coch'le-a*, (from its resembling a snail shell,) and the *sem-i-cir'cu-lar* canals.

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467. What tube opens into the middle ear? What is its use? Explain fig. 81. 468 Describe the internal ear.

469. The internal ear is the only part that is absolutely essential in hearing. Other parts, already described, may be removed, and yet the person may hear.

Fig. 82.

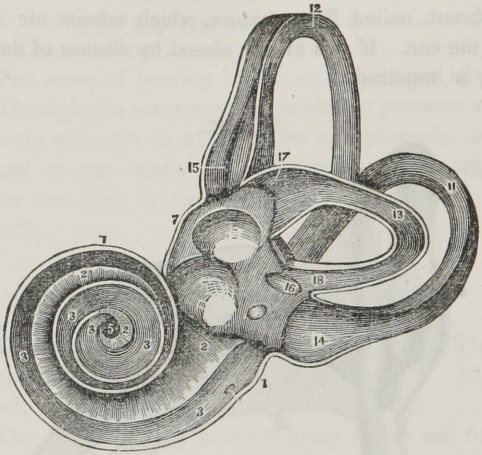

Fig. 82. A view of the labyrinth laid open. This figure is highly magnified. 1, 1, The cochlea. 2, 2, 3, 3, Two channels, that wind two and a half turns around a central point, (5.) 7, The central portion of the labyrinth, called the vestibule. 11, 12, 13, 14, 15, 16, 17, 18, The semicircular canals. The cochlea and semicircular canals open into the vestibule.

470. The AUDITORY nerve, or nerve of hearing, proceeds from the brain, and expands upon the membrane that lines the internal ear, similar to the expansion of the optic nerve.

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469. What part of the ear is absolutely essential in hearing? What does fig. 82 represent? 470. Describe the auditory nerve.

CHAPTER XXXIV.

PHYSIOLOGY OF THE ORGANS OF HEARING.

471. HEARING is that function by which we obtain a knowledge of the vibratory motions of bodies, which constitute sounds. The precise function of all the different parts of the ear are not known.

472. The function of the external ear, is to collect sounds and reflect them into the tube that connects the external with the middle ear. The "drum of the ear" receives all the impressions of the air which enter the tube, and conveys them to the bones of the ear. It also serves to moderate the intensity of sound.

473. The supposed office of the middle ear, is to carry the vibrations made on the drum to the internal ear. This is effected by the air which it contains, and by the chain of small bones that are enclosed in this cavity.

474. But little is known of the functions of the internal ear; its parts are filled with a watery fluid in which the filaments of the auditory nerve terminate.

475. The auditory nerve, like the optic, has but one function, that of special sensibility, or transmitting sound to the brain. The nerves which furnish the ear with ordinary sensibility, proceed from the fifth pair.

476. The transmission of sound through the different parts

471—476. *Give the use of the organs of hearing.* 471. What is hearing? 472. What is the function of the external ear? Of the drum of the ear? 473. What is the use of the middle ear? 474. What is said of the functions of the internal ear? 475. Of the auditory nerve?

of the ear, will now be explained by the aid of fig. 83. The vibrations of the air are collected by the external ear, and conducted through the tube (1) to the drum of the ear, (2.)

Fig. 83.

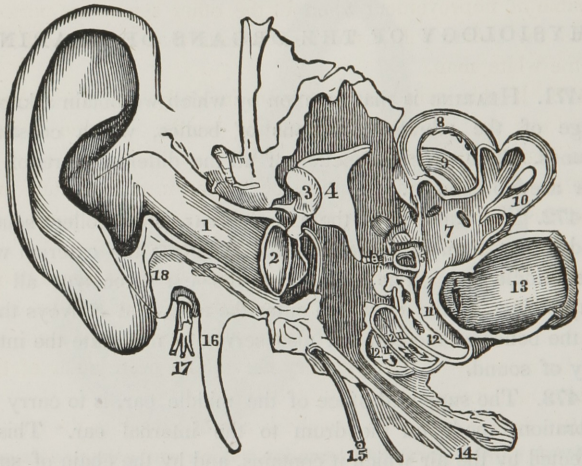

Fig. 83. A view of all the parts of the ear. 1, The tube that leads to the internal ear. 2, The drum of the ear. 3, 4, 5, The bones of the ear. 7, The central part of the labyrinth named the vestibule. 8, 9, 10, The semicircular canals. 11, 12, The channels of the cochlea. 13, The auditory nerve. 14, The channel from the middle ear to the throat, (eustachian tube.) 15, The chorda tympani nerve. 16, The styloid process. 17, The seventh pair of nerves, (facial.) 18, The mastoid process of the temporal bone.

From the drum the vibrations pass along the chain of bones, (3, 4, 5.) The bone (5) communicates with the internal ear, (7, 8, 9, 10, 11, 11, 11, 12, 12, 12.) From the internal ear the impression is carried to the brain by the auditory nerve, (13.)

Note. Let the pupil review the anatomy and physiology of the ear from fig. 83, or from anatomical outline plate 10.

HYGIENE OF THE ORGANS OF HEARING.

477. Hearing, like the other senses, is capable of very great improvement. By cultivation, the blind are enabled to judge with great accuracy the distance of bodies in motion. It is also capable of improvement when all the other senses are perfect. Thus the Indian will distinguish sounds that cannot be heard by the white man.

478. If this sense is destroyed in early life, the person also loses the power of articulating words. Hence a man born deaf is always dumb.

479. Acute hearing requires perfection in the structure and functions of the different parts of the ear, and that portion of the brain from which the auditory nerve proceeds.

480. The common causes of impaired hearing, are a thickening of the drum of the ear, an accumulation of wax upon its exterior surface, a closure of the eustachian tube, disease of the brain, palsy of the auditory nerve, and destruction of the middle and internal ear.

481. It is injurious to put the heads of pins into the ear, as they frequently cause inflammation. The wax can be softened by dropping into the tube some oil, and in a few hours remove it, by ejecting warm soap-suds into the ear.

Observation. When worms and insects find their way into the tube of the external ear, they can usually be driven out, by dropping in warm olive-oil.

477—481. *Give the hygiene of the organs of hearing.* 477. Show how the faculty of hearing is capable of improvement. 478. What follows the loss of hearing in early life? 479. On what does acute hearing depend? 480. State some of the causes of impaired hearing. 481. What caution is given respecting the use of pins in the ear? How can insects be removed from the ear?

CHAPTER XXXV.

MEANS OF PRESERVING THE HEALTH.

482. Our bodies are constituted according to certain laws, and every person should learn these, in order to regulate his actions and duties, so that the health may be unimpaired, and the power of enjoyment, activity, and usefulness continue while life lasts.

483. It is a law of the muscles, that they should either be used in some occupation, or called into action by some social play and active sport. (See Chap. VIII.)

484. All admit that food is necessary to sustain life; and unless it be of a proper quality, taken in proper quantities, and at proper times, the functions of the digestive organs will be deranged, and disease produced. (See Chap. XII.)

485. Pure air is essential to the full enjoyment of health. The close, impure air of heated rooms and crowded assemblies may be breathed, and the effect be so gradual as not to arrest attention; yet it is a violation of the physical laws. (See Chap. XXI.)

486. The body also requires sleep; and if it is not taken at the right time, or with regularity, we do not feel a full refreshment from "tired nature's sweet restorer." Let youth be taught that "early to bed and early to rise" gives him health and its attendant blessings. The brain, like other organs of the body, should be called into action at proper times. (See Chap. XXIX.)

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482. Why is it incumbent on every person to learn the laws of health? 483. Give a law of the muscles. 484. In preserving the health, why is it necessary to give attention to the food which is eaten? 485. What beside food is essential to the full enjoyment of health? What is said of the impure air of heated rooms and crowded assemblies? 486. What should be observed in regard to sleep?

487. From the extent of the surface of the skin, and the close sympathy that exists between it and those organs whose office is to remove the waste particles of matter from the body, it is, therefore, very important in the preservation of the health, that the functions of this membrane be properly maintained. (See Chap. XXVI.)

REMOVAL OF DISEASE.

488. It is seldom that a physician is called in the first stages of disease. At this period, the treatment adopted should be proper and judicious, or the sufferings of the patient are increased, and life, to a greater or less degree, is jeopardized. Hence the utility of knowing what *should be done*, and what *should not be done*, in order that the health may be rapidly regained.

489. In all instances of acute disease, it is proper to rest, not only the body, but the mind. To effect this, the patient should cease from physical exertion, and also withdraw his thoughts from study and business operations. This should be done, even if the person is but slightly indisposed.

490. Select a room for a sick person that is exposed to as little external noise as possible, as impressions made on the ear greatly influence the nervous system. Likewise select a spacious, well-ventilated apartment, that has no superfluous furniture. The practice of placing a sick person in a small, ill-arranged sleeping-room, when a more spacious room can be used, is poor economy, not to say unkind.

