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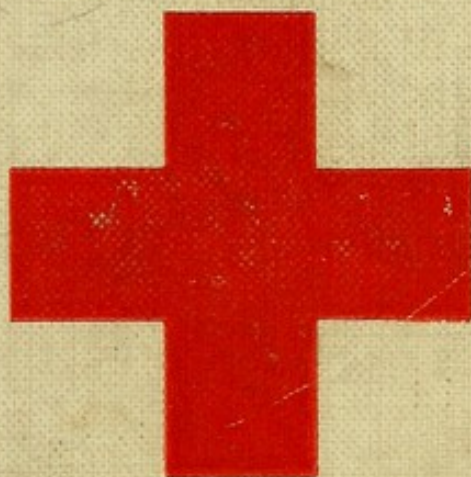
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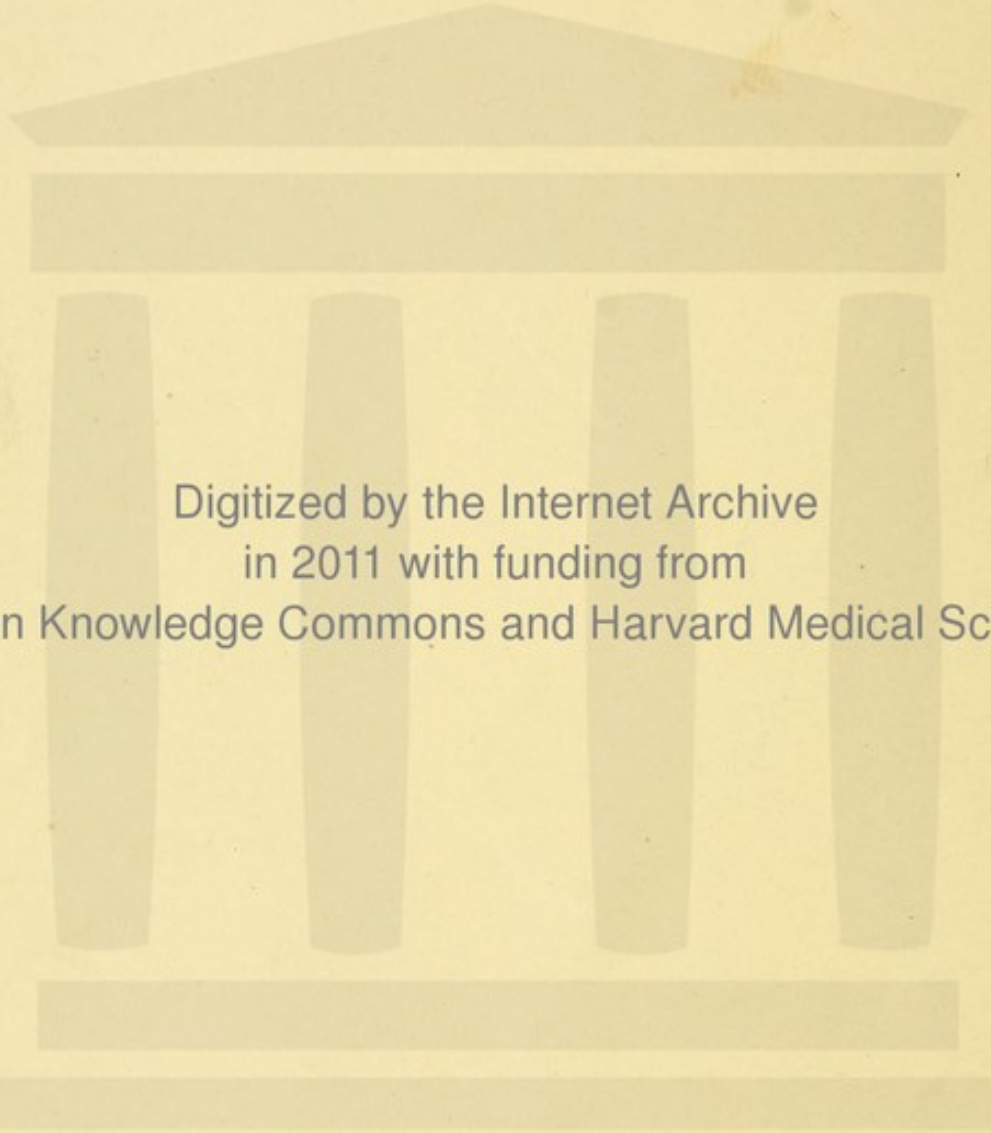
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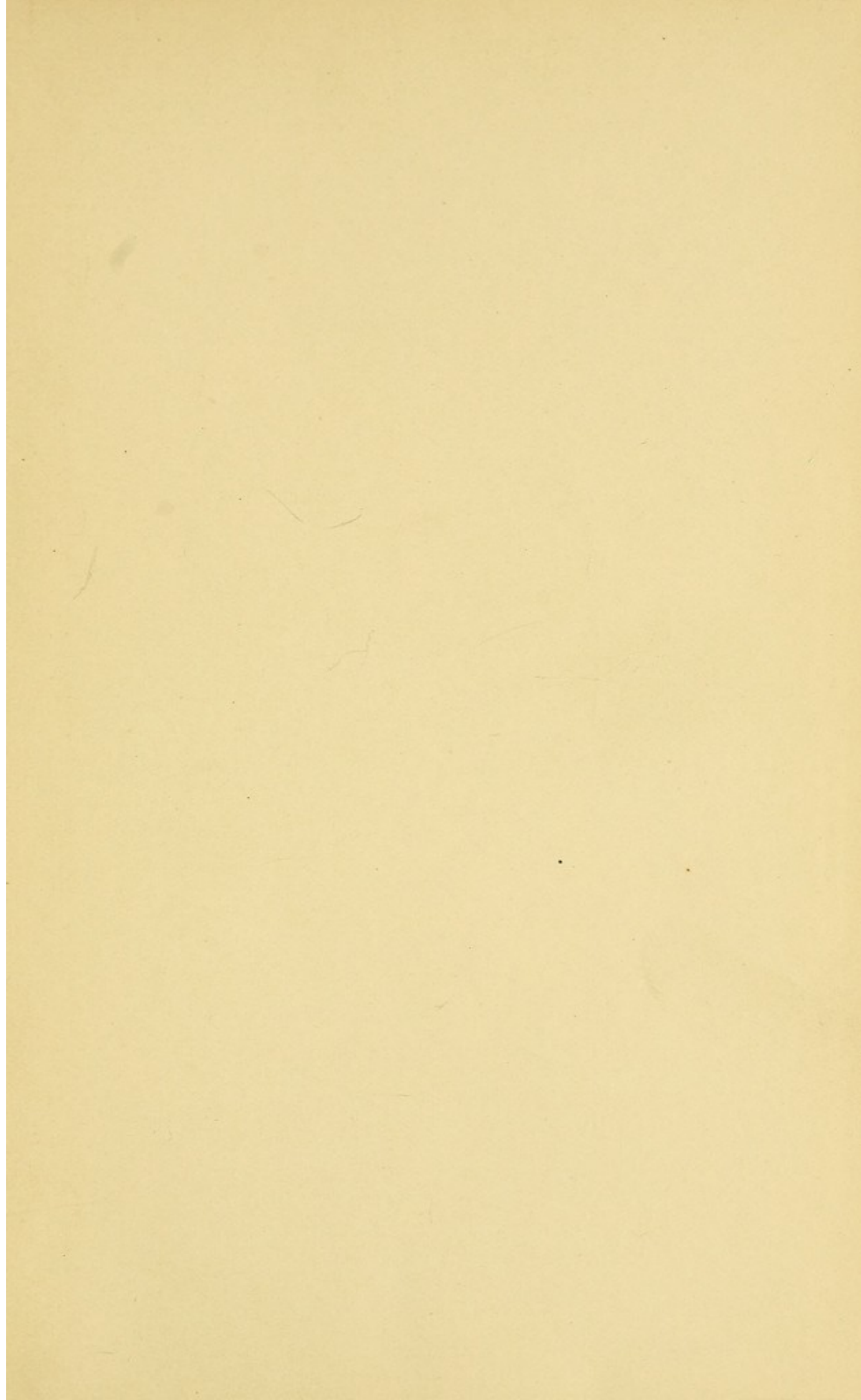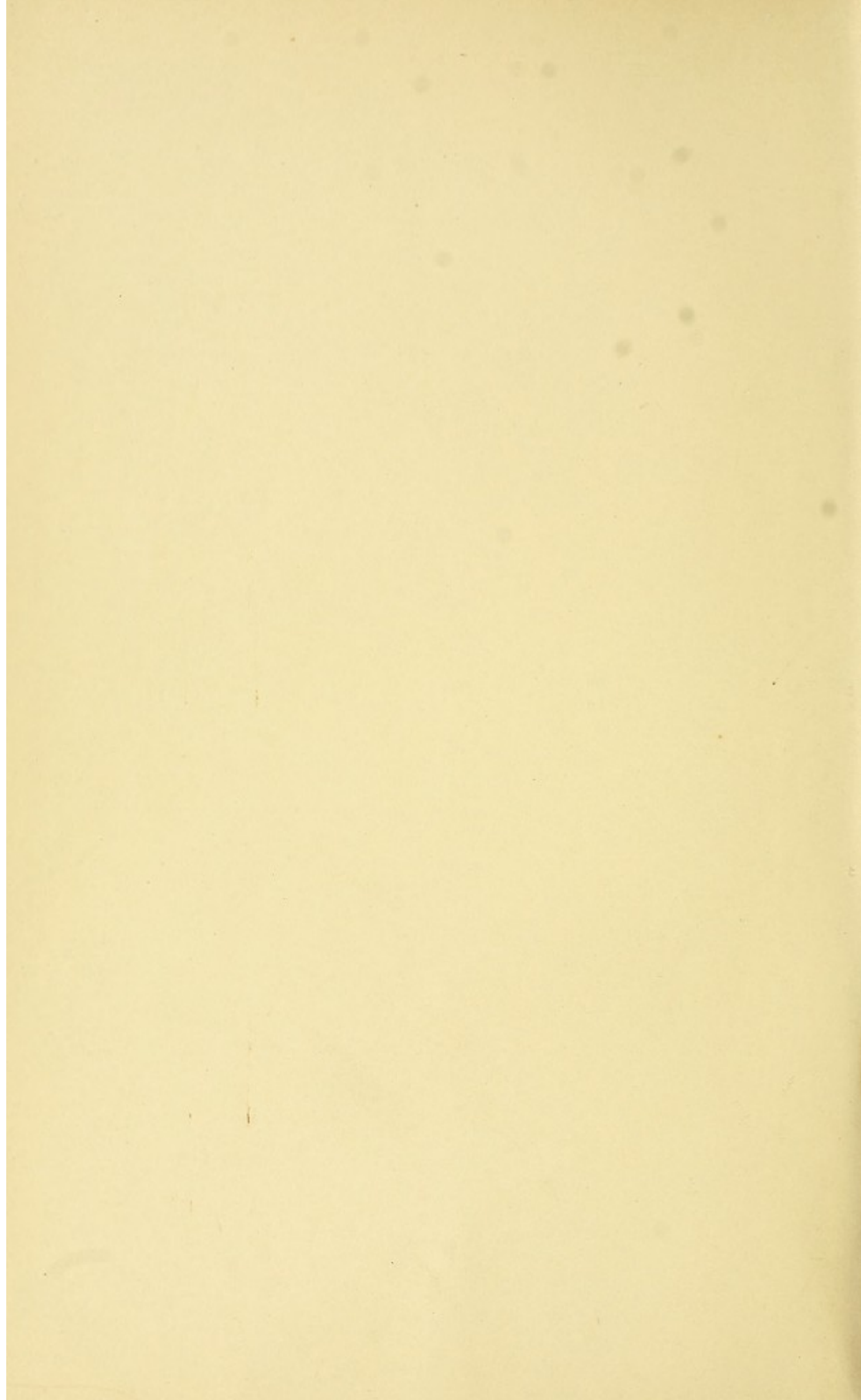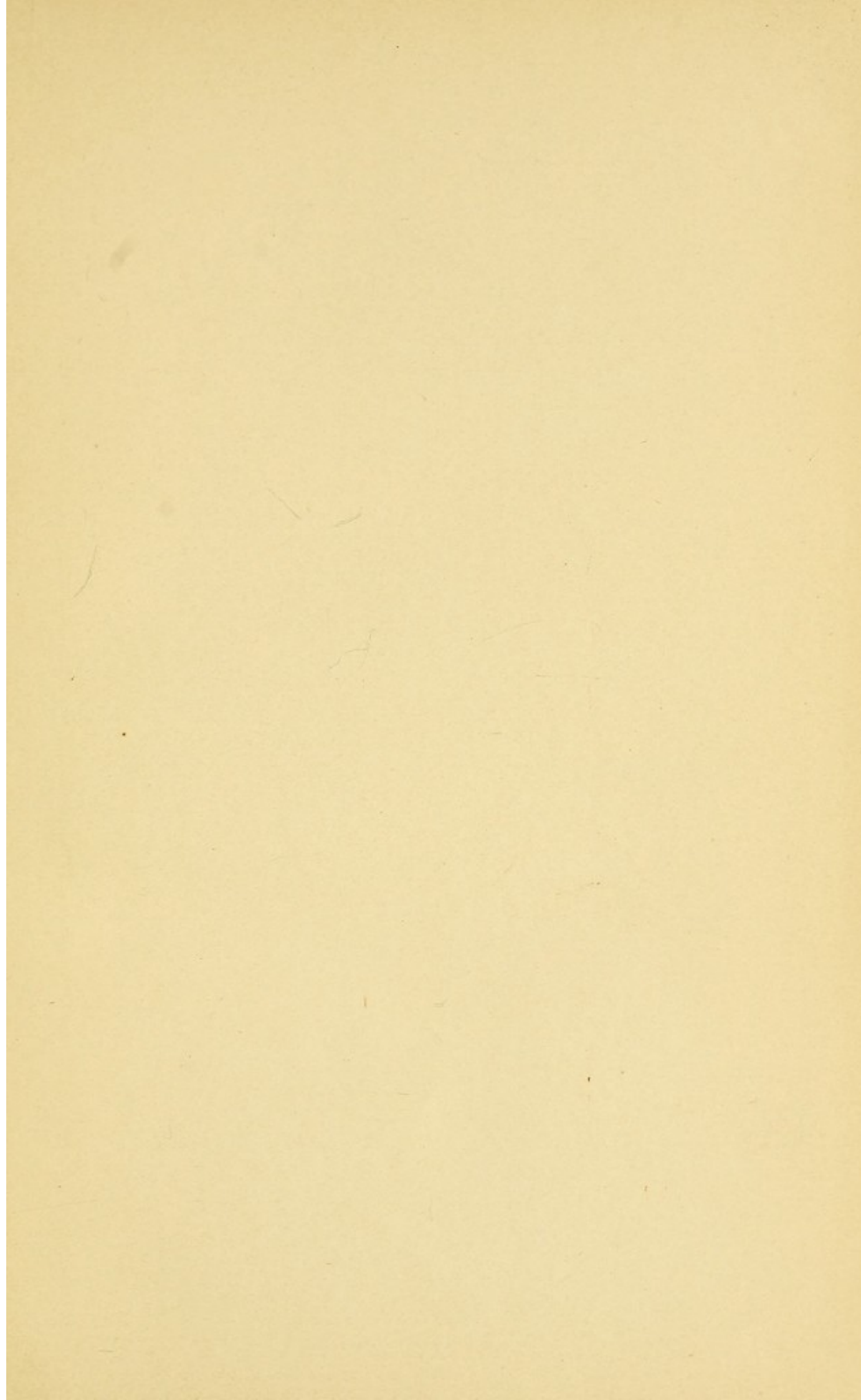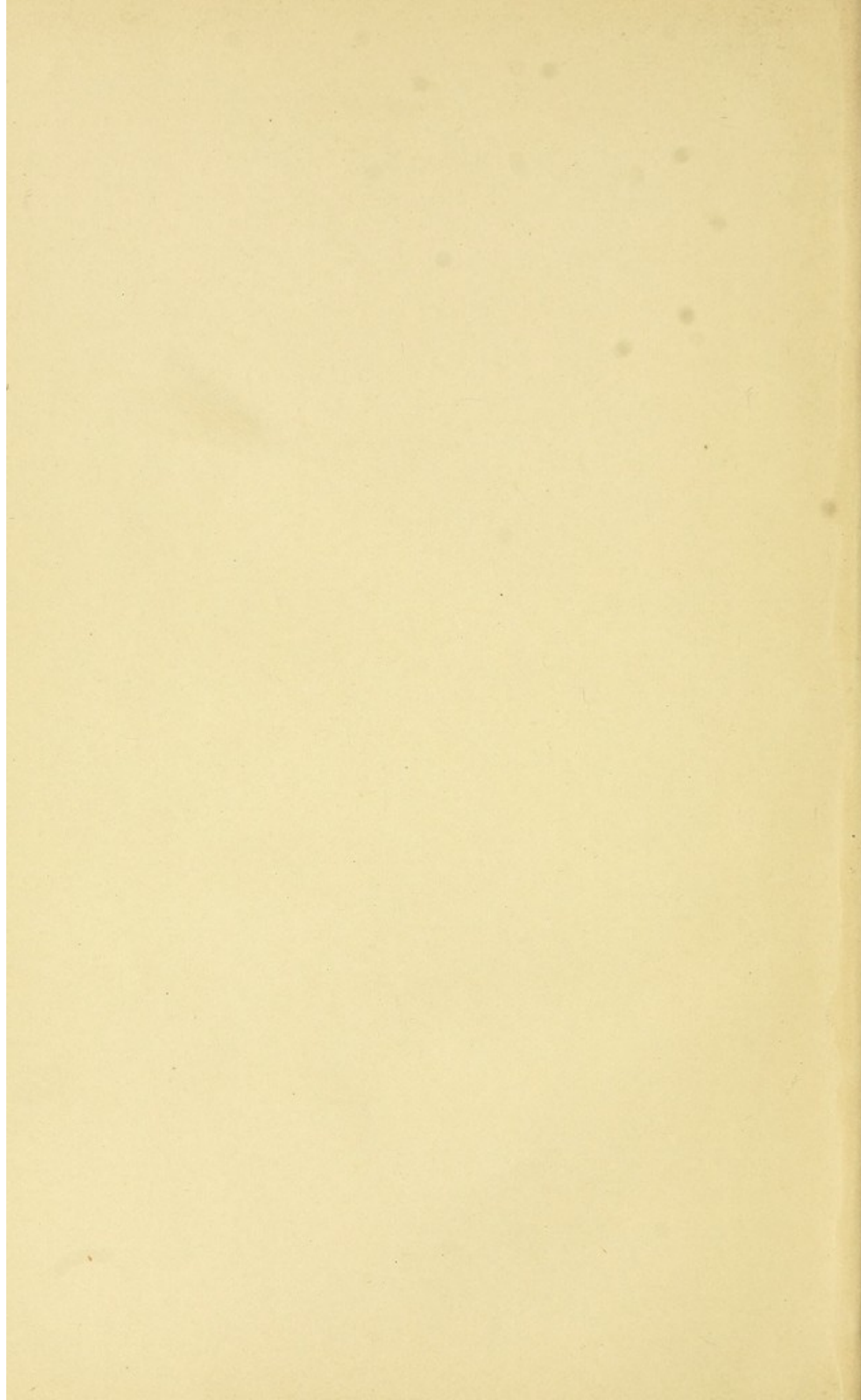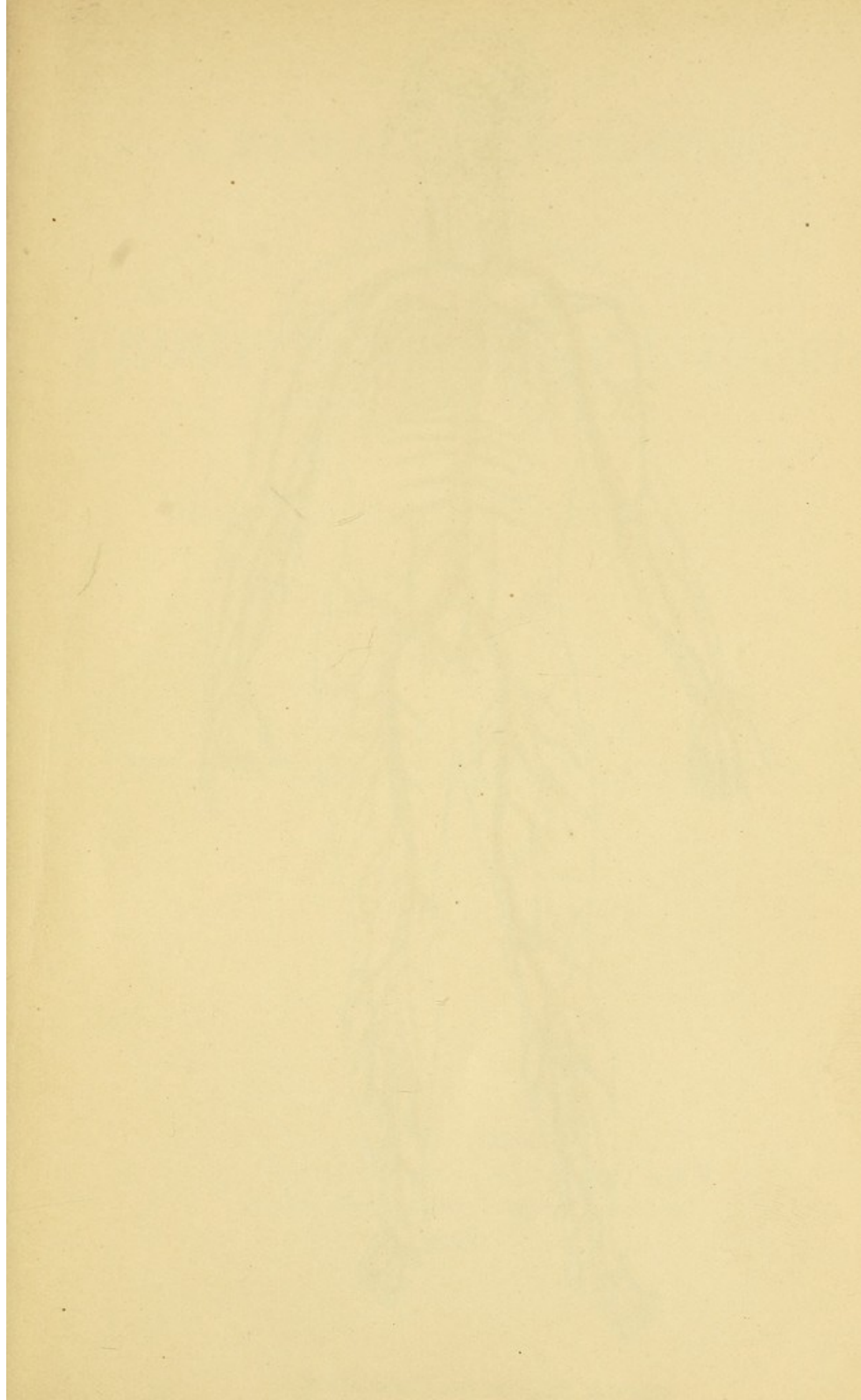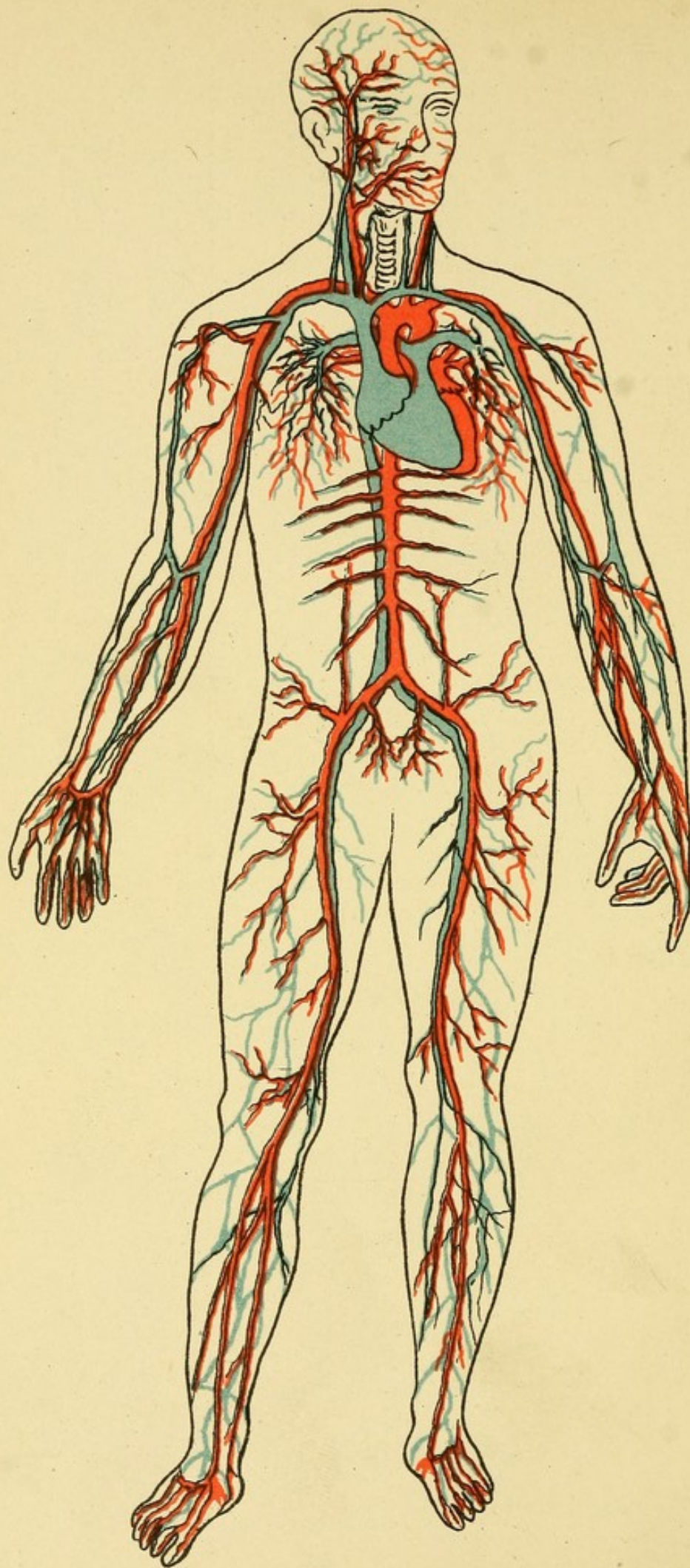
GENERAL PLAN OF THE CIRCULATION.

A MANUAL OF INSTRUCTION

IN THE PRINCIPLES OF

PROMPT AID TO THE INJURED

DESIGNED FOR MILITARY AND CIVIL USE

BY

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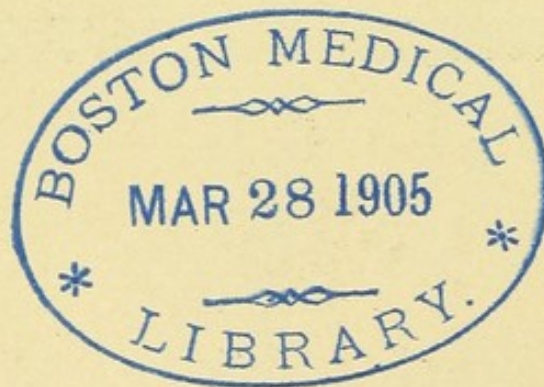
TO

JOSEPH D. BRYANT, M. D.,

IN ACKNOWLEDGMENT OF HIS HIGH POSITION

AS A TEACHER OF ANATOMY AND SURGERY,

AND AS A LUCID WRITER

AND EXPONENT OF THEIR PRACTICAL APPLICATION,

THIS MANUAL IS DEDICATED

BY THE AUTHOR.

PREFACE.

THE object of this Manual is to instruct those who are desirous of knowing what course to pursue in emergencies, in order that sick or injured may be temporarily relieved. Special effort has been made to so arrange the matter and introduce such points as will be of use to the ambulance corps connected with the different military organizations. It will be appreciated that it is a difficult task to give to non-medical persons information which will properly instruct them to cope with emergencies without encouraging them to usurp the functions of the physician or surgeon.

In order that the subject may be well understood, it is essential to know something of the construction of the human body and the functions of the different organs; for this reason, considerable space has been devoted to anatomy and physiology. The author has endeavored to explain each topic in a plain and simple manner, and when medical terms are used their lay synonyms are also given. Numerous illustrations have been inserted to aid in making the work the more intelligible—many of which have been taken from the works of Esmarch, Flint, Tracy, and others, due credit, however, being given in each instance.

The author is particularly indebted to Dr. Glover C. Arnold, of this city, for proof-reading, and also many valuable suggestions. To Major Charles Smart, Surgeon, U. S. A., the author wishes to express his thanks for the permission given to introduce in this work the Manual of Transportation now used by the U. S. Army.

ALVAH H. DOTY, M. D.

59 WEST THIRTY-SIXTH STREET, NEW YORK,
        March 4, 1889.

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PROMPT AID TO THE INJURED.

CHAPTER I.

BONE.

BONE is composed of animal matter, consisting of gelatin, fat, and blood-vessels, and "bone-earth," principally phosphate of lime. It derives its tenacity and elasticity from the former, and the "bone-earth" gives to it the necessary hardness.

When soup is made by boiling a bone, there is simply a liberation of the gelatin or animal matter, which principle may be extracted, by the same process, even from bone two or three thousand years old. The animal part forms about one third and the earthy matter two thirds of bone. Although the proportion remains the same throughout life, bone is less dense during the early years. This will explain why the bones of children are so elastic that, when considerable force is applied, they are apt to bend, like a green stick, rather than break, as in the adult bone under similar circumstances.

Rickets is a disease of childhood representing a diminished amount of earthy matter, when the bones become bent and distorted. The deformities are particularly marked in the bones of the lower extremity, which support the body. With the exception of the teeth, bone is the hardest structure in the body.

1

A section of bone (Fig. 1) shows it to be composed of two kinds of tissue—*compact*, which is exceedingly dense and hard like ivory; and *cancellous*, or "spongy" bone, which is a network of thin plates and columns of bone. The compact tissue constitutes the outer portion of bone, and is very much increased where great strength is required, as in the shaft of the femur or "thigh-bone." The cancellous tissue is internal, and especially abundant where bone expands to form large surfaces for support, as in the extremities of the bones of the thigh, legs, etc. Cancellous tissue is not only very light, but very strong; a portion, corresponding in size and shape to a piece of loaf or cut sugar, will support a weight of three or four hundred pounds, while a square inch of compact tissue, about one half inch in thickness, will support a weight of five thousand pounds. Bone is twice the strength of oak.

In the skull, where great strength is necessary to support and protect the brain, we find two layers of compact tissue : the external portion, known as the "outer" table, and the internal as the "inner" table, with a small amount of cancellous tissue, known as the diploë, existing between them.

FIG. 1.—The right femur, or thigh-bone, sawn in two lengthwise. Showing arrangement of compact and cancellous tissues.

The long bones are hollow. This condition admits of the proper length, diameter, and strength, while it greatly diminishes the weight.

The "medullary" or "hollow canal" in the shaft, and

the cancellous tissue of the extremities of long bones, also the cancellous tissue of other bones throughout the body, contains a substance called *marrow* or " oil of bone." In the medullary canal it is called yellow marrow, and is composed of about ninety-six per cent of fat, while the " red marrow," which is found in cancellous tissue, is principally water and contains but a trace of fat. The medullary canals in the bones of birds communicate with the lungs and contain air instead of marrow, thereby rendering them very light and properly adapted for flight.

Bone is supplied with nutrition from two sources; the *periosteum*, and the *nutrient arteries*. The periosteum is a firm and resisting fibrous membrane, pinkish in color, which is adherent to the bone, and covers it at all points except where cartilage exists. This membrane is a structure in which blood-vessels divide, subdivide, and pass into minute openings in the compact tissue, supplying it with nutrition. The cancellous tissue receives its nutrition from larger vessels (nutrient arteries), which are branches of the main arteries in the vicinity of the bone, and pass through the compact tissue to their destination. When the periosteum is removed from the bone, the compact tissue is deprived of its principal means of nutrition, and death or " necrosis " (corresponding to gangrene in soft tissues,) is apt to ensue. This may happen in disease, or as the result of an injury, particularly to superficial bones such as the tibia, bones of the head, etc. A familiar example is a "felon," which demands immediate and special treatment at the hands of the surgeon.

When bone is in the normal condition and properly covered with periosteum, it feels smooth and moist, and when struck with a probe it gives a dull sound ; but when the periosteum is removed, it feels rough and hard, and striking it with a probe produces a metallic sound. It is important to the surgeon to recognize these different conditions, and be thus easily enabled to decide whether the periosteum is present or absent.

The *endosteum* is a thin, fragile membrane which corresponds in nutritive function to the periosteum, and lines the medullary canal in the long bones.

Bones are supplied with nerves and lymphatics or absorbents.

The *lymphatics* have been known to remove by absorption ivory pegs used to hold in place the broken ends of a bone which would not unite by the natural process.

The shape of a bone depends upon the function it performs. Bones are divided into *long, short, flat,* and *irregular*. The long bones, of which the femur or " thigh-bone " is a type, are composed of a shaft and two extremities, and, with their muscular attachments, act as levers, and also for support. The short bones are found where a number of joints are required, or where force is to be distributed over oblique surfaces. An example of the former is the vertebræ or spine, and of the latter, the carpus or wrist.

The flat bones are used in the construction of cavities and to protect their contents, and are also for muscular attachment.

The irregular bones are the lower jaw (inferior maxillary), ribs, etc.

The *skeleton* (Fig. 2), which represents the bones in their proper relations, is the framework to which the soft structures of the body are attached. It consists of a central column (the spine); four extremities : two upper (the arms), and two lower (the legs); and three bony cavities : (1) the cranium or skull, containing the brain ; (2) the thorax or chest, containing the heart and lungs ; and (3) the pelvis or basin, containing the pelvic and some of the abdominal organs.

The skeleton is composed of two hundred bones. There are several small bones found in the tendons of muscles, at the union of the skull-bones, and also in the ear, which are not included in this enumeration. This number is divided in the following manner :

FIG. 2.—The skeleton.

The spine or vertebral column........ 26
Cranium...........................   8
Face 14
Os hyoides, sternum, and ribs........ 26
Upper extremities................... 64
Lower extremities.................. 62
                                    ————
                                     200
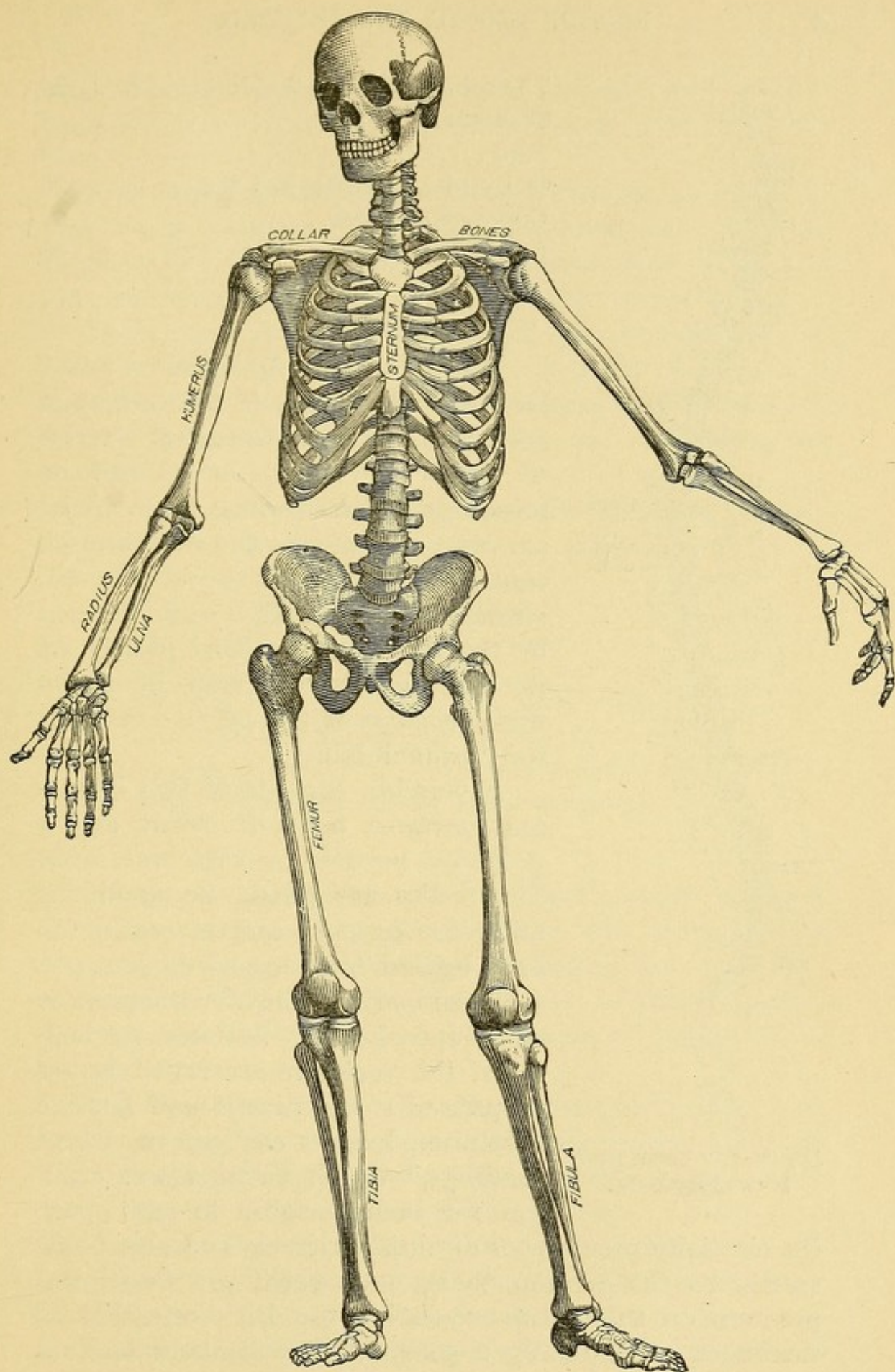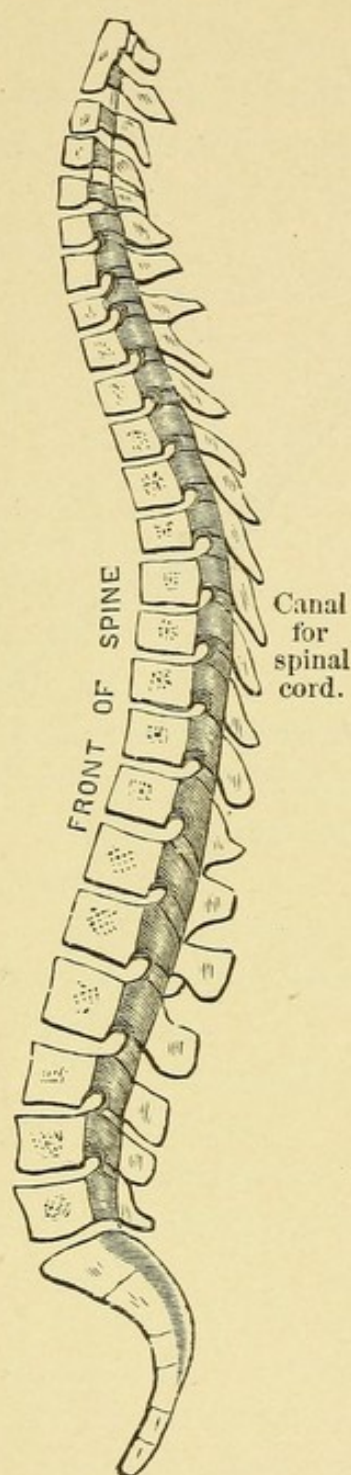
FIG. 3.—The spine, sawn in two lengthwise.

The *spine* (Fig. 3), which is about one third the length of the body, is a jointed column consisting of a series of bones (vertebræ) articulated or joined together, forming three slight curves. It supports the skull and its contents, and protects the spinal cord, which is contained in a canal formed by the union of the bony parts. At its base the column rests upon the upper portion of the pelvis—between the "haunch-bones."

A vertebra consists of two important parts—a body, in front, and a posterior portion or vertebral arch. The bodies are piled one upon the other for support and strength, the arch behind forming, by its junction with the body, a canal for the passage of the spinal cord. Between the bodies of the vertebræ are found layers or pads of a very elastic and flexible substance, known as "intervertebral cartilage," which forms a soft cushion for each vertebra to rest upon. Its elasticity prevents or diminishes shock, and also tends to restore the column to its erect position. Continued pressure on this substance during the day diminishes its thickness, consequently a person will lose about half an

inch in height during this period ; the rest and recumbent position of the night restore it to its previous condition.

It is important to remember that leaning too much on one side, as at a desk, will cause a permanent change in the cartilage, so that the vertebral column may be bent to one side without the bone being primarily involved.

The curves in the vertebral column are necessary to assist in forming cavities for the reception of important organs. It is said that the curves increase the strength of the column tenfold ; they also aid in destroying shock.

The twenty-six bones comprising the vertebral column are divided in the following manner, viz. :

Cervical or neck...................... 7
Dorsal or back................................ 12
Lumbar or loins................................. 5
The sacrum, which represents five vertebræ (in fœtal
    life) fused into a single bone.................... 1
The coccyx or " crupper," which is formed from four
    bones in the same manner as the sacrum........ 1
                                             26

The freest movement in the vertebral column is found in the neck or cervical region, and the least movement in the back, between the shoulders, the spine here being connected with the ribs. The weakest part of the spine is at the last dorsal vertebra, and this portion of the vertebral column is very movable.

It is very essential to know that different elevations on the surface of the body (bony prominences, etc.) indicate the situation of certain important internal organs ; thus the vertebral column furnishes valuable information. Rubbing the fingers briskly up and down the spine will produce sufficient friction to redden the skin over the bony prominences known as "spinous processes." These processes are formed by the union posteriorly of the sides of

the vertebral arches already spoken of. With the body bent forward and the arms folded across the chest, the spinous processes can be made even more apparent.

The spinous process of the seventh or lowest cervical vertebra is particularly prominent, and has received the name of "vertebra prominens," and should be carefully sought for, as it will aid in locating others.

The lower or inferior angle of the scapula or "shoulder-blade" is on a line with the seventh dorsal vertebra.

Having located the different vertebræ, the following points are to be remembered, viz.:

Fifth Cervical.—Œsophagus begins.

Seventh Cervical.—Apex or upper part of lung; consequently a knife, or bullet wound, above this line, unless carried downward, would not injure the lung.

Third Dorsal.—Upper border of arch of aorta, and extent downward of trachea or "windpipe," which, at this point, divides into two portions.

Fourth Dorsal.—Arch of aorta ends; upper level of heart.

Eighth Dorsal.—Left side, lower level of heart.

Ninth Dorsal.—Left side, lower end of œsophagus, passing through diaphragm, and upper edge of spleen.

Tenth Dorsal.—Left side, lower level of lung, and upper or cardiac opening of stomach.

Eleventh Dorsal.—Left side, lower border of spleen.

First Lumbar.—About the middle of kidneys.

The *skull* (Fig. 4) is the case for the lodgment and protection of the brain and its membranes, and important blood-vessels and nerves. It is composed of twenty-two bones, enumerated in the following manner:

Cranium (8 bones).—Occipital, 1; parietal, 2; frontal, 1; temporal, 2; sphenoid, 1; ethmoid, 1.

Face (14 bones).—Nasal, 2; superior maxillary, 2; lachrymal, 2; malar, 2; palate, 2; inferior turbinated, 2; vomer, 1; inferior maxillary, 1.

The cranial bones protect the brain, and are uniformly

FRONTAL

SUTURE

PARTETAL

SUTURE

SUTURE

TEMPORAL

SUTURE

MALAR

Superior Maxillary.

Inferior Maxillary.

Occipital.

Mastoid Process.
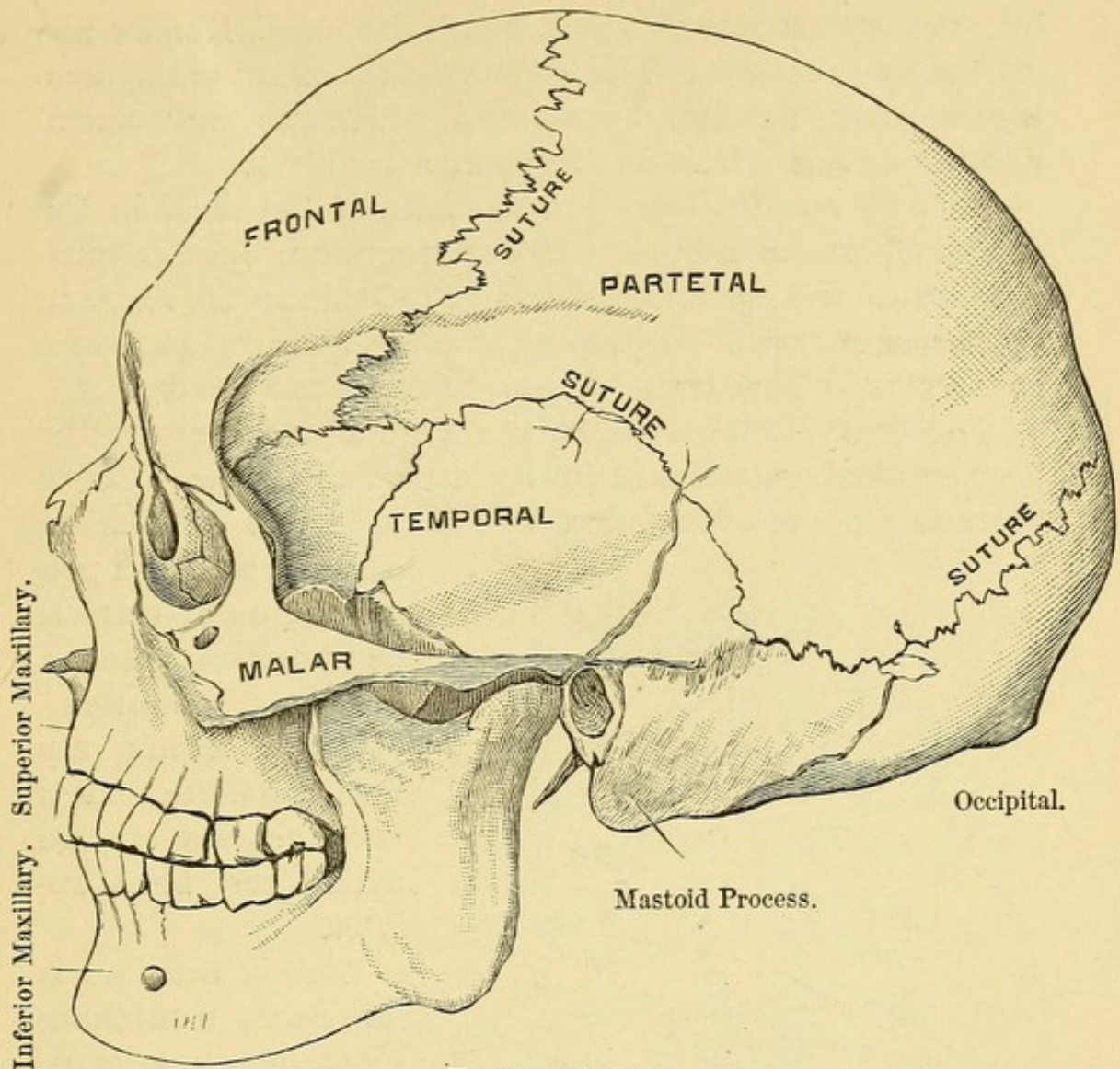
FIG. 4.—The skull.

strong and compact; while the bones of the face contain principally the organs of special sense, and give the proper symmetry to this portion of the skull, some of them are extremely thin, and are readily broken. The different bones of the skull are connected by sutures or "seams," and the overriding of these bones lessens the size of the head during birth, and permits variations, in size, for some little time afterward.

The fontanelles, or "soft spots" on an infant's head, correspond to the subsequent points of union of two or more bones of the cranium, which have not become fully hardened or ossified, but still retain the character of the mem-

brane or soft structure from which the cranial bones are originally developed. These spots disappear when the bone becomes fully developed or ossified, which generally occurs within one and a half or two years after birth.

A large opening exists at the base of the skull in the occipital bone, called the "foramen magnum," for the transmission of the spinal cord from the brain to the canal in the spinal column. Other and smaller openings are found in the skull which transmit blood-vessels and nerves.

The skull is supported by the vertebral column. The first cervical vertebra is firmly attached to the base of the skull at the "foramen magnum," while the second cervical acts as a pivot, having a vertical or upright portion, called the "odontoid" process, which fits into the first cervical vertebra, and around which the head rotates.

The *hyoid* bone is an arch, something like a horseshoe, which is placed above the prominence on the front of the neck called the pomum Adami, or "Adam's apple," and aids in supporting the tongue, and gives attachment to certain muscles.

Fig. 5.—Thorax, anterior view (Sappey).

1, 2, 3, sternum ; 4, circumference of the upper portion of the thorax ; 5, circumference of the base of the thorax ; 6, first rib ; 7, second rib ; 8, 8, last five sternal ribs ; 9, upper three false ribs ; 10, last two, or floating ribs ; 11, costal cartilages.

The *thorax* or chest (Figs. 5 and 6) is the bony frame-work which contains the heart, lungs, and important blood-vessels and nerves. It is formed
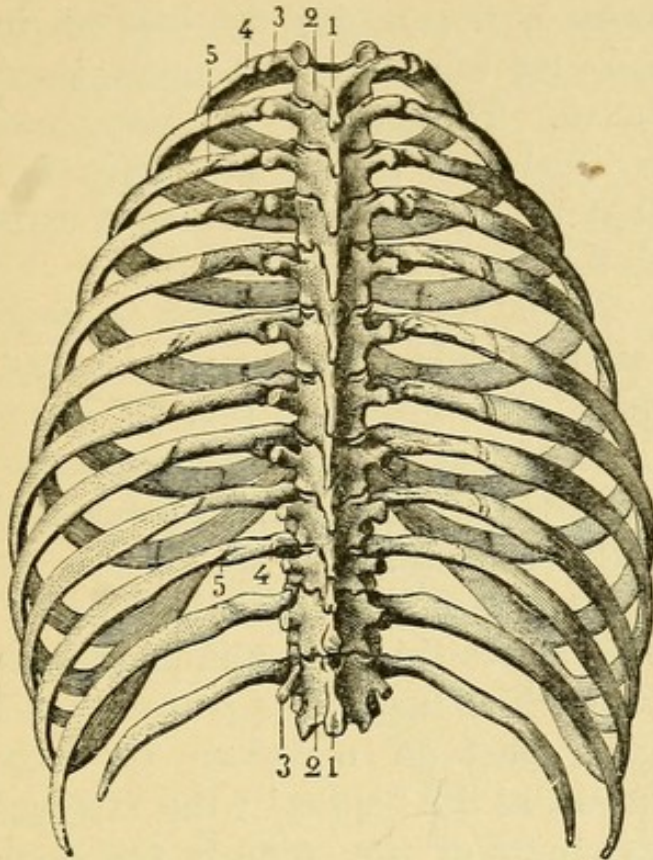
FIG. 6.—Thorax, posterior view (Sappey).
1, 1, spinous processes of the dorsal vertebræ ;
2, 2, laminæ of the vertebræ ; 3, 3, transverse processes ; 4, 4, dorsal portions of the ribs ; 5, 5, angles of the ribs.

by the sternum in front, and the ribs and vertebræ at the side and back, and is separated from the abdominal cavity by a muscular partition known as the diaphragm or "midriff."

The *sternum* or "breast-bone" is a flat and narrow bone about seven inches long, situated in the front of the chest, and supporting the clavicles or "collar-bones" and the ribs, with the exception of the last two ribs.

The *ribs* (Fig. 7) are twenty-four in number, twelve on each side, and are numbered from above downward. They articulate posteriorly with the dorsal vertebræ, and the upper ten connect in front with the sternum by means of cartilages (costal cartilages), which are interposed between the ends of the ribs and the sternum, and allow of greater motion and elasticity. The two lower ribs, the eleventh and twelfth, are simply connected with the vertebræ, and are known as "floating" ribs, as they have no attachment in front. The peculiar arrangement and attachment of the ribs render them a very important element in respiration ; during this act the ribs are elevated and depressed by the action of the respiratory muscles. When the ribs are elevated during inspiration, the thorax or chest is enlarged and air passes into the lungs ; in expiration the ribs are de-

HEAD

BODY OR SHAFT

FIG. 7.—A rib.

pressed, the cavity diminished in size, and the air in the lungs is expelled. The elasticity of these bones is illustrated by the fact that children in Arabia use the ribs of camels for bows.

Each upper extremity is composed of thirty-two bones, and includes the following: scapula, clavicle, humerus, radius, ulna, eight carpal bones, five metacarpal bones, and fourteen phalanges.

The *scapula* or "shoulder-blade" (Fig. 8) is a thin, flat, and triangular bone, which has on the posterior and upper part an elevation or ridge known as the "spine"; the external extremity of the spine is the acromion process, which connects with the outer end of the clavicle. The outer and upper portion of the scapula forms the glenoid cavity or "socket" which receives the ball-shaped head of the humerus or "arm-bone." The scapula, in this manner, assists in the formation of the shoulder-joint. It also furnishes broad surfaces for the attachment of muscles, and aids in protecting the contents of the thorax.

The *clavicles* or "collar-bones" (Fig. 9), shaped something like the italic letter *f*, are on the anterior and upper part of the chest, and extend from the upper portion of the sternum or "breast-bone" to the acromion processes of the shoulder-

blades referred to above ; they hold the shoulders upward,
backward, and outward.   When a clavicle is broken the
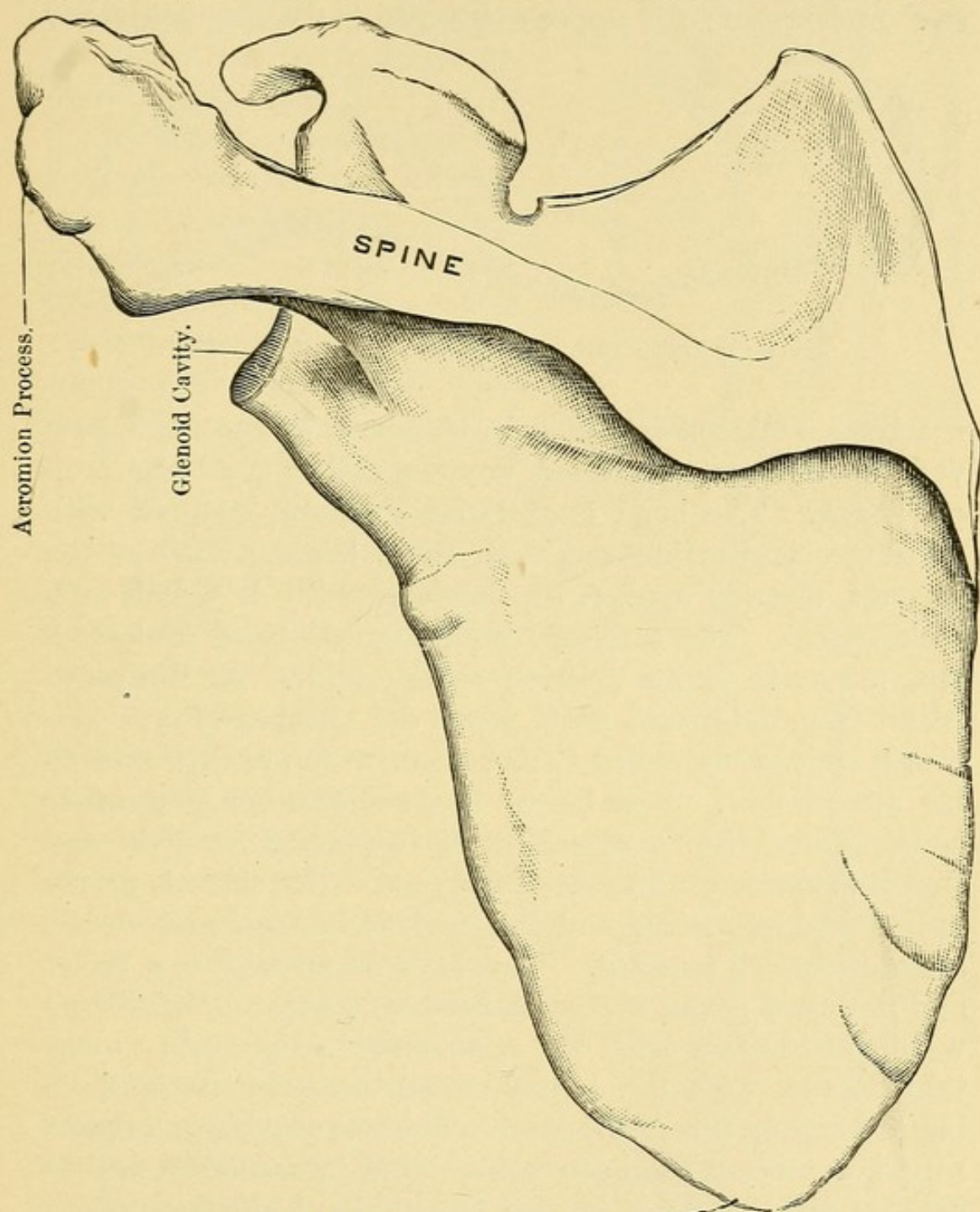
FIG. 8.—Left scapula, or shoulder-blade.

arm drops downward, forward, and inward, its support be-
ing gone.   Manual labor increases the size, strength, and
curvature of the clavicle.   The collar-bone is less curved
in women than in men.

The *humerus* or "arm-bone" (Fig. 10) is the longest and strongest bone of the upper extremity. It has a shaft and two extremities; the upper extremity is the largest part of

Sternal Extremity.

Acromial Extremity.
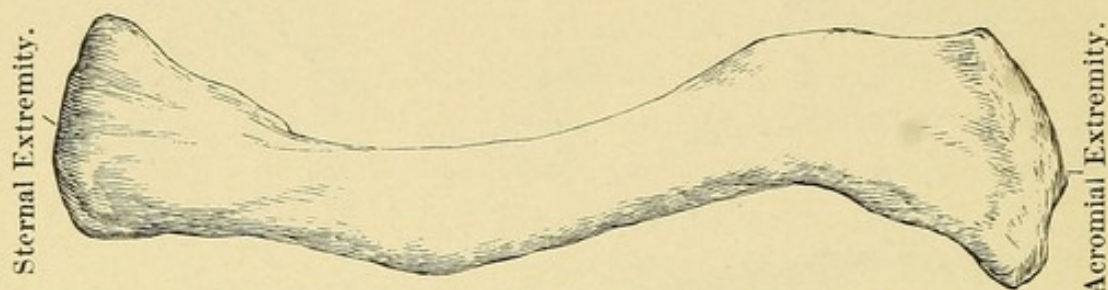
FIG. 9.—Anterior surface of left clavicle, or collar-bone.

the bone, and consists of a head joined to the shaft by a very short and constricted portion called the "anatomical" neck. The head is globular in form, covered with cartilage, and articulates with the glenoid cavity of the scapula, already spoken of, forming with it a ball-and-socket joint. The cartilage covering the head protects it and prevents undue friction in the joint. At the point where the anatomical neck joins the shaft are found two rough eminences called tuberosities, which are for muscular attachment. Just below the tuberosities is another constriction—the "surgical" neck—so called from the fact that it is the common seat of fracture. The shaft is partly cylindrical, prismatic, and flattened, and roughened for the attachment of muscles. The lower extremity is a broad and flattened (from before backward) portion of the bone which articulates with the ulna principally, and to a certain degree, with the radius of the forearm, these three bones forming the elbow-joint. The humerus has a greater range of motion than any other bone in the body, and is oftener dislocated; it is also frequently broken or fractured, particularly just below the head, at the surgical neck already described.

The *radius* and *ulna* (Fig. 11) are the bones that constitute the forearm.

The *radius*, so called from its fancied resemblance to

the spoke of a wheel, is the external bone lying parallel with the ulna when the palm of the hand is turned upward. It resembles other long bones in having a shaft and two extremities. The upper or lesser extremity forms only a small portion of the elbow-joint, while the lower extremity, which is broad, forms the wrist by articulating with two of the carpal or wrist bones. The lower end also articulates with the corresponding portion of the ulna. The shaft of the radius is more or less irregular and rough for the origin and insertion of muscles. The ease with which the forearm and hand may be turned with the palm down (" pronation "), and with the palm up ("supination "), is due to the peculiar articulation of the upper end of the radius with the ulna. The upper end of the radius (or head) is somewhat knob-shaped, with a depression or excavation on its upper surface; the excavation articulates with a small portion of the lower extremity of the humerus, and represents the limited part it takes in the formation of the elbow-joint.
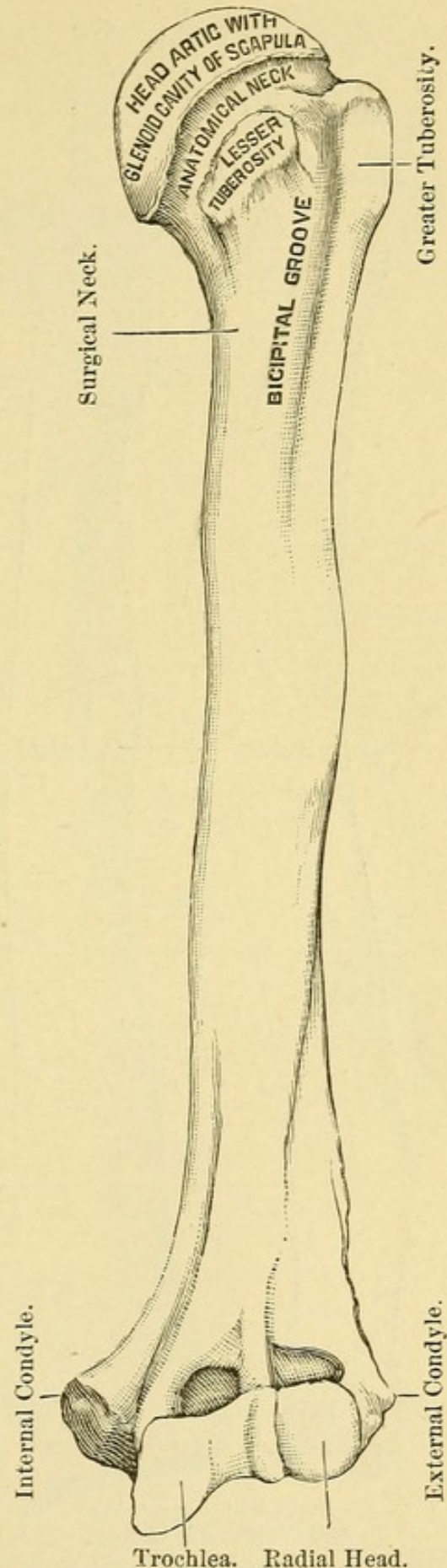
Fig. 10.—Left humerus, or arm-bone.
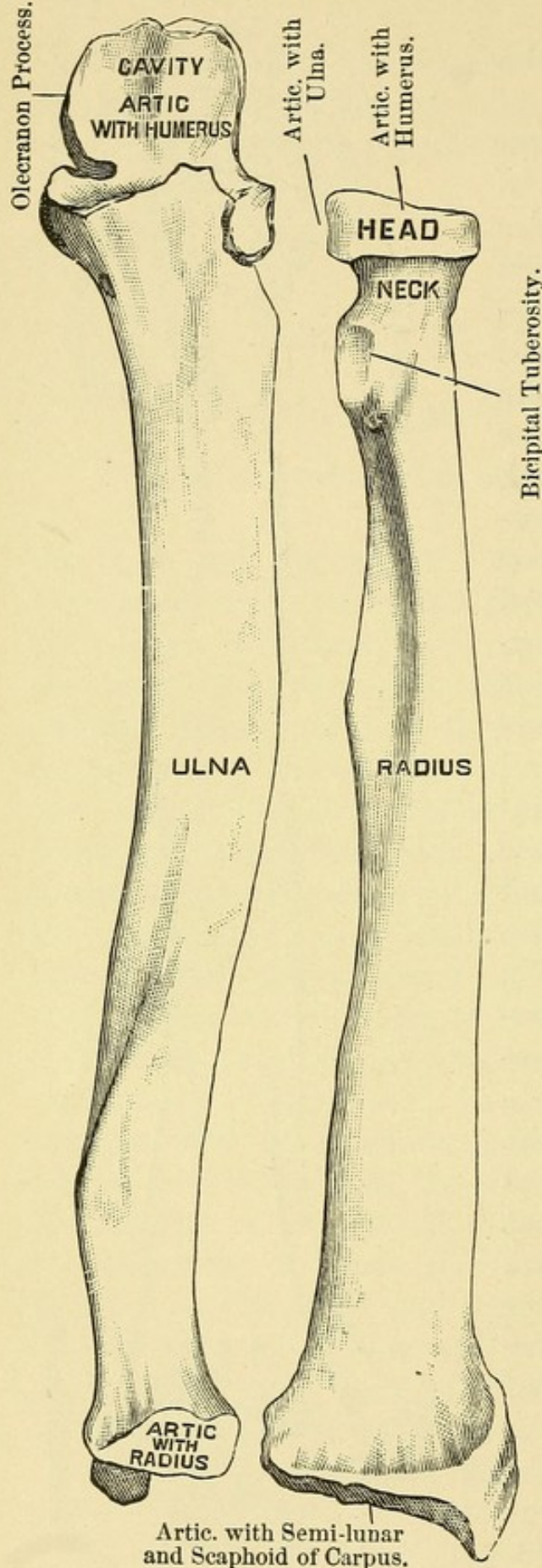
FIG. 11.—Left radius and ulna, or bones of the fore-arm.

Below the portion of the radius just described is a constricted portion, called the neck ; a ligament in the form of a loop, named the orbicular ligament, is thrown around this part, and attached to the outer side of the ulna ; this ligament, while it holds the radius in position, allows the neck of the radius, which it encircles, to freely rotate.

The *ulna*, which is composed of a shaft and two extremities, is the companion of the radius, and situated internal to it ; the lower extremity is very small, and, although connected with the radius, has no articulation with the carpal or wrist bones, consequently it does not enter into the formation of the wrist ; but the upper end is large, and contains a depression or cavity which receives the lower extremity of the humerus. The prominent point of the elbow is the extreme end of the ulna, and is known as the "olecranon process" of

Articulate with Radius forming Wrist-Joint.

Carpus.

SEMI·LUNAR

SCAPHOID

CUNEIFORM

PISIFORM

UNCIFORM

OS MAGNUM

TRAPEZOID

TRAPEZIUM

Metacarpus.

Phalanges.
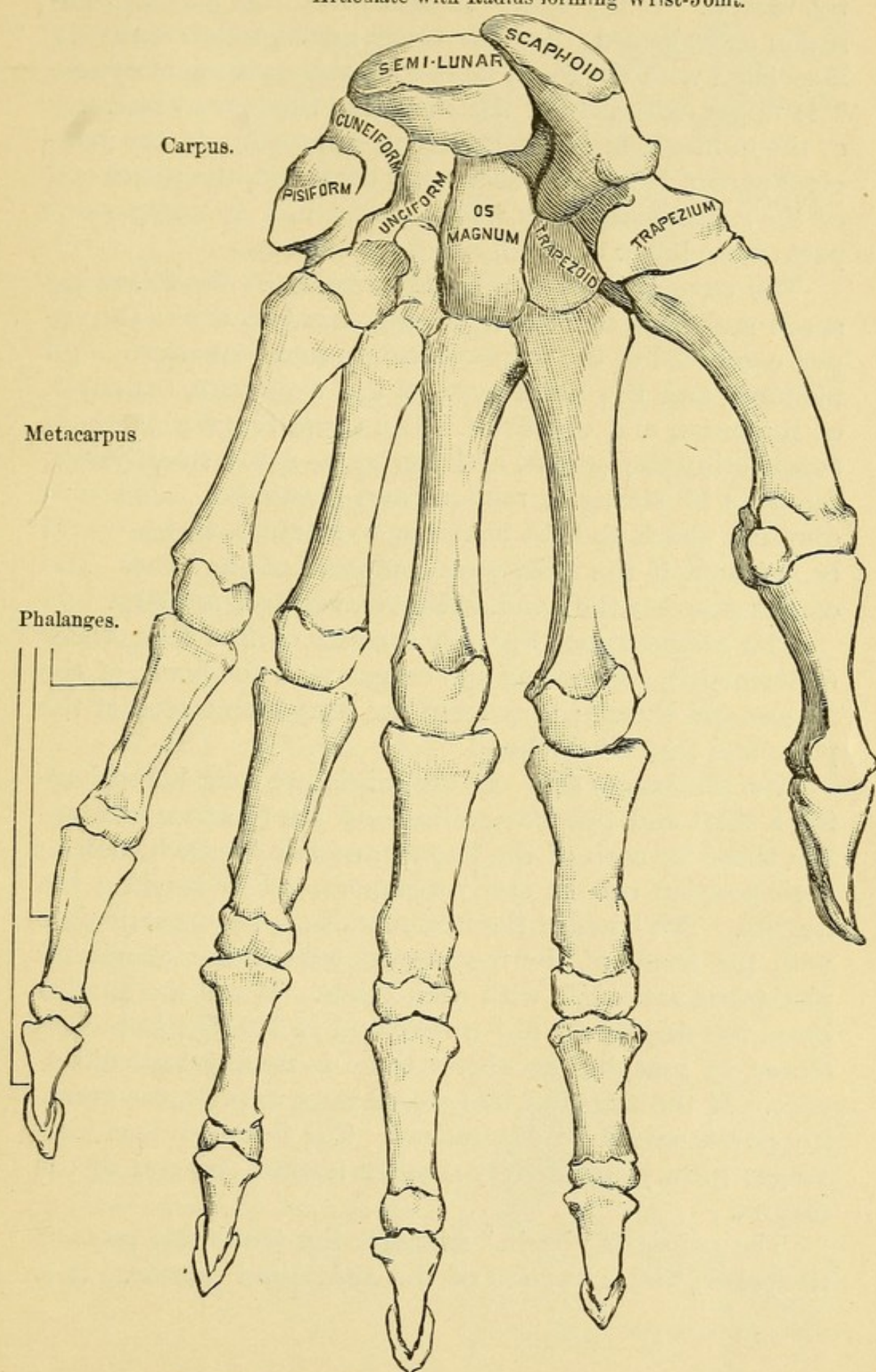
FIG. 12.—Bones of the left hand. Palmar surface.

2

the ulna or "funny-bone," so called from the peculiar sensation experienced when the ulnar nerve, which is closely associated with the inner border of this process, is struck. The upper extremity of the ulna and the lower extremity of the humerus make up the elbow-joint—that is, the principal part of it ; while, as already described, the upper end of the radius articulates with a small and less important part of the lower extremity of the humerus.

The *carpus* or wrist (Fig. 12) consists of the following small and irregular bones, arranged in two rows: the upper, composed of the scaphoid, semi-lunar, cuneiform, and pisiform, and the lower row, of the trapezium, trapezoid, os magnum, and unciform. The large number of bones constituting the carpus, and having so many small joints, increases its strength, motion, and elasticity. They also diminish shock and the tendency to fracture, which would be frequent if the wrist were composed of one bone. The carpus supports the hand and preserves its symmetry.

The *metacarpus* (Fig. 12) consists of five long bones (metacarpal), connecting the carpus with the bones of the fingers and thumb; they form the bony framework of the palm and back of the hand.

The *phalanges* (Fig. 12) are miniature long bones, having a shaft and two extremities, and are fourteen in number, three for each of the fingers and two for each thumb; their position can be easily demonstrated by bending the fingers. The bases of the first row of phalanges articulate with the heads of the metacarpal bones ; the remaining phalanges articulate with each other. When the hand is open, the fingers do not correspond in length; but when closed, in grasping an object, there is no apparent difference. If the fingers when closed were uneven, the grasping power would be diminished. The three rows of phalanges grow progressively smaller toward the end of the fingers.

The *pelvis* or "basin" supports the trunk and protects the pelvic, and a portion of the abdominal organs. It is

composed of the two innominate or "haunch" bones, the sacrum, and the coccyx ; the last two have been described with the spinal column.

The *innominate* bones are situated one on each side and in front, and form the greater portion of the pelvis, while the sacrum and coccyx form the posterior portion. On the outer side of an innominate bone is found a depression or socket, known as the cotyloid cavity or acetabulum, corresponding in function to the glenoid cavity of the scapula, which receives the head of the femur or "thigh-bone."

The *femur* (Fig. 13) is the longest and strongest bone in the body : its length is characteristic of the human skeleton. In the erect position, the tips of the fingers reach to about the middle of the thigh, while in the orangoutang, the fingers reach to the ankle. This depends also on the comparative shortness of the arm in the human skeleton.

The femur is divided into a shaft and two extremities, the upper extremity being composed of a globular head,

Fig. 13.—Right femur, or thigh-bone.

Fibula.

Tibia.

CREST

INTERNAL SURFACE, SUBCUTANEOUS
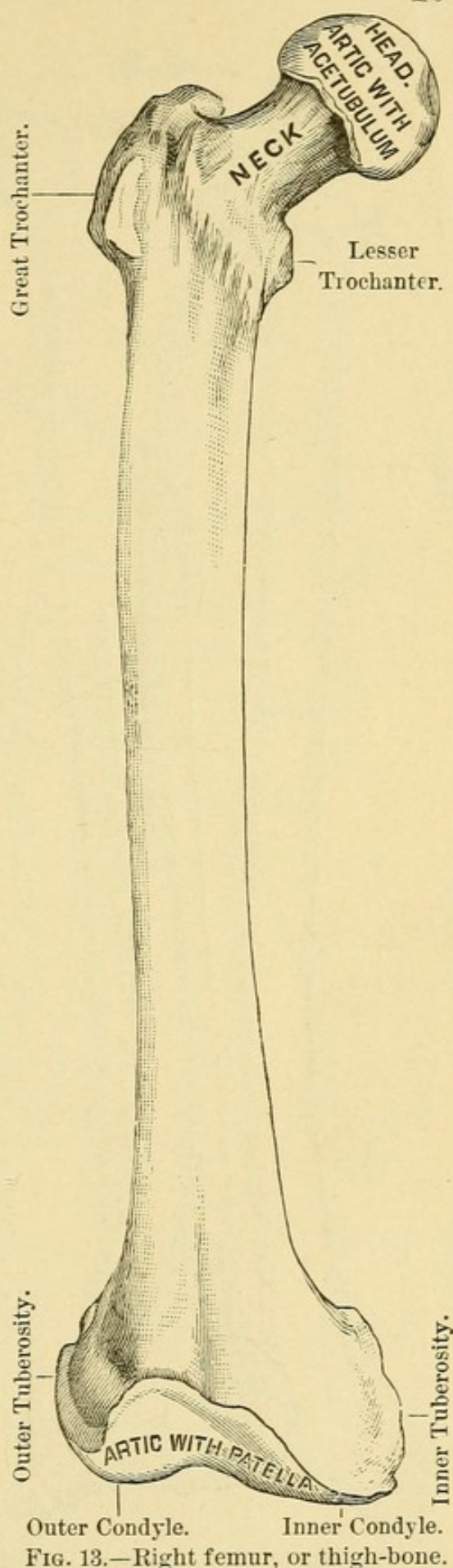
Fig. 14.—Right tibia or shin-bone, and fibula or splint-bone.   Anterior surface.
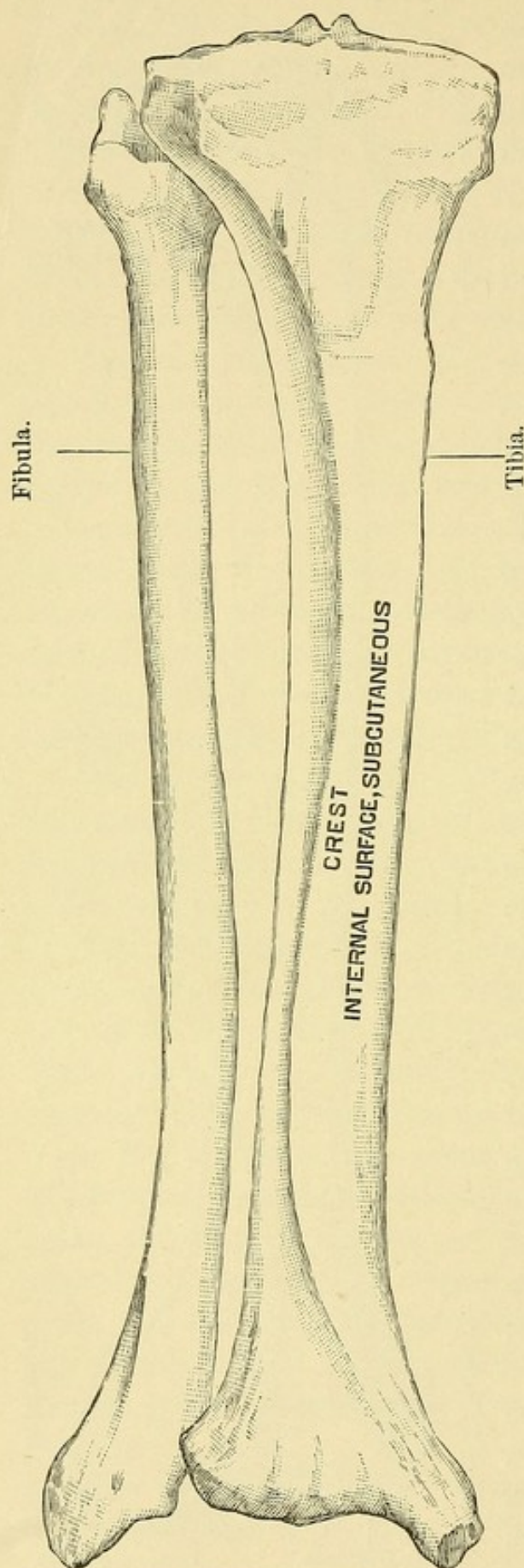
which is connected obliquely with the shaft by quite a long neck; at the point where the neck joins the shaft there are two prominences, the higher being the larger, and on the outer side of the bone, and called the great trochanter, the smaller one being on the inner side, and somewhat below, known as the lesser trochanter. The eminences are for the insertion of muscles. The head of the femur is contained in the cotyloid cavity or acetabulum of the innominate or haunch bone. The long neck of the femur keeps the shaft at the proper distance from the pelvis, prevents any interference with its action, and allows greater motion. The shaft of the femur is almost cylindrical, and furnishes surfaces which are somewhat roughened for the origin and insertion of muscles. The lower extremity is very large and broad, articulates with the upper extremity of the tibia or leg-bone and

the patella or knee-cap, and forms the knee-joint. In early life, or in middle age, the neck of the femur is oblique with the shaft, while in old age, it approaches a right angle. This change, with the fact that late in life the neck is, to a certain extent, absorbed and more compact, will explain why in old age the neck of the bone is very often broken.

The femur articulates with the pelvis, tibia, and patella.

The *tibia* or "shinbone" and *fibula* or "splint-bone" (Fig. 14) are the bones of the leg, and have the characteristics of long bones.

The *tibia*, which is very superficial in front (having only the skin as a covering), is the larger of the two bones, and is constructed mainly for strength, and supports the femur; it
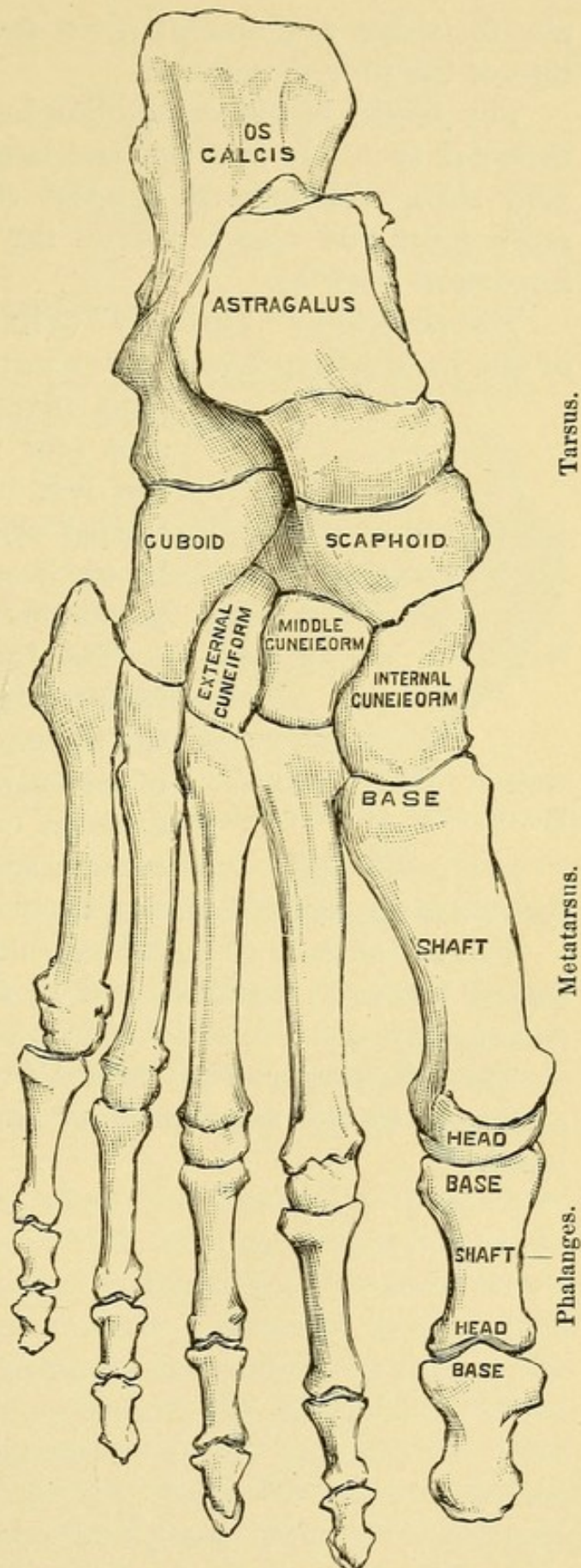
Fig. 15.—Bones of right foot. Dorsal surface.

also furnishes attachment for a few muscles. The direction of the tibia is vertical.

The *fibula* is the companion-bone of the tibia and is external to it. It is about the length of the tibia, and is very slim, and helps to support the tibia and form the ankle-joint, and also furnishes the origin of a number of important muscles.

The *patella* or "knee-cap" (Fig. 16) is situated in front of the knee-joint; it is in the sheath of a tendon, and assists in protecting the joint, and also aids in properly extending the leg. When the leg is extended and the muscles are relaxed, it will be found that the patella is freely movable.
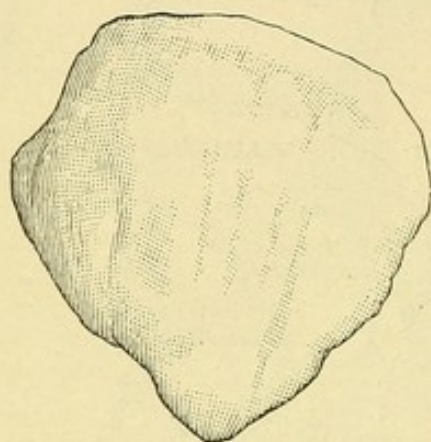
FIG. 16.—The patella, or knee-cap.

The *tarsus* or "instep" (Fig. 15) corresponds to the carpus in the upper extremity, and consists of seven bones (tarsal), viz.: calcaneum or os calcis, astragalus, cuboid, scaphoid, internal cuneiform, middle cuneiform, and external cuneiform.

The *metatarsal* (Fig. 15) bones correspond to the metacarpal bones in number, and in a general way to their description.

The *phalanges* (Fig. 15) are fourteen in number, and arranged in the same manner as the phalanges of the hand.

CHAPTER II.

*JOINTS—CARTILAGE—LIGAMENTS—SYNOVIAL MEM-
BRANE—MUSCLES.*

JOINTS.

BONES are joined at different points, constituting articulations or "joints"; some are immovable, as joints of the skull; others slightly movable, as joints of the spine; while the remainder are freely movable, as the knee and shoulder joints, joints of the fingers, etc.

The movable joints are divided into three kinds:

1. Joints having a gliding movement; as the tarsus and carpus.

2. Ball-and-socket joints, as where a globular head is received into a cup-like cavity, and admitting of motion in all directions, as shoulder and hip.

3. Hinge-joints, where the motion is limited to two directions; forward and backward, as the elbow.

Joints admit of the following movements: flexion, extension, rotation, adduction, abduction, circumduction, pronation, and supination.

Flexion takes place when the forearm is bent upon the arm, the leg upon the thigh, etc.; and *extension*, when these parts are extended or straightened; *rotation* occurs when a part is turned in and out; *adduction* is illustrated by the movement which carries the arm or leg *toward* the one of the opposite side or toward the median line of the body; *abduction*, the movement in the opposite direction; *circumduction* is exemplified when the arm is swung in a circle, as at the shoulder-joint; *pronation* is when

the palm of the hand is turned downward; and *supination* is when the palm is turned upward.

The following structures enter into the formation of a joint, viz. : bone, cartilage, ligaments, tendons, synovial membrane, blood-vessels, and nerves.

CARTILAGE.

Cartilage or "gristle" is a very firm and dense substance, found principally in joints, and covers the ends of bones entering into their formation ; it protects the adjacent bony surfaces against friction, and also prevents shock which would occur if the bones were directly applied to each other. The continued pressure brought to bear on cartilage in a joint would render it subject to inflammation and disease if it were supplied with blood-vessels ; consequently, cartilage has no blood-supply, and is known as the non-vascular tissue ; it absorbs its nutrition from the surrounding tissues by a process known as "imbibition." Cartilage connected with ribs has already been described (see RIBS). Cartilage is also found in tubes such as the air-passages, ear, nose, etc., where it is necessary that the tubes should be kept permanently open.

LIGAMENTS.

Ligaments are of two kinds, viz., the white fibrous and the yellow elastic.

The white fibrous ligaments are composed of bundles of white fibrous tissue which are closely interlaced ; they are found at the movable joints, and serve to connect the extremities of the bones forming an articulation ; they are inextensible but very flexible and strong, and, while they admit of the free movement necessary at the joint, they do not allow the articular ends of the bones to be abnormally displaced. When a dislocation occurs, the ligaments are either ruptured or torn from their attachments. The ligaments composed of yellow elastic tissue are extremely extensible, and are fewer in number than those composed of

white fibrous tissue. Examples of this variety are the ligamenta subflava and the ligamentum nuchæ. The latter extends from the spinous process of the seventh cervical vertebra to a protuberance on the occipital bone at the base of the skull. It is rather rudimentary in man, but well developed in animals, where it aids in supporting the head, and acts as a substitute for muscular power. The " ligamenta subflava " are small ligaments of the same tissue (yellow elastic) connected with the different vertebræ composