LIST OF ILLUSTRATIONS.

The Laws of Health.

CHAPTER I.

THE FRAMEWORK OF THE BODY.

The Bones—Their Uses—Their Size and Shape—Their Structure and Composition—The Properties of Bone—The Skeleton—The Joints and Motion—The Spinal Column—The Repair of Bone—Changes in the Skeleton.

1. The Bones.—The human body is the house in which the soul of man dwells during life. When life ends and the soul takes its departure, its temporary home speedily falls to pieces; some parts of it sooner, some later. As in a mansion that has been allowed to go to decay, or has been wasted by fire, the frail portions perish, while the masonry, the walls and the stouter timbers remain, so in the untenanted body, its stronger, harder parts, the *bones*, outlast the softer ones,—those by means of which we feel, breathe and move.

2. The Uses of the Bones.—The bones supply the foundation, frame and rafters of the house in which we live. They determine and preserve the general outline and size of the body. They give rigidity to the limbs, so that movements are possible, and also serve as a protection to the more delicate and important parts.

The more delicate the organ, the more completely does Nature shield it. For example: the brain, which is soft in texture, is enclosed on all sides by a spherical box of bone; the

eye, though it must be near the surface of the body to command an extensive view, is sheltered from injury within a deep recess of bone; the lungs, requiring freedom of motion as well as protection, are surrounded by a mobile "chest" composed partly of bone and partly of muscle.

3. The Size and Shape of the Bones.—Nearly every scientific principle known in architecture was anticipated by the Divine hand which framed our bodies long before human science began to exist. The size and form of the bones vary greatly in different parts of the body. There are, however, but three general classes: the *long* bones, such as those of the limbs; the *short*, as in the wrist; and the *flat*, like the shoulder-blade. The long bones are commonly round and hollow at their middle portion, as greater degree of strength is furnished by the same amount of material, if it is in the form of a tube, than if it is a solid pillar of the same length.

4. The Structure of Bone.—Let us examine one of the long bones after it has been sawed through lengthwise (Fig. 1.)

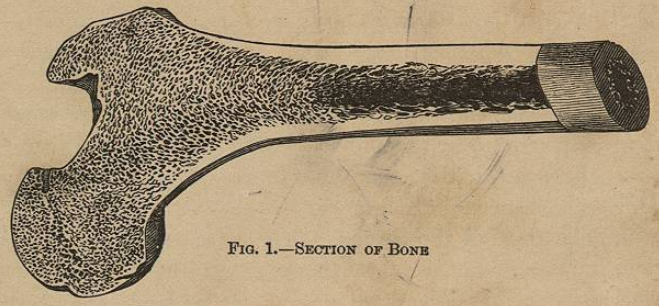

FIG. 1.—SECTION OF BONE

We notice the hollow central cavity, containing an oily substance, called the *marrow*. We find that the outer surface is hard like ivory, and is pierced here and there with small openings for the admission of blood-vessels. The interior, especially at the ends, is comparatively light and porous, the slender fibres interlacing like miniature lattice-work. So that, although a

bone be as hard as stone externally, it is by no means as heavy. If a thin section of bone be examined under the microscope, we discover that it is pierced by numerous fine tubes (Fig. 2), about which layers of bone-substance are arranged. By means of these tubular passages the blood-vessels, which nourish the bones, run to and fro through their inner structure.

FIG. 2.

STRUCTURE OF BONE ENLARGED.

5. The Composition of Bone.—Bone is partly a mineral and partly an animal substance, united in the proportion of two parts of the former with one of the latter. Each of these substances may be separated from the other for examination. First, if we expose a bone to the action of fire, the animal matter, which is called *gelatine*, is driven off, or "burned out." We now find that although the shape of the bone remains the same, that which is left is quite brittle and will not sustain weight as before. Again, we may remove the mineral ingredient, which is a form of lime, by placing a second piece of bone in a dilute acid. The lime is thus dissolved away, leaving the shape the same. The bone is now no longer stiff and hard, but is flexible; and if a long and thin bone, a rib for example, has been made use of in the experiment, it may be tied in a knot without breaking. In early life the bones contain more of the animal substance; in old age, more of the mineral. Hence the bones of the young, although exposed to a great variety of accidents, do not break readily; and when broken unite rapidly. On the the other hand, the bones of old persons are decidedly brittle, and when broken, do not always unite well and quickly.

6. Properties of the Bones.—From these facts, made known to us by chemistry and the microscope, we learn that the bones are not so simple and uninteresting as at first appears.

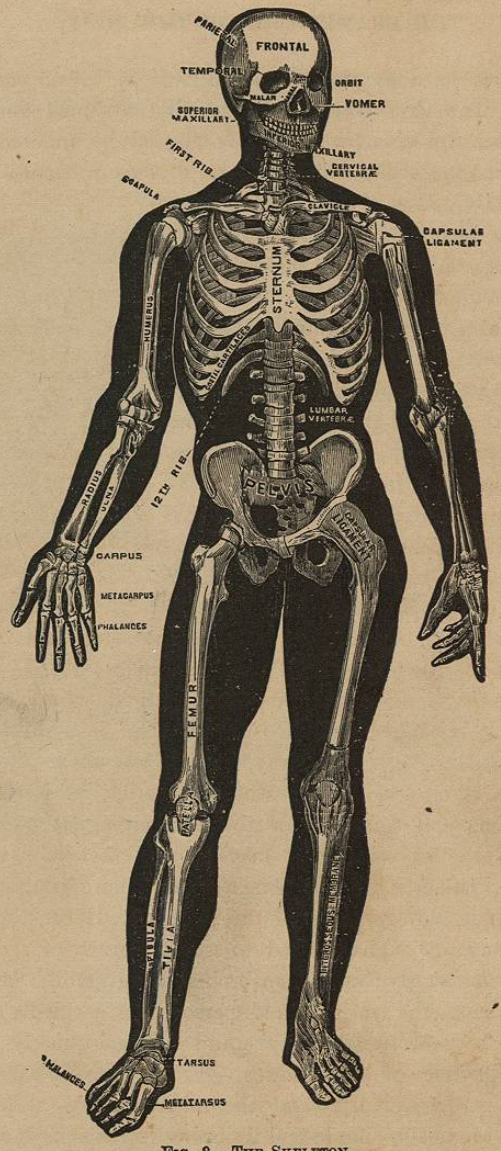

FIG. 3.—THE SKELETON.

but are adapted with wonderful care and skill to all the purposes they are designed to serve. They are strong, but not heavy; hard, but not brittle; somewhat elastic by reason of the gelatine, and yet solid and firm by reason of the lime. Their exposed portions are so made as to be dense and resisting, while the interior is more sponge-like and well furnished with blood-vessels which nourish and cause them to live.

7. The Skeleton.—The bones of the human body are about 200 in number, each of which is known to the anatomist by its appropriate name. A few of these names are marked upon the accompanying engraving (Fig. 3.) All these bones when united together in their natural relations form the *Skeleton.* The greater number of the bones are arranged in pairs, one of each kind on each side of the frame. The skeleton contains three important cavities.

The first of these surmounting the frame, is a box of bone, called the *skull;* below this, is a hooped case, or "chest;" and lower down is a bony basin, called the *pelvis.* The two latter compose the "trunk." The trunk and skull are maintained in their proper relations by the "spinal column." Branching from the trunk are two sets of limbs: the arms, which are attached to the chest by means of the "collar-bone" and "shoulder-blade;" and the legs, directly joined to the lower part of the trunk.

8. These three cavities are designed for the lodgment and protection of the more delicate and perishable parts of the system. Thus, the skull together with the bones of the face, shelter the brain and the organs of four senses—sight, hearing, smell, and taste. The chest contains the heart, lungs, and great blood-vessels, while the lower part of the trunk holds and shields a variety of organs, chiefly those concerned in nourishing the body.

9. The Joints.—The point of union of two or more bones forms a joint, or *articulation*, the connection being made in various ways according to the kind and amount of motion de-

sired. The movable joints are connected by strong fibrous bands, called ligaments. These ligaments are of a silvery whiteness, and very unyielding; so much so, that the bone to which a ligament is attached may be broken, while the ligament itself remains uninjured. When this connecting material of the joints is strained or lacerated by an accident, a "sprain" is the consequence. An injury of this sort frequently is quite as serious as the breaking of a bone.

10. Motion in the Joints.—The ligaments then make the joints firm and strong. How are they rendered flexible and easy of motion? In the first place, the bones are made somewhat broad and flat at the ends, and are so formed that one will fit into the other In the next place, these fitted surfaces are

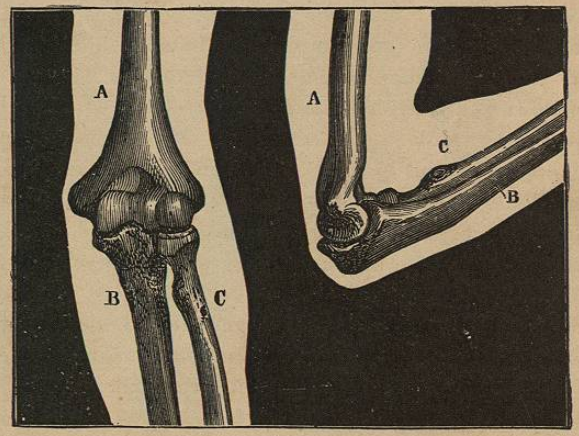

FIG. 4.—ELBOW JOINT. A, Bone of the arm; B, C, Bones of the fore-arm.

covered with a thin layer of "cartilage," an elastic and exceedingly smooth material, which not only enables them to move easily over each other, but also serves, like the springs of a carriage, to deaden the force of jolts and jars. A third provision for smooth motion is the introduction between the ends of

the bones of a thin *sac*, containing a fluid resembling the white of egg. This fluid serves the same end in the joints, as the oil that is used on the wheels of a carriage; it diminishes wear and noise and friction. But it is self-supplied, and flows only so fast as it is used up by the motions of the joint. (*Read note, end of chapter.*)

11. The Spinal Column.—The spinal column is commonly called the "back-bone," as if it were a single bone, whereas it really consists of a chain of 26 small bones, named *vertebræ*. It is channeled out for the reception of the spinal cord. (Fig. 5.)

FIG. 5.—THE SPINAL COLUMN.

12. The joints of the vertebræ are remarkable for the thick layers of cartilage which separate the adjacent surfaces of bone. The amount of motion between any two of these bones is not great; but these little movements, taken together, admit of very considerable flexibility in several directions. The abundant supply of these cartilages adds greatly to the elasticity of the frame. It is due, in part to this elastic material, and in part to the frequent curves of the spine, that the brain and other delicate organs are not more frequently injured by the shock of sudden falls or missteps. During the day, the constant pressure upon these joints, while the body is erect, diminishes the thickness of the cartilages; so that a person is not so tall in the evening as in the morning. The effects of this compression pass away when the body is in a reclining posture.

13. The Growth of Bone.—The bones, like all other parts of the body, are constantly undergoing change, worn out material being withdrawn to make room for a fresh supply. This change

has been shown conclusively by experiment. If an animal be fed with madder—a red coloring matter—for a day or two the bones soon become tinged; then, if the madder be discontinued for a few days, the original color returns. If, however, this material be alternately given and withheld at short intervals, the bone will be marked by alternate rings of red and white. In a very young animal, all the bones become red in a single day; in old ones, a longer time is necessary. The process of waste and repair in the hard bones, therefore, is constantly taking place and with astonishing rapidity.

14. The Repair of Bone.—Nature's provision for uniting broken bones is very complete. At first, blood is poured out around the ends of the bone, as a result of the injury. This is gradually absorbed and gives place to a watery fluid, which, thickening from day to day, acquires at the end of two weeks the consistency of jelly. This continues to harden by the deposit of new bone-substance until, at the end of five or six weeks, the broken bone may be said to be united. It is, however, still fragile, and must be used carefully a few weeks longer, but months pass before the union can be said to be complete. When firmly united, the bone is very strong, and if another accident happens to it, it is quite as liable to break in some new place as at the point of union.

15. Changes in the Skeleton.—Man does not reach his full height until he is about twenty-five years old; and even after that age, the bones continue to increase in strength and hardness. Before that age, they are comparatively soft and flexible, by reason of the gelatin they contain. This is especially true in childhood; and it is fortunate that it is so, since that condition is much more favorable to the steady and rapid growth of the bones than if they contained more of the lime, as is the case in old age when there is no occasion for change in the size or shape of the skeleton. The skull, however, is said to increase slightly in size even in advanced life in those persons in whom the brain is continually employed in thought or study. However, this very flexibility of the bones, in early life, which favors their steady growth and prevents their breaking easily, is sometimes the source of serious deformity. A young child may be allowed to stand and walk too early, and as a consequence, the lower limbs become permanently bent inward, in the distortion called "knock-knees," or outward, as in "bow-legs." For the same reason, a bent position of the spinal column, permitted to exist habitually in childhood, may result in a life-long deformity.

16. The Erect Posture.—Youth is, in a great measure, the forming as well as the growing period of the frame. Bad habits of posture, early formed, become fixed in later life, and their results—as seen in contracted chests and round shoulders—are with difficulty remedied. Right habits, on the other hand, tend to produce an erectness of posture which is favorable, not alone to strength and health, but also to grace and ease. The following directions should be learned and practiced: hold the head erect with the chin somewhat near the neck; expand the chest in front; throw the shoulders back, keeping them of the same height on both sides; maintain the natural curves of the spine, as shown in the last figure. Man alone, of all the animals, has the power to stand and move in the erect posture.

NOTE.

How Joints may be Injured (p. 16, ¶ 10).—"All the joints are liable to dislocation—that is, being 'put out' of their place. Owing to the shallowness of the cavity at the shoulder, this joint is frequently dislocated; and this sometimes happens with the thigh, but not so often, as the cup in which the femur moves is much deeper. Joints which have been dislocated should at once be 'set;' but now that you have seen how liable you are to accident, I hope you will be careful not to indulge in too violent or rough exercise, by which you might not only dislocate the joints, and so in time weaken them, but might also break the bones, and perhaps become crippled for life. Many children have the habit of pulling their fingers so as to make them 'crack.' This is exceedingly wrong, for it is to a certain extent pulling the joints out of their sockets, and this may so loosen the parts as to cause permanent injury."—DAVIDSON'S "OUR BODIES."

TABLE OF THE SKELETON.

(SEE FIG. 3, PAGE 15.)

THE SKELETON CONTAINS 206 BONES.

I. THE HEAD (28 Bones).

1. THE SKULL (8 Bones).

- 1 Fron'tal (forehead).
- 1 Oc-cip'i-tal (back of head).
- 2 Pa-ri'e-tals (side of head).
- 2 Tem'po-rals (temples).
- 1 Sphe'noid ("wedge-shaped").
- 1 Eth'moid ("sieve-like," through which filaments of the olfactory nerve pass to the nose).

II. THE TRUNK (54 Bones).

1. THE SPINAL COLUMN (26 Bones).

- 7 Cer'vi-cal (or neck) ver'te-bræ.
- 12 Dor'sal (or back) vertebræ.
- 5 Lum'bar (or loin) vertebræ.
- Sa'crum (the "sacred" bone, because used in sacrifices).
- Coc'cyx (the "cuckoo" bone, because of its likeness to the bill of that bird).

III. THE LIMBS (124 Bones).

1. THE UPPER LIMBS (64 Bones).

- Clav'i-cle, or Collar-bone (from "*clavis*," a key).
- Scap'u-la, or Shoulder-blade.
- Hu'mer-us (arm).
- Ul'na (forearm), from the Greek word meaning "Elbow."
- Ra'di-us (forearm), from the Latin word meaning "Spoke."
- 8 Car'pals, or Wrist-bones.
- 5 Met-a-car'pals (in the palm), *meta* "beyond," and *carpus* "the wrist."
- 14 Pha-lan'ges (3 in each finger, 2 in the thumb).

TABLE OF THE SKELETON.—CONTINUED.

THE HEAD.—Continued.

2. THE FACE (14 Bones).

- 2 Na'sal Bones (they form the "bridge" of the nose).
- 2 Ma'lar (or cheek) Bones.
- 2 Lach'ry-mals (from a Latin word meaning "tear"; small thin bones which form a part of the inner wall of the orbits).
- 2 Pal'ate Bones.
- 2 Tur'bin-ated ("cone-shaped," one on each side of the outer wall of the nasal cavities).
- 2 Upper and 1 Lower Max'il-la-ry (or jaw) Bones.
- 1 Vo'mer ("plough-share," a thin bone which separates the nostrils).

3. THE EAR (6 Bones).

- Mal'le-us, or "mallet."
- In'cus, or "anvil."
- Sta'pes, or "stirrup."

THE TRUNK.—Continued.

2. THE RIBS (24 Bones).

- 12 on each side; the upper seven are called "true" ribs, the five lower ones are "false," or "floating" ribs.

3. THE HYOID.

- A small "U-shaped" Bone in the upper part of the neck, and supports the base of the tongue.

4. THE STERNUM (Breast-Bone).

5. THE TWO HIP-BONES.

THE LIMBS.—Continued.

2. LOWER LIMBS (60 Bones).

- Fe'mur (thigh-bone).
- Pa-tel'la, or Knee-pan.
- Tib'i-a (leg-bone), a Latin word meaning "flute."
- Fib'u-la (leg-bone), a Latin word for "pin."
- 7 Tar'sals (forming the instep).
- 5 Met-a-tar'sals.
- 14 Phalanges (2 in the great toe, 3 in each of the others).

QUESTIONS FOR TOPICAL REVIEW.

NOTE.

Some Properties of Bone.—The power of bone to resist decay is remarkable. Fossil bones deposited in the ground long before the appearance of man upon the earth have been found by Cuvier exhibiting a considerable portion of cartilage. The jaw of the Cambridge mastodon contained over forty per cent. of animal matter—enough to make a good glue—and others about the same. From this we see that a nutritious soup might be made from the bones of animals that lived before the creation of man. The teeth resemble bone in their structure, but resist decay longer; they are brought up by deep-sea dredging, when all other parts of the animal have wasted away. The bones differ at different ages, and under different social conditions. In the disease called "rickets," quite common among the ill-fed children of the poor in Europe, but somewhat rare in America, there is an inadequate deposit of the mineral substance, rendering the bones so flexible that they may be bent almost like wax. In females and weak men the bones are light and thin, while in a powerful frame they are dense and heavy. Exercise is as necessary to the strength of bone as to the strength of muscle; if a limb be disused, from paralysis or long sickness, the bones lose in weight and strength as well as the soft parts. Bone is said to be twice as strong as oak, and, to crush a cubic inch of it, a pressure equal to 5,000 pounds is requisite.

CHAPTER II.

THE MUSCLES.

Movements of the Body—The Muscles—Flexion and Extension—The Tendons—Contraction—Physical Strength—Relative Strength of Animals—Physical Culture—Necessity for Exercise—Its Effects—Forms of Exercise—Excessive Exercise—Walking—Riding—Gymnastics—Open-air Exercise—Sleep—Recreation.

1. Movements of the Body.—We have seen that, in some respects, the human body resembles a house built for the soul to dwell in. But, inasmuch as its walls are flexible and its foundation is movable, it is something more than a house; in some respects, it may be likened to a machine. The body has the power of motion, as when we swing the arm; it is also capable of locomotion, as when we walk or run from one place to another. The machinery which effects these and many other movements is the *muscles*. The word muscle means "a little mouse," and is supposed to refer to the peculiar sensation produced, as of a small moving body, when a muscle is felt in action; for example, grasp the upper portion of the arm while the elbow-joint is caused to move to and fro. The burrowing motion then felt in the front of the arm is caused by the action of the "biceps" muscle (Fig. 6). This is the muscle which, in the arm of the blacksmith, becomes so large and powerful.

2. The Muscles, or the Flesh.—The muscles, nearly four hundred in number, form the great bulk of the body external to the skeleton. They largely determine its weight and outline. They are nearly all designed to move the bones, but a few act