491. Care is necessary in regulating the light of a sick-room. While a strong light would produce an increased action of the vessels of the brain, on the contrary, a moderate light would be

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487. Why should the functions of the skin be properly maintained? 488. What is important in the first stages of disease? 489. What is proper in all instances of acute disease? How can it be effected? 490. What rooms should be selected for the sick? Why? 491. What is said in reference to the quantity of light admitted into a sick-room?

an appropriate stimulus to this organ. It is seldom necessary to exclude all light from the sick chamber.

492. A sick person, whether a child or an adult, should not be disturbed by visitors, even if their calls are short. The excitement of meeting them is followed by a depression of the nervous system. The more dangerous and apparently nearer death the sick person is, the more rigorous should be the observance of this suggestion.

493. Nor should the sick-room be opened to privileged classes; for the excitement caused by a visit from relations and the virtuous, will do as much injury to the sick, as that produced by strangers and the vicious. The custom of visiting and conversing with sick friends during the intervals of daily labor, and particularly on *Sunday*, is a great evil. No person will thus intrude herself in the sick chamber, who cares more for the welfare of the suffering friend than the gratification of a *sympathetic curiosity*. Inquiries can be made of the family respecting the sick, and complimentary or necessary messages can be communicated through the nurse.

Illustration. While attending a Miss B., of N. H., sick of fever, I pronounced her better, withdrew medicine, directed a simple, low diet, and the exclusion of all visitors. In the evening, I was sent for, to attend her. There was a violent relapse into the disease, which continued to increase in severity until the fourth day, when death terminated her sufferings. I learned that, soon after I gave directions that no visitors be admitted into her room, several *particular* friends were permitted to enter the chamber and talk with the sick girl. Their conversation produced a severe headache; and, to use the language of the patient, "it seemed as if their talk would kill me;" and *it did kill her*.

494. No *solid food* should be taken in the first stages of dis-

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492. What effect have calls on the sick? 493. What is said of the custom of calling and conversing with the sick during the intervals of daily labor? Give an illustration. 494. What suggestions relative to food, in the first stages of disease?

ease, even if the affection is slight. The thirst can be allayed by drinking cold water, barley-water, and other preparations of an unstimulating character. It is wrong to tempt the appetite of a person who is indisposed. The cessation of a desire for food, is the warning of Nature, that the system is in such a state that it cannot be digested.

495. When a patient is recovering from illness, the food should be simple, and in quantities not so great as to oppress the stomach. It should also be given with regularity. "Eat little and often," with no regard to regularity, is a bad practice.

496. When a physician attends a sick person, he should have the *special* management of the food, particularly after the medicine has been withdrawn and the patient is convalescent. The prevailing idea that *every* person may safely advise relative to food, or that the appetite of the convalescing person will guide correctly, is dangerous, and cannot be too much censured.

Illustration. In 1832, I attended a Miss M., sick of fever. After an illness of a few days, the fever abated, and I directed a simple, unstimulating diet. Business called me from the town two days. During my absence, an officious matron called; found her weak, but improving; and told her she needed food to strengthen her; and "it would now do her good." Accordingly, a piece of beefsteak was prepared, and given to the convalescent girl. She ate heartily, and the result was, a relapse into a fever more violent than the first attack.

497. It is very important in disease that the skin be *kept clean.* A free action of the vessels of this part of the body exerts a great influence in removing disease from the internal organs, as well as keeping them in health. If the thirty ounces

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495. When the patient is convalescent, how should the food be given? What is said of the practice of eating "little and often"? 496. Who should have the special management of food when medicine is withdrawn? What idea prevails in the community? Give an illustration of the evil effects attending such an idea. 497. Does the skin exert a great influence in removing disease from the internal organs, as well as in keeping them in health?

of waste, hurtful matter, that passes through the "pores" of the skin in twenty-four hours, is not removed by frequent bathing and dry rubbing, the action of these vessels is deranged, which increases the disease of the internal organs.

Illustration. Mrs. M. R., of N., Mass., was afflicted with disease of the lungs and cough. This was accompanied with a dry, inactive condition of the skin. As medicine had no salutary effect in relieving her cough, she was induced by the advice of the clergyman of the parish to enter upon a systematic course of bathing twice every day. Soon the skin became soft, its proper functions were restored, the disease of the lungs yielded, and the cough disappeared.

498. The sick-room should be kept very clean, and in perfect order. When a sick person sees every thing neat and in its proper place, a feeling of comfort is induced, which aids in the recovery of the health; while filth and disorder are objects of annoyance, and tend to depress the nervous system.

499. Every sick person should breathe *pure air.* The purer the blood that courses through the body, the greater the energy of the system to remove disease. The confined, vitiated air of the sick-chamber not unfrequently prolongs disease; and in many instances, the affection is not only aggravated, but even rendered fatal, by its injurious influences.

Illustrations. 1st. In 1833, I was called, in consultation with another physician, to Mr. H., who was much debilitated and delirious. For several successive days he had not slept. His room was kept very warm and close, for fear he would "take cold." The only change that I made in the treatment, was to open the door and window, at a distance from the bed. In a short time, the delirium ceased, and he fell into a quiet slumber. From this time he rapidly recovered, and I have no doubt that the delirium was the result of breathing impure air.

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498. How should the sick-room be kept? 499. Why should every sick person, particularly, breathe pure air? Are not diseases prolonged, and even rendered fatal, from breathing the impure, vitiated air of the sick chamber? Give illustration 1st.

2d. Formerly, every precaution was used to prevent persons sick of the small-pox from breathing fresh air. When Mrs. Ramsay had this disease in Charleston, S. C., her friends, supposing that life was extinct, caused her body to be removed from the house to an open shed. The pure air revived the vital spark, and she lived to be an ornament to her sex.

500. MEDICINE is sometimes necessary to *assist* the natural powers of the system to remove disease; but it is only an *assistant*. While emetics are occasionally useful in removing food and other articles from the stomach, that would cause disease if suffered to remain, and cathartics are valuable, in some instances, to relieve the alimentary canal of irritating residuum, yet the frequent administration of either will cause serious disease.

501. Although medicine is useful in some instances, yet, in a great proportion of the cases of disease, including fevers and inflammations of all kinds, attention to the laws of health will tend to relieve the system from disease, more certainly and speedily, and with less danger, than when medicines are administered.

502. Thomas Jefferson, in writing to Dr. Wistar, of Philadelphia, said, "I would have the physician learn the limit of his art." I would say, Have those who are continually advising "herb teas, pills, bitters," and other "cure-alls," for any complaint, labelled with some popular name, learn the limits of their duty, namely, attention to the laws of health. The rule of every family, and each individual, should be, to touch not, taste not, of medicine of *any kind*, except when directed by a well-educated and honest physician, (sudden disease from accidents excepted.)

Give illustration 2d. 500. What is said of the use of medicine? 501. What is said of its use in fevers and many other cases of disease? 502. What remark by Thomas Jefferson to Dr. Wistar? What should be the rule of every person in regard to taking medicine? What exception?

CHAPTER XXXVI.

DIRECTIONS FOR NURSES.

503. The nurse requires knowledge and practice to enable her to discharge aright her duty to the patient, as much as the physician and surgeon do to perform what is incumbent on them. Woman, from her constitution and habits, is the natural nurse of the sick; and, in general, no small portion of her time is spent in ministering at the couch of disease and suffering.

504. As the young and vigorous, as well as the aged and the infirm, are liable to be laid upon the bed of sickness, by an epidemic, or imprudent exposure, or by some accident, it is therefore necessary that the girl, as well as the matron, may know how she can render services in an efficient and proper manner. No *girl* should consider her education complete who is not acquainted with the principles of the duties of a general nurse and a temporary watcher.

505. It is to be regretted, that, while we have medical schools and colleges to educate physicians, there is no institution to educate *nurses* in their equally responsible station. In the absence of such institutions, the defect can be remedied, to some extent, by teaching every girl *hygiene* or *the laws of health.* To make such knowledge more available and complete, attention is invited to the following suggestions relative to the practical duties of a nurse.

506. Bathing. The nurse, before commencing to bathe

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503. Does the nurse require knowledge and practice in her employment, as well as the physician? 504. Who is the natural nurse of the sick? What, then, is incumbent on every girl? 505. Should there be schools to educate nurses, as well as physicians and surgeons? 506. What should a nurse provide herself with, before bathing a patient?

the patient, should provide herself with water, two towels, a sponge, a piece of soft flannel, and a sheet, and also notice the temperature of the room.

507. When the patient is feeble, use *tepid* or warm water. Cold water should only be used when the system has vigor enough to produce reaction upon the skin. This is shown by the increased redness of the skin, and a feeling of warmth and comfort. Before using the sponge to bathe, a sheet, or fold of cloth, should be spread smoothly over the bed, and under the patient, to prevent the bed-linen on which the patient lies from becoming damp or wet.

508. Apply the wet sponge to one part of the body at a time; as the arm, for instance. By doing so, the liability of contracting chills is diminished. Take a dry, soft towel, wipe the bathed part, and follow this by vigorous rubbing with a crash towel, or, what is better, a mitten made of this material; then use briskly a piece of soft flannel, to remove all moisture that may exist on the skin, and particularly between the fingers and the flexions of the joints. In this manner bathe the entire body.

509. The sick should be thoroughly bathed, at least twice in twenty-four hours. Particular attention should be given to the parts between the fingers and toes, and about the joints, as the accumulation of the waste matter is most abundant on these parts. In bathing, these portions of the system are very generally neglected. The best time for bathing, is when the patient feels the most vigorous, and freest from exhaustion. The practice of daubing the face and hands with a towel dipped in hot rum, camphor, and vinegar, does not remove the impurities, but causes the skin soon to feel dry, hard, and uncomfortable.

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507. When should cold water be used? 508. How should the bathing then be performed, so that the patient may not contract a cold? 509. How often should a sick person be bathed? What is said of daubing the face and hands merely with a wet cloth?

510. Food. It is the duty of every woman to know how to make the simplest preparations adapted to a low diet, in the most wholesome and the most palatable way. Water-gruel,* which is the simplest of all preparations, is frequently so ill made as to cause the patient to loathe it. Always prepare the food for the sick in the neatest and most careful manner.

511. When the physician enjoins abstinence from food, the nurse should strictly obey the injunction. She should be as particular to know the physician's directions about diet, as in knowing how and when to give the prescribed medicines, and obey them as implicitly.

512. When a patient is convalescing, the desire for food is generally strong, and it often requires firmness and patience, together with great care, on the part of the nurse, that the food is prepared suitably, and given at proper times. The physician should direct how frequently it should be taken.

513. Pure Air. It is the duty of the nurse to see that not only the room is well ventilated in the morning, but that fresh air is constantly coming in during the day. Great care must be taken, however, that the patient does not feel the current.

514. Bed-linen, as well as that of the body, should be aired every day, and oftener changed in sickness than in health. All clothing, when changed, should be well dried, and warmed by a fire previous to its being put on the patient or the bed.

515. Temperature. The warmth of the chamber should be carefully watched by the nurse. The feelings of the patient

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* Directions for making the simple preparations for the sick are found in almost every cook-book.

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510. Should every woman know how to make the simple preparations adapted to a low diet? 511. Should the nurse strictly obey the injunctions of the physician relative to food? 512. What period of a person's illness requires the most care in regard to the food? 513. Give another duty of the nurse. 514. What directions respecting the bed-linen of the patient? What is necessary when there is a change of clothing? 515. Why should there be a well-adjusted thermometer in every sick-chamber?

or nurse are not to be relied on, as an index of the temperature of the room. There should be a well-adjusted thermometer in every sick-room. This should be frequently consulted by the nurse.

516. The temperature of the sick-chamber should be *moderate*. If it is so cold as to cause a chill, the disease will be aggravated. If, on the other hand, it is too warm, the patient is enfeebled and rendered more susceptible to cold on leaving the sick-chamber. The Latin maxim, "*In medio tutissimus ibis*," (in medium there is most safety,) should be regarded in the rooms of the sick.

517. QUIET. The room of the patient should be kept free of noise. The community should be guided by this rule, that no more persons remain in the room of the sick, than the welfare of the patient demands. It is the duty of the physician to direct when visitors can be admitted or excluded from the sick-room, and the nurse should see that these directions are enforced.

518. The movements of the attendants should be gentle and noiseless. Shutting doors violently, creaking hinges or shoes, and all unnecessary noise, should be avoided. Most persons refrain from loud talking in the sick-chamber, but are not equally careful to abstain from *whispering*, which is often more trying than a common tone.

519. The deportment and remarks of the nurse to the patient should be calm and encouraging. The illness of a friend, or persons who have recently died, should not be alluded to in the sick-room. No doubts or fears of the patient's recovery, either by a look or by a word, should be communicated by the nurse, in the chamber of the sick.

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516. What is said of the temperature of the sick-chamber? 517. Should the sick-room be kept quiet? 518. What is said of noise in the sick-chamber? Of whispering? 519. What should be the deportment of the nurse toward the patient? Should doubts and fears of the patient's recovery be communicated in the sick-room?

520. When such information is necessary to be communicated, it is the duty of the physician to impart it to the sick person.

521. The nurse should not confine herself to the sick-room more than six hours at a time. She should eat her food regularly, sleep at regular periods, and take exercise daily in the open air. To do this, let her quietly leave the room when the patient is sleeping. A watcher, or temporary nurse, may supply her place. There is but little danger of contracting disease, if the nurse attends to the simple laws of health, and remains not more than six hours at a time in the sick-room.

DIRECTIONS FOR WATCHERS.

522. These necessary assistants, like the nurse, should have knowledge and practice. They should ever be cheerful, gentle, firm, and attentive, in the presence of the patient.

523. A simple, nutritious supper should be eaten before entering the sick-room; and it is well, during the night, to take some plain food.

524. When watching in cold weather, a person should be warmly dressed, and furnished with an extra garment, as a cloak or shawl, because the system becomes exhausted toward morning, and less heat is generated in the body.

525. Whatever may be wanted during the night, should be brought into the sick-chamber, or the adjoining room, before the family retires for sleep, in order that the slumbers of the patient be not disturbed by haste, or searching for needed articles.

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520. When necessary to impart such intelligence, on whom does it depend? *521.* How long should a nurse remain in the sick-chamber at a time? *522.* What qualifications are necessary in a watcher? *523.* What directions in regard to the food of the watcher? *524.* When watching in cold weather, what precaution is necessary? *525.* What suggestion to watchers?

526. The same general directions should be observed by watchers, as are given to the nurse; nor should the watcher deem it necessary to make herself acceptable to the patient by agreeable conversation.

527. It can hardly be expected that the farmer, who has been laboring hard in the field, or the mechanic, who has toiled during the day, is qualified to render all those little attentions that a sick person requires. Hence, would it not be more benevolent and economical to employ and *pay* watchers, who are qualified by knowledge and *training*, to perform this duty in a faithful manner, while the kindness and sympathy of friends may be *practically* manifested by assisting to defray the expenses of these qualified and useful assistants?

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526. What should watchers observe? 527. What is said of employing those persons to watch who labor hard during the day?

APPENDIX.

POISONS AND THEIR ANTIDOTES.

528. Poisoning, either from accident or design, is of such frequency and danger, that it is of the greatest importance that every person should know the proper mode of procedure in such cases, in order to render immediate assistance when within his power.

529. Poisons are divided into two classes—*mineral* (which will include the acids) and *vegetable.*

530. The first thing, usually, to be done, when it is ascertained that a poison has been swallowed, is to evacuate the stomach, unless vomiting takes place spontaneously. Emetics of the sulphate of zinc, (white vitriol,) or ipecacuanha, (ipecac,) or the wine of antimony, should be given.

531. When vomiting has commenced, it should be aided by large and frequent draughts of the following drinks: flaxseed tea, gum-water, slippery-elm tea, barley-water, sugar and water, or any thing of a mucilaginous or diluent character.

MINERAL POISONS.

532. Ammonia.—The *water of ammonia,* if taken in an over-dose, and in an undiluted state, acts as a violent corrosive poison.

533. The best and most effectual antidote is *vinegar.* It should be ad-

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528. Is it useful to know the antidotes or remedies for poison? 529. Into how many classes are poisons divided? 530. What is the first thing to be done when it is ascertained that poison has been swallowed? 531. What should be taken after the vomiting has commenced? 532. What effect has an over-dose of ammonia? 533. The antidote?

ministered in water, without delay. It neutralizes the ammonia, and renders it inactive. Emetics should not be given.

534. ANTIMONY. — The *wine of antimony* and *tartar emetic*, if taken in over-doses, cause distressing vomiting. In addition to the diluent, mucilaginous drinks, give a tea-spoonful of the sirup of poppies, paregoric, or twenty drops of laudanum, every twenty minutes, until five or six doses have been taken, or the vomiting ceases.

535. The antidotes are *nut-galls* and *oak bark*, which may be administered in infusion, or by steeping in water.

536. ARSENIC. — When this has been taken, administer an emetic of ipecac, speedily, in mucilaginous teas, and use the stomach-pump as soon as possible.

537. The antidote is the *hydrated peroxide of iron.* It should be kept constantly on hand at the apothecaries' shops. It may be given in any quantity, without injurious results.

538. COPPER. — The most common cause of poisoning from this metal, is through the careless use of cooking utensils made of it, on which the *acetate of copper* (verdigris) has been allowed to form. When this has been taken, immediately induce vomiting, give mucilaginous drinks, or the *white of eggs*, diffused in water.

539. The antidote is the *carbonate of soda*, which should be administered without delay.

540. LEAD. — The *acetate* (sugar) *of lead* is the preparation of this metal which is liable to be taken accidentally, in poisonous doses. Induce immediate vomiting, by emetics and diluent drinks.

541. The antidote is diluted *sulphuric acid.* When this acid is not to be obtained, either the *sulphate of magnesia*, (epsom salts,) or the *sulphate of soda*, (glauber's salts,) will answer every purpose.

542. MERCURY. — The preparation of this mineral by which poisoning is

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Should an emetic be given for this poison? 534. What effect has an over-dose of the wine of antimony or tartar emetic? 535. What is the antidote? 536. What should immediately be done when arsenic is swallowed? 537. What is the antidote? Can any quantity of this preparation of iron be given without injurious results? 538. What should be given when verdigris has been taken into the stomach? 539. What is the antidote? 540. What should immediately be given when sugar of lead is taken? 541. What is the antidote?

commonly produced, is *corrosive sublimate.* The mode of treatment to be pursued, when this poison has been swallowed, is as follows: The *whites of a dozen eggs* should be beaten in two quarts of cold water, and a tumbler-full given every two minutes, to induce vomiting. When the whites of eggs are not to be obtained, soap and water should be mixed with wheat flour, and given in copious draughts, and the stomach-pump introduced as soon as possible. Emetics or irritating substances ought not to be given.

543. NITRE — *Saltpetre.* This, in over-doses, produces violent poisonous symptoms. Vomiting should be immediately induced by large doses of mucilaginous, diluent drinks; but emetics, which irritate the stomach, ought not to be given.

544. ZINC. — Poisoning is sometimes caused by the *sulphate of zinc,* (white vitriol.) When this takes place, vomiting should be induced, and aided by large draughts of mucilaginous and diluent drinks. Use the stomach-pump as soon as possible.

545. The antidote is the *carbonate* or *super-carbonate of soda.*

546. NITRIC, (aqua fortis,) MURIATIC, (marine acid,) or SULPHURIC (oil of vitriol) ACIDS, may be taken by accident, and produce poisonous effects.

547. The antidote is *calcined magnesia,* which should be freely administered, to neutralize the acid and induce vomiting. When magnesia cannot be obtained, the *carbonate of potash* (salæratus) may be given. *Chalk,* powdered and given in solution, or strong *soap suds,* will answer a good purpose, when the other articles are not at hand. It is of very great importance that something be given speedily to neutralize the acid. One of the substances before named should be taken freely, in diluent and mucilaginous drinks; as gum-water, milk, flaxseed or slippery-elm tea. Emetics ought to be avoided.

548. OXALIC ACID. — This acid resembles the sulphate of magnesia, (epsom salts,) which renders it liable to be taken, by mistake, in poisonous doses. Many accidents have occurred from this circumstance. They can easily be distinguished by tasting a small quantity. *Epsom*

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542. Give the treatment when corrosive sublimate has been swallowed. 543. What effect has an over-dose of saltpetre? What treatment should be adopted? 544. What is the treatment and antidote for white vitriol? 547. What is the antidote for aqua fortis and oil of vitriol? Should emetics be avoided? 548. How can oxalic acid be distinguished from epsom salts?

salts, when applied to the tongue, have a very bitter taste, while *oxalic acid* is intensely sour.

549. The antidote is *magnesia*, between which and the acid a chemical action takes place, producing the oxalate of magnesia, which is inert. When magnesia is not at hand, *chalk*, *lime*, or *carbonate of potash*, (salæratus,) will answer as a substitute.

550. Give the antidote in some of the mucilaginous drinks before named. No time ought to be lost, but the stomach-pump should be introduced as soon as a surgeon can be obtained.

551. Ley. — The ley obtained by the leaching of ashes may be taken by a child accidentally. The antidote is vinegar, or oil of any kind. The vinegar neutralizes the alkali by uniting with it, forming the acetate of potash. The oil unites with the alkali, and forms soap, which is less caustic than the ley. Give, at the same time, large draughts of mucilaginous drinks, as flaxseed tea, &c.

VEGETABLE POISONS.

552. The vegetable poisons are quite as numerous, and many of them equally as violent, as any in the mineral kingdom. We shall describe the most common, and which, therefore, are most liable to be taken.

553. Opium. — This is the article most frequently resorted to by those wishing to commit suicide, and, being used as a common medicine, is easily obtained. From this cause, also, mistakes are very liable to be made, and accidents result from it. Two of its preparations, *laudanum* and *paregoric*, are frequently mistaken for each other; the former being given when the latter is intended.

554. *Morphia*, in solution, or *morphine*, as it is more commonly called by the public, is a preparation of the drug under consideration, with which many cases of poisoning are produced. It is the active narcotic principle of the opium; and one grain is equal to six of this drug in its usual form.

555. When an over-dose of opium, or any of its preparations, has been

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549. What is the antidote for an over-dose of oxalic acid? When magnesia cannot be obtained, what will answer as a substitute? 551. What is the antidote when ley is swallowed? 552. Are vegetable poisons as numerous and as violent in their effects as mineral? 553. What is said of opium and its preparations? 555, 556. What treatment should be adopted when an over-dose of opium or any of its preparations is taken?

swallowed, the stomach should be evacuated as speedily as possible. To effect this, as much *tartar emetic* as can be held on a ten cent piece, or as much *ipecacuanha* as can be held on a twenty-five cent piece, should be dissolved in a tumbler of warm water, and one half given at once, and the remainder in twenty minutes, if the first has not, in the mean time, operated. In the interval, copious draughts of warm water, or warm sugar and water, should be drank.

556. The use of the stomach-pump, in these cases, is of the greatest importance, and should be resorted to without delay. After most of the poison has been evacuated from the stomach, a strong infusion of *coffee* ought to be given; or some one of the vegetable acids, such as *vinegar* or *lemon-juice*, should be administered.

557. The patient should be kept in motion, and salutary effects will often be produced by dashing a bucket of cold water on the head. *Artificial respiration* ought to be established, and kept up for some time. If the extremities are cold, apply warmth and friction to them. After the poison has been evacuated from the stomach, stimulants, as warm wine and water, or warm brandy and water, ought to be given, to keep up and sustain vital action.

558. STRAMONIUM — *Thorn-Apple.* This is one of the most active narcotic poisons, and when taken in over-doses, has, in numerous instances, caused death.

559. HYOSCIAMUS — *Henbane.* This article, which is used as a medicine, if taken in improper doses, acts as a virulent irritating and narcotic poison.

560. The treatment for the two above-mentioned articles is similar to that of poisoning from over-doses of opium.

561. CONIUM — *Hemlock.* Hemlock, improperly called, by many, *cicuta*, when taken in an over-dose, acts as a narcotic poison. It was by this narcotic that the Athenians used to destroy the lives of individuals condemned to death by their laws. Socrates is said to have been put to death by this poison. When swallowed in over-doses, the treatment is similar to that of opium, stramonium, and henbane, when over-doses are taken.

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557. Should the person be kept in motion? What is said of artificial respiration, warmth, friction, and stimulants? 560. What should be the treatment when an over-dose of stramonium or henbane is taken? 561. What name is sometimes improperly given to *conium*, or hemlock? How was this narcotic poison used by the Athenians? How are the effects of an over-dose counteracted?

562. BELLADONNA — *Deadly Nightshade.* CAMPHOR. ACONITE — *Monkshood, Wolfsbane.* BRYONY — *Bryonia.* DIGITALIS — *Foxglove.* DULCAMARA — *Bitter-sweet.* GAMBOGE. LOBELIA — *Indian Tobacco.* SANGUINARIA — *Bloodroot.* OIL OF SAVIN. SPIGELIA — *Pinkroot.* STRYCHNINE — *Nux vomica.* TOBACCO. All of these, when taken in over-doses, are poisons of greater or less activity. The treatment of poisoning, by the use of any of these articles, is similar to that pursued in over-doses of opium. (See *Opium*, page 173.)

563. In *all* cases of poisoning, call a physician as soon as possible.

MEANS OF DISTINGUISHING DEATH FROM ASPHYXIA.

564. It is no uncommon occurrence, that persons considered dead, have been restored to life at the moment when a post mortem examination was to have been made, or even when they were in the coffin or tomb. This mistake arises from the difficulty of distinguishing *real* from *apparent* death.

565. In death, although the limbs are stiff, their position is easily changed, but they remain where last placed. When a limb is stiff from convulsions or asphyxia, its position is changed with difficulty, and it immediately returns to its former state. Cessation of breathing, or the "beating" of the heart, coldness, or insensibility, are no certain indications of death. The sign most certain, is well-marked putrefaction; but it does not belong to the unprofessional to decide whether putrefaction has commenced; the physician alone can establish the fact.

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562. What is the treatment when an over-dose of deadly nightshade, monkshood, foxglove, bitter-sweet, gamboge, lobelia, bloodroot, tobacco, &c., is taken? 563. Should a physician be called in all cases when poison is swallowed? 565. How can death be distinguished from asphyxia?

GLOSSARY.

AB-SORP'TION. From the Latin *absorbere*, to suck up.

A-CE-TAB'U-LUM. From the Latin *acetum*, vinegar. The cavity in the hip-bone, so called from its resemblance to the ancient Greek vinegar vessel.

A-NAT'O-MY. From the Greek *ana*, through, and *temnô*, I cut. A description of the structure of animals.

A-ORT'A. From the Greek *aorte*, to keep in air. The large vessel that carries blood from the heart.

AP-PA-RA'TUS. From the Latin *ad*, for, and *parare*, to prepare. A collection of organs.

AP-PEND'IX. From the Latin *ad*, to, and *pendere*, to hang. Something added.

A'QUE-OUS. From the Latin *aqua*, water. A humor of the eye.

AR'TE-RY. From the Greek *arteria*, formed from *aër*, air, and *terein*, to keep. The ancients believed that the arteries were filled with air, like the wind-pipe.

AS-PHYX'I-A. From the Greek *a*, privative, and *sphuxis*, pulse. Suspended animation.

AT'MOS-PHERE. From the Greek *atmos*, vapor, and *sphaira*, a sphere. The air which surrounds the earth.

AUD'IT-O-RY. Belonging to the sense of hearing.

AU'RI-CLE. From the Latin *auris*, an ear. The two cavities of the heart derive the name from their resemblance to ears.

BI-CUS'PIDS. From the Latin *bis*, two, and *cuspis*, a point. The name of certain teeth.

BILE. A yellow, bitter, nauseous fluid, secreted by the liver.

BRAIN. The pulpy mass enclosed in the cranium, or skull-bones.

BRONCH'I-A. From the Greek *brogchos*, the throat. The two branches of the wind-pipe.

CAP'IL-LA-RY. From the Latin *capillus*, hair. The capillary vessels are the extremely minute terminations of the arteries, and commencing branches of the veins.

CAR'BON. From the Latin *carbo*, a coal. An elementary combustible substance.

CAR-BON'IC. Containing carbon.

CAR'PUS. From the Greek *karpos*, the wrist. There are eight bones in the wrist.

CAR'TI-LAGE. Gristle; a part of the animal body, softer than bone, but harder than ligament.

CA'VA. Latin. Hollow. *Vena Cava*, the hollow, or deep-seated vein.

CER-E-BEL'LUM. The lower and smaller portion of the brain.

CER'E-BRUM. The upper and larger portion of the brain.

CHEST. The part of the body between the neck and the belly.

CHO'ROID. From the Greek *chorion*, the skin, and *eidos*, resemblance. A coat of the eye.

CHYLE. From the Greek *chulos*, nutritious juice.

CHYME. From the Greek *chumos*, a grayish juice.

CIL'IA-RY. Latin. Relating to the eyelid.

CLAV'I-CLE. From the Latin *clavis*, a key. The collar-bone.

COC'CYX. Latin. The lower extremity of the spinal column.

COCH'LE-A. Latin. A snail-shell. A name given to one of the three cavities of the internal ear.

CO'LON. Greek. A portion of the large intestine.

CON'CAVE. Hollow; as the inner surface of a spherical body.

CON'VEX. Bulging; as the external surface of a spherical body.

CORN'E-A. From the Latin *cornu*, a horn. One of the coats of the eye.

CRYS'TAL-LINE. A humor, or lens of the eye. It serves to transmit and refract the rays of light.

CUS'PID. From the Latin *cuspis*, a point. The name of certain teeth.

CU'TI-CLE. The external layer of the skin.

CU'TIS VE'RA. Latin. The true skin. The internal layer of the skin.

DI'A-PHRAGM. From the Greek *diaphragma*, a partition. The muscle that separates the lungs and heart from the stomach, liver, and intestines.

DI-GES'TION. The process of dissolving food in the stomach, and preparing it for circulation and nourishment.

DU-O-DE'NUM. The first of the small intestine, being about twelve fingers' breadth.

EN-AM'EL. The smooth, hard substance which covers the crowns of the teeth.

EP-I-GLOT'TIS. From the Greek *epi*, upon, and *glottis*, the glottis. A kind of cartilaginous valve at the upper part of the larynx, behind the base of the tongue.

EU-STA'CHI-AN TUBE. So called from its discoverer, *Eustachius*. A tube that connects the middle ear with the throat.

EX-HA'LENT. From the Latin *exhalare*, to throw out.

EX-TREM'I-TIES. The limbs; as the legs and arms.

FAS'CI-A. Latin. A thin membrane that surrounds the muscles and tendons.

FE'MUR. Latin. The thigh-bone.

FI'BRE. An organic filament, or thread, of a solid consistence, which enters into the composition of every animal and vegetable texture.

FIB'U-LA. Latin. A clasp. The outer and lesser bone of the leg.

FIL'A-MENT. From the Latin *filum*, a thread. A small fibre.

FOL'LI-CLE. From the Latin *follis*, a bag. Very minute secreting cavities.

FORE-ARM. That part of the arm between the elbow and wrist.

FUNC'TION. From the Latin *fungor*, I act, I perform. The action of organs; as the function or action of the eye is to see, the ear to hear.

GAN'GLI-ON. From the Greek *gagglion*, a knot. An enlargement upon a nerve or tendon.

GUST'A-TO-RY. From the Latin *gustus*, the taste. Belonging to the sense of taste.

GAS'TRIC JUICE. From the Greek *gaster*, the stomach. The fluid secreted by the stomach.

GLOT'TIS. A small, oblong opening at the upper part of the larynx.

GLANDS. From the Latin *glans*, a nut. Soft, fleshy organs, of various sizes.

HEART. A muscular organ, situated in the left side of the chest.

HU'MER-US. The bone of the arm, situated between the shoulder-joint and elbow.

HU'MOR. Every fluid substance of an organized body; as the chyle, the blood.

HY'DRO-GEN. From the Greek *hydro*, water, and *geinomai*, I engender. A gas which constitutes one of the elements of water.

HY-GI-ENE'. The science of preserving the health.

IN-CI'SOR. From the Latin *incido*, I cut. The fore-teeth.

IN-TES'TINE. Latin. The alimentary canal.

I'RIS. Latin. The rainbow. The colored membrane around the pupil of the eye.

LAB'Y-RINTH. From the Greek *laburinthos*, a place full of turnings. A name given to the windings of the internal ear.

LACH'RY-MAL. From the Latin *lachrymа*, a tear.

LAC'TE-AL. From the Latin *lac*, milk. The vessels that convey the chyle, or a milk-like substance, into the veins.

LAR'YNX. From the Greek *larugx*, a whistle. The upper part of the windpipe.

LIG'A-MENT. From *ligo*, I bind. A strong, fibrous substance, which binds bones, &c., together.

LIV'ER. A large gland situated below the right lung.

LYM-PHAT'ICS. Vessels that perform the office of absorption.

ME-DUL'LA. From the Latin *medulla*, marrow.

ME-DUL'LA OB-LON-GA'TA. The spinal cord that is situated within the skull-bones.

MEM'BRANE. From the Latin *membrana*, a film, a delicate web. A name given to different thin organs.

MES'EN-TER-Y. From the Greek *mesos*, in the middle, and *enteron*, an intestine. A membrane in the middle of the intestines, by which they are attached to the spinal column.

MET-A-CAR'PUS. From the Greek *meta*, after, and *karpos*, the wrist. That part of the hand between the wrist and fin gers.

MET-A-TAR'SUS. From the Greek *meta*, after, and *tarsos*, the instep. That part of the foot between the instep and toes.

MID'RIFF. The diaphragm.

MI'TRAL. Resembling a *mitre*, or bishop's bonnet. The name of two valves of the heart.

MO'LAR. From the Latin *molo*, I grind The name of certain teeth.

MU'CUS. A viscid fluid secreted by the mucous membrane, which it serves to moisten, and also to defend.

MUS'CLE. A bundle of fibres enclosed in a sheath.

NERVE. An organ of sensation and motion in animals.

NI'TRO-GEN. From the Greek *nitron*, nitre, and *gennaô*, I beget. One of the gases that compose atmospheric air.

NU-TRI'TION. The act or process of promoting the growth, or repairing the waste of the system.

Œ-SOPH'A-GUS. From the Greek *oiô*, I carry, and *phagô*, I eat. The tube that leads from the mouth to the stomach.

OL-FACT'O-RY. From the Latin *olfac tus*. Belonging to the sense of smell.

O-MEN'TUM. Latin. The caul, so called because the ancient priests prophesied from an inspection of this membrane.

OR'GAN. From the Greek *organon*, an instrument. A part of the system destined to exercise some particular function.

OX'Y-GEN. From the Greek *oxus*, acid, and *geinomai*, I engender. A gas which constitutes about one fifth of our atmosphere.

PAN'CRE-AS. From the Greek *pan*, all, and *kreas*, flesh; that is, *quite fleshy*. A gland situated behind the stomach.

PA-PIL'LA. From the Latin *papilla*, nipple. Small, conical prominences seen on the tongue and skin.

PA-ROT'ID. From the Greek *para*, about, and *ous*, the ear. A gland situated under the ear.

PA-TEL'LA. From the Latin *patina*, a dish. The knee-pan.

PEL'VIS. Latin. A basin. The name of a bony structure at the lower part of the trunk.

PER-I-OS'TE-UM. From *peri*, about, and *os*, bone. The membrane, or skin that surrounds the bones.

PER-SPI-RA'TION. The evacuation of the fluids of the body through the pores of the skin.

PHA-LAN'GES. From the Greek *phalagx*, a file of soldiers. The bones composing the fingers and toes.

PHAR'YNX. From the Greek *pharugx*, the pharynx. The swallow.

PHYS-I-OL'O-GY. From the Greek *phusis*, nature, and *logos*, a discourse. The science which treats of the functions of animals and vegetables.

PLEU'RA. Greek. The membrane that lines the chest and surrounds the lungs.

PUL'MO-NA-RY. Belonging to the lungs.

PLEX'US. Latin. Any union of nerves or fibres, in the form of net-work.

RA'DI-US. Latin. A spoke. The small bone of the fore-arm.

REC'TUM. The lower and straight portion of the intestines.

RE-SID'U-UM. Residue. The waste remains of the food.

RET'I-NA. From the Latin *rete*, a net. The net-like expansion of the optic nerve on the inner surface of the eye.

SA'CRUM. A bone so called because it was offered in sacrifice. The lower portion of the spinal column.

SA-LI'VA. Latin. The fluid secreted in the mouth.

SCAP'U-LA. Latin. The shoulder-blade.

SCLE-ROT'IC. From the Greek *skleroo*, I harden. A membrane of the eye

SE-CRE'TION. From the Latin *secernere*, to separate. The function of several glands, by which they separate from the blood the material which they respectively demand for their several purposes.

SEM-I-LU'NAR. From the Latin *semi*, half, and *luna*, moon. The name of two valves at the commencement of the aorta and pulmonary artery.

SKEL'E-TON. From the Greek *skellô*, I dry. The articulated, dry bones of an animal.

SPI'NAL CORD. A prolongation of the brain.

SPINE. From the Latin *spina*, a thorn. The back-bone.

SPLEEN. The milt. It was supposed by the ancients to be the seat of melancholy, anger, and vexation.

STER'NUM. Greek. The breast-bone.

STOM'ACH. The principal organ of di gestion, situated below the left lung.

SUB-LIN'GUAL. From the Latin *sub*, under, and *lingua*, the tongue. The name applied to the gland under the tongue.

SUB-MAX'IL-LA-RY. From the Latin *sub*, under, and *maxilla*, the jaw-bone. The name applied to the gland under the jaw.

SUT'URE. From the Latin *suo*, I stitch.

The seam or joint which unites the skull-bones.

SYN-O'VI-A. From the Greek *sun*, with, and *oon*, an egg. The lubricating fluid of the joints.

SYS'TEM. From the Greek *sun*, together, and *istemi*, I place. An assemblage of organs, arranged according to some plan or method; as the nervous system.

SYS-TEM'IC. Belonging to the general system.

TEN'DON. From the Greek *teinô*, I stretch. Strong, white cords, that connect the muscles to the bone which they move.

THO-RAC'IC. From the Greek *thôrax*, the chest.

TIB'I-A. Latin. A pipe or flute. The largest bone of the leg.

TRA'CHE-A. From the Greek *trachus*, rough, and *arteria*. The canal that conveys air to the lungs.

TRI-CUS'PID. From the Latin *tres*, three, and *cuspis*, a point. The three valves in the right side of the heart.

TRUNK. The body of animals, without the limbs.

TYM'PAN-UM. Latin. The drum of the ear.

UL'NA. Latin. A cubit. A bone of the fore-arm.

VALVE. From the Latin *valva*, a small door. Any membrane, or doubling of any membrane, which prevents fluid from flowing back in the vessels and canals of the animal body

VEINS. From the Latin *vena*. The vessels that carry the blood to the heart.

VEN'TRI-CLE. Latin. A small cavity of the animal body.

VERT'E-BRA, -Æ. From the Latin *verto*, I turn. A joint of the spinal column.

VES'I-CLE. From the Latin *vesicula*, a small vessel, or bladder.

VI'TAL. From the Latin *vita*, life.

VIT'RE-OUS. Pertaining to glass. A name given to one of the humors of the eye.

KEY TO ANATOMICAL OUTLINE PLATES.

SUGGESTIONS TO TEACHERS.

In using these plates, we would suggest, that the pupil carefully examine the illustrating cuts interspersed with the text, in connection with the lesson to be recited. The similarity between these and the plates will enable the pupil to recite, and the teacher to conduct his recitation, from the latter.

Let a pupil show the situation of an organ, or part, on an anatomical outline plate, and also give its structure; while other members of the class note all omissions and misstatements. Another pupil may give the use of that organ, and if necessary, others may give an extended explanation. The third may explain the laws on which the health of the part depends, while other members of the class supply what has been omitted. After thus presenting the subject in the form of topics, questions may be proposed promiscuously, from each paragraph, and where examples occur in the text, let other analogous ones be given.

If the physiology and hygiene of a given subject have not been studied, confine the recitation to those parts only on which the pupil is prepared. When practicable, the three departments should be united; but this can only be done when the chapter on the hygiene has been learned, while the physiology can be united with the anatomy, in all chapters upon physiology.

PLATE I.

A FRONT VIEW OF THE SKELETON.

Bones of the Head. 7, The sphenoid bone. 8, The frontal bone. 10, The parietal bone. 11, The os unguis. 12, The superior maxillary bone, (upper jaw.) 13, The nasal bone. 14, The ethmoid bone. 15, The malar bone, (cheek-bone.) 16, The vomer. 17, The inferior maxillary bone, (the lower jaw.) *a*, Its body. *b*, Its ramus, or branch. 18, The teeth.

Bones of the Trunk. 1, 1, The spinal column. 2, The sternum. 3, 3, The ribs. 4, The sacrum. 5, The innominatum.

Bones of the Upper Extremities. 19, The clavicle, (collar-bone.) 20, The

scapula, (shoulder-blade.) 21, The humerus. 22, The ulna. 23, The radius. 24, 25, 26, 27, 28, 29, 30, 31, The bones of the carpus, (wrist.) 32, 32, 32, The five bones of the metacarpus, (the palm of the hand.) 33, 33, 33, The first range of finger-bones. 34, 34, The second range of finger-bones. 35, 35, 35, The third range of finger-bones.

Bones of the Lower Extremities. 36, The femur, (thigh-bone.) 37, The patella, (knee-pan.) 38, The tibia, (shin-bone.) 39, The fibula. 40, 40, 40, The bones of the tarsus, (instep.) 41, 41, The bones of the metatarsus, (middle of the foot.) 42, 42, The bones of the toes.

ARTICULATIONS. (Left side of the plate.)

Ligaments of the Trunk. 1, 1, The common spinal ligament. 2, 2, The intervertebral ligament, (cartilage between the vertebræ.) 9, 10, 11, 12, Articulations of the ribs with the spinal column. 13, 13, 14, 15, 16, Ligaments that connect the cartilages of the ribs with the sternum.

Ligaments of the Upper Extremities. 25, The ligament that connects the clavicle and sternum. 27, The ligament that connects the upper rib and clavicle. 28, 29, 30, Ligaments that connect the clavicle and scapula. 31, 32, 33, 34, Ligaments of the shoulder-joint. 35, 35, 36, Ligaments of the elbow-joint. 37, 38, 39, 40, Ligaments of the wrist. 41, 42, 43, 44, Ligaments of the fingers.

Ligaments of the Lower Extremities. 49, 49, Ligaments of the hip-joint. 50, 50, Ligaments of the patella. 51, 52, 53, 54, 55, Ligaments of the knee-joint. 56, A large bursa mucosa. 57, The ligament of the tibia and fibula. 58, 58, The interosseous ligament. 59, 59, Ligaments of the ankle-joint. 60, 61, 62, Ligaments of the metatarsus. 63, 64, Ligaments of the toes.

A, The brachial artery. B, The brachial vein. C, The radial artery. D, The femoral artery. E, The femoral vein. F, G, The anterior tibial artery.

PLATE II.

A BACK VIEW OF THE SKELETON.

Bones of the Head. 5, The occipital bone. 6, The parietal bone. 7, The temporal bone. 8, The frontal bone. 9, The sphenoid bone. 15, The malar bone. 16, The nasal bone. 17, The superior maxillary bone, (upper jaw.) 18, The inferior maxillary bone, (lower jaw.) 19, The teeth.

Bones of the Trunk. 1, 1, The spinal column. 2, The sacrum. 3, The coccyx. 20, The innominatum. 4, 4, The ribs.

Bones of the Upper Extremities. 21, The clavicle, (collar-bone.) 22, The scapula, (shoulder-blade.) 23, The humerus. 24. The ulna. 25, The radius. 26, 27, 28, 29, 30, 31, 32, The bones of the carpus, (wrist.) 33, 33, 33, The bones of the metacarpus, (palm of the hand.) 34, 34, 34, The first range of finger-bones. 35, 35, The second range of finger-bones. 36, 36, 36, The third range of finger-bones.

Bones of the Lower Extremities. 37, The femur, (thigh-bone.) 38, The patella, (knee-pan.) 39, The tibia, (shin-bone.) 40, The fibula. 41, 42, 43, 44, 45, The bones of the tarsus, (instep.) 46, 46, The bones of the metatarsus, (middle of the foot.) 47, 47, Bones of the toes.

ARTICULATIONS. (Left side of the plate.)

Ligaments of the Trunk. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Ligaments of the spinal column. 14, 14, 15, 15, Ligaments that connect the ribs and spinal column. 11, 11, 21, 22, 23, 24, 25, 26, Ligaments that connect the sacrum and innominatum.

Ligaments of the Upper Extremities. 27, 28, Ligaments that connect the clavicle and scapula. 29, The capsular ligament of the shoulder-joint. 30, 30, Ligaments of the elbow. 31, 32, 33, 34, Ligaments of the carpus, (wrist.)

Ligaments of the Lower Extremities. 9, Tendon of the gluteus muscle. 35, The capsular ligament of the hip-joint. 36, 36, Ligaments of the knee-joint. 37, The ligament that connects the tibia and fibula. 38, The interosseous ligament. 39, 40, Ligaments of the ankle-joint.

PLATE III.

A FRONT VIEW OF THE MUSCLES.

Muscles of the Head and Neck. 7, The sterno-mastoideus muscle. 8, The sterno-hyoideus muscle. 9, The omo-hyoideus muscle. 10, The trapezius muscle. 11, The orbicularis oculi muscle. 12, The frontal muscle. 14, The orbicularis oris muscle. 15, The elevator muscle of the nostrils. 16, The zygomatic muscle. 17, The depressor of the lower lip. 18, The depressor anguli oris muscle. 19, The triangular muscle of the nose. 20, 21, The aural muscles. 22, The masseter muscle.

Muscles of the Trunk. 2, 3, The external oblique muscles.

Muscles of the Upper Extremities. 1, The grand pectoral muscle. 3, 4, The serratus muscle. 23, The deltoid muscle. 24, The biceps brachialis muscle. 25, The coraco-brachialis muscle. 26, The anterior brachial muscle. 27, The triceps brachialis muscle. 28, The long supinator muscle. 29, The external radial muscle. 30, The pronator teres muscle. 31, The anterior radial muscle. 32, The palmaris brevis muscle. 33, The anterior ulnar muscle. 35, The palmar muscle. 36, The abductor muscle of the thumb. 37, The adductor muscle of the thumb. 38, 39, Small flexor muscles of the thumb. 40, The abductor muscle of the little finger. 41, 41, The lumbricales muscles. 61, 61, The bifurcation of the tendons of the superficial flexor muscle, in the fingers.

Muscles of the Lower Extremities. 42, The fascia lata muscle. 43, The sartorius muscle. 44, The rectus femoris muscle. 45, The vastus externus muscle. 46, The vastus internus muscle. 47, The internal straight muscle. 48, The pectineus muscle. 49, The adductor muscle. 50, The psoas

muscle. 51, The tibialis anticus muscle. 52, The long extensor muscle of the great toe. 53, The long extensor muscle of the toes. 54, The anterior peroneal muscle. 55, The long lateral peroneal muscle. 56, 57, The gastrocnemii muscles. 58, The long flexor muscle of the great toe. 59, The short extensor muscles of the toes. 60, The abductor muscle of the great toe.

The figures and letters on the left side of the plate, indicate the position of important fasciæ, that cover the muscles and enclose the tendons.

PLATE IV.

A BACK VIEW OF THE MUSCLES.

Muscles of the Head and Neck. 4, The sterno-mastoideus muscle. 5, The complexus muscle. 6, The mylo-hyoideus muscle. 7, 8, The occipito-frontalis muscle. 9, The masseter muscle. 10, 11, 12, The anterior, middle, and posterior aural muscles. 13, The temporal muscle.

Muscles of the Trunk. 1, 1, The trapezius muscle. 2, The latissimus dorsi muscle. 3, The rhomboideus muscle. 4, The external oblique muscle.

Muscles of the Upper Extremities. 5, The deltoid muscle. 6, 7, The infra-spinatus muscle. 9, The triceps extensor muscle. 10, The internal brachial muscle. 11, The long supinator muscle. 12, The external radial muscle. 13, The second external radial muscle. 14, The anconeus muscle. 15, 16, The extensor digitorum communis muscle. 17, The extensor carpi ulnaris muscle. 18, The flexor carpi ulnaris. 19, 20, The extensor ossis metacarpi pollicis muscles. 21, An extensor muscle of the thumb. 22, 28, Interossii muscles.

Muscles of the Lower Extremities. 29, The gluteus maximus muscle. 30, The gluteus medius muscle. 31, The biceps flexor cruris muscle. 32, The semi-tendinosus muscle. 33, The semi-membranosis muscle. 34, The gracilis muscle. 35, The adductor muscle. 36, The vastus externus muscle. 37, The sartorius muscle. 38, 39, The gastrocnemii muscles. 40, The long peroneal muscle. 41, The external peroneal muscle. 42, The long flexor muscle of the great toe. 43, The long extensor muscle of the toes. 44, The short extensor muscle of the toes. 47, The short flexor muscle of the toes.

The figures and letters on the left side of the plate, indicate the position of membranous fasciæ which envelop the muscles and tendons.

PLATE V.

ORGANS OF THE THORAX AND ABDOMEN.

Fig. 1. *The Mouth and Neck.* (A Side view.) 1, The upper lip. 2, The lower lip. 3, The upper jaw. 4, The lower jaw. 5, The tongue. 6, The hard palate, (roof of the mouth.) 7, The parotid gland. 8, The sub-

lingual gland. T, The larynx. 10, The pharynx. 11, The œsophagus. 12, The upper portion of the spinal column. C, The spinal cord.

The Chest and its Organs. 9, 9, The trachea. R, The right auricle of the heart. L, The left auricle. 13, The left ventricle of the heart. 14, The right ventricle. 15, The aorta. 16, The pulmonary artery. 17, The vena cava descendens. 18, The right subclavian vein. 19, The left subclavian vein. 20, The right jugular vein. 21, The left jugular vein. 22, The right carotid artery. 23, The left carotid artery. 24, 25, 26, The upper, middle, and lower lobes of the right lung. 27, 28, The upper and lower lobes of the left lung. 29, 29, 29, The diaphragm. P, P, P, P, The pleura, that lines the cavity of the chest. S, S, The clavicles. O, O, O, O, The ribs. M, M, M, M, Muscles of the chest. 40, The thoracic duct, opening into the left subclavian vein.

The Abdomen and its Organs. 30, The stomach. 31, 32, The right and left lobe of the liver. F, The fissure that separates the two lobes. 33, The gall bladder. 34, 34, The duodenum. 35, The ascending colon. 36, The transverse colon. 37, The descending colon. 38, 38, 38, 38, The small intestine. 39, 39, The walls of the abdominal cavity turned down. 41, The spleen.

Fig. 2. *The Relation of the Lacteals and Thoracic Duct.* 1, 1, A section of the small intestine. 2, 2, 2, 2, 2, 2, 2, 2, Mesenteric glands, through which the lacteals from the intestine pass. 3, Several lacteal vessels entering the enlarged portion and commencement of the thoracic duct. 5, 5, 5, The thoracic duct. 6, The thoracic duct opening into the left subclavian vein. 7, (See 40, Fig. 1.) 8, The right subclavian vein. 9, The vena cava descendens. 10, 11, 11, The aorta. 12, The carotid arteries. 13, 13, The jugular veins. 14, The vena azagos. 15, 15, The spinal column. 16, The diaphragm.

Fig. 3. *The Relation of the Larynx, Trachea, Bronchia, and Air-cells.* 1, 1, 1, An outline of the right lung. 2, 2, 2, An outline of the left lung. 3, The larynx. 4, The trachea. 5, The right bronchia. 6, The left bronchia. 7, 7, 7, 7, Divisions of the right bronchia. 8, 8, 8, 8, Divisions of the left bronchia. 9, 9, 9, 9, 9, 9, Air-cells.

Fig. 4. *An ideal View of a lateral and vertical Section of the Larynx.* 1, 1, The superior vocal cords, (ligaments.) 2, 2, The inferior vocal cords. 3, 3, The glottis. 4, 4, The ventricles of the larynx.

PLATE VI.

HEART, ARTERIES, AND VEINS.

Fig. 1. *The Heart and large Arteries.* 1, The right auricle of the heart. 2, The right ventricle of the heart. 3, The left auricle. 4, The left ventricle. 5, The pulmonary artery. 6, The aorta. 7, 7, The descending aorta. 8, The arteria innominata. 9, The left carotid artery. 10, The left subclavian artery. 56, The right subclavian artery.

Arteries of the Neck and Head. 15, The right carotid artery. 16, The left carotid artery. 17, The right temporal artery. 50, The right facial artery. 54, The left temporal artery.

Arteries of the Upper Extremities. 11, 11, The left brachial artery. 12, The left radial artery. 13, 13, The right brachial artery. 14, The right radial artery. 51, The right ulnar artery.

Arteries of the Lower Extremities. 18, The left iliac artery. 19, The right iliac artery. 20, The left femoral artery. 21, The right femoral artery. 22, The peroneal artery. 23, The left anterior tibial artery. 24, The muscular artery. 25, 25, The right and left arteria profunda. 26, The right anterior tibial artery. 27, The right peroneal artery.

The Veins of the Neck and Head. 28, The vena cava descendens 29, The left subclavian vein. 30, The right subclavian vein. 31, The right jugular vein. 32, The left jugular vein. 53, The right temporal vein. 55, The left temporal vein. 49, The right facial vein.

Veins of the Upper Extremities. 33, The left brachial vein. 34, The left radial vein. 35, The right brachial vein. 36, The right radial vein. 51, The right ulnar vein.

Veins of the Lower Extremities. 37, The vena cava ascendens. 38, The left iliac vein. 39, The right iliac vein. 40, The left femoral vein. 41, The right femoral vein. 42, The left anterior tibial vein. 43, The left peroneal vein. 44, The right anterior tibial vein. 45, The right peroneal vein. 46, 46, The profunda veins. 47, The muscular veins. 48, 48, 48, 48, 48, 48, Intercostal arteries and veins.

Fig. 2. *The Relation of the Cavities of the Heart to the large Blood-vessels.* 1, The vena cava descendens. 2, The vena cava ascendens. 3, The right auricle of the heart. 4, The opening between the right auricle and right ventricle. 5, The right ventricle. 6, The tricuspid valves. 7, The pulmonary artery. 8, 8, The branches of the pulmonary artery that pass to the right and left lung. 9, The semilunar valves of the pulmonary artery. 10, The left pulmonary veins. 11, The right pulmonary veins. 12, The left auricle. 13, The opening between the left auricle and left ventricle. 14, The left ventricle. 15, The mitral valves. 16, 16, The aorta. 17, The semilunar valves of the aorta. 18, The septum between the right and left ventricle.

Fig. 3. *An ideal View of the Heart, Arteries, and Veins.* A, The right auricle. B, The right ventricle. C, The tricuspid valves. D, The opening between the right auricle and right ventricle. E, The left auricle. F, The left ventricle. G, The mitral valves. H, The opening between the left auricle and left ventricle. I, The septum between the right and left ventricle. K, The pulmonary artery. L, The semilunar valves of the pulmonary artery. M, M, The right pulmonary artery. N, N, The left pulmonary artery. O, O, O, O, O, O, The capillary vessels of the lungs. P, P, P, The right pulmonary vein. Q, Q, The left pulmonary vein. R, R, The aorta. S, The semilunar valves of the aorta. T, T, A branch of the aorta to the upper extremities. U, U, U, U, A branch to the lower extremities. V, V, V, V, V, V, The capillary vessels at the extremity

of the branches of the aorta. W, W, The descending vena cava. X, X, X, The ascending vena cava.

In Figs. 1, 2, 3, the course of the blood through the circulatory vessels is indicated by arrows.

PLATE VII.

THE PULMONARY CIRCULATION.

Fig. 1. 1, The right auricle of the heart. 2, The left auricle. 3, The right ventricle of the heart. 4, The left ventricle. 5, The pulmonary artery. 6, The branch of the pulmonary artery to the left lung. 7, The branch of the pulmonary artery to the right lung. 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, Branches of the pulmonary artery in the right and left lung. 9, 9, 9, 9, 9, 9, Air-cells. 10, 10, 10, 10, 10, 10, 10, Small pulmonary veins in the right and left lung. 11, The left pulmonary vein. 12, 12, The right pulmonary vein.

Fig. 2. *An ideal View of the Pulmonary Circulation.* 1, 1, The right lung. 2, 2, The left lung. 3, The trachea. 4, 4, 4, 4, 4, The right bronchia. 5, 5, 5, 5, 5, The left bronchia. 6, 6, 6, 6, 6, 6, Air-cells, with arteries and veins passing around them. 7, The right auricle of the heart. 8, The right ventricle of the heart. 9, The tricuspid valves. 10, The pulmonary artery. 11, 11, 11, 11, The right pulmonary artery. 12, 12, 12, 12, 12, The left pulmonary artery. 13, 13, 13, 13, The right pulmonary vein. 14, 14, 14, 14, The left pulmonary vein. 15, The left auricle. 16, The left ventricle. 17, The mitral valves. 18, The septum between the right and left ventricles.

Fig. 3. *An ideal View of the Capillaries.* 1, 1, A branch of the pulmonary artery. 2, 2, A branch of the pulmonary vein. 3, 3, Capillary vessels between the artery and vein.

Fig. 4. *An ideal View of the Relations of the Bronchia, Air-cells, Pulmonary Arteries, and Veins.* 1, A bronchial tube. 2, 2, 2, Air-cells. 3, A branch of the pulmonary artery. 4, A branch of the pulmonary vein.

PLATE VIII.

THE CEREBRUM, CEREBELLUM, SPINAL CORD, AND NERVES.

1, The cerebrum. 2, The cerebellum. 3, 3, The spinal cord. 4, The brachial plexus of nerves. 5, The lumbar plexus of nerves. 6, The sacral plexus of nerves. 7, The facial nerve. 8, 17, The radial nerve. 9, 9, 16, The ulnar nerve. 10, The median nerve. G, The circumflex nerve of the shoulder.

11, 11, The great sciatic nerve. 12, The external popliteal, or peroneal

nerve. 13, 13, The posterior tibial nerve. 14, The external tibial nerve. 15, The muscular branch of the external peroneal nerve. 18, The muscular branch of the sciatic nerve. P, Q, The posterior tibial nerve.

The letters and other figures indicate minor nervous filaments distributed to the various muscles and the skin.

PLATE IX.

THE SKIN.

Fig. 1. *A perspiratory Tube and Gland.* 1, 1, The contorted portion of the tube that forms the gland. 2, 2, Two branches which unite to form the main duct of the gland. 3, 3, The perspiratory tube. 4, The cuticle. 5, Its colored portion. 6, The cutis vera, (true skin.) 7, 7, Fat vesicles, in which the gland is imbedded.

Fig. 2. *A Papilla of the Skin.* 1, 1, Two papillæ, formed of an artery, vein, and nerve. 2, 2, 2, 2, Nerves forming a loop in the papillæ. 3, 3, Arteries of the papillæ. 4, 4, Veins of the papillæ. 5, 5, A net-work of arteries, veins, and nerves. 6, 6, Nerves of the skin. 8, 8, Arteries of the skin. 7, 7, Veins of the skin.

Fig. 3. *A Hair, and its Oil-Glands.* 1, 1, The hair. 2, 2, The sheath of the hair. 3, Oil-glands that surround the bulb of the hair, the ducts of which open into the sheath of the hair, (2, 2.)

Fig. 4. *A Section of the Skin.* 1, 1, The cuticle. 2, 2, Its colored portion. 3, 3, The papillary layer. 4, 4, A net-work of arteries, veins, and nerves, upon the upper surface of the cutis vera. 5, 5, 5, 5, The cutis vera, (true skin.) 6, 6, 6, Hairs that originate in the cutis vera. 7, 7, 7, Oil-glands, the ducts of which connect with the sheath of the hair. 8, 8, 8 8, 8, 8, 8, 8, Perspiratory glands and their ducts. 9, 9, 9, 9, 9, Nerves of the skin. 10, 10, 10, 10, 10, Arteries of the skin. 11, 11, 11, 11, 11, Veins of the skin. 12, 12, 12, 12, Papillæ, or ridges of the skin.

PLATE X.

AN ANTERO-POSTERIOR SECTION OF THE EYE.

Fig. 1. 1, 1, The sclerotic coat. 2, 2, The cornea. 3, 3, The choroid coat. 4, 4, The retina. 5, 5, The iris. 6, 6, The posterior chamber of the eye that contains the aqueous humor. 7, 7, The anterior chamber. 8, 8, The pupil. 9, The crystalline humor. 10, 10, The vitreous humor. 11, The optic nerve. 12, A representation of a pen. 13, An inverted image of the pen (12) on the retina. 14, 14, A canal surrounding the crystalline humor. 15, 15, The bevelled junction of the cornea and scle-

rotic coats. A, a perpendicular ray of light from the pen. B, B, oblique rays, that are refracted in passing through the humors of the eye.

Fig. 2. *A View of the External, Middle, and Internal Ear.* 1, 1, The external ear. 2, The meatus auditorius externus, (the tube that connects with the middle ear.) 3, The membrana tympani, (drum of the ear.) 8, 8, The tympanum, (middle ear.) 4, The malleus. 5, The incus. 6, The orbicularis. 7, The stapes, (stirrup-bone,) that connects with the vestibule of the internal ear. 9, 9, (4, 5, 6, 7, The small bones of the middle ear,) 10, 11, 12, The semicircular canals. 13, 13, The cochlea. 14, The auditory nerve. 15, The division of the auditory nerve to the semicircular canals. 16, The division to the cochlea. 17, 17, The Eustachian tube. 18, The chorda tympani nerve. 19, The seventh pair (facial) nerve. 20, The styloid process of the temporal bone. 21, 21, 21, 21, 21, The petrous or hard portion of the temporal bone, in which the parts of the middle and internal ear are situated.

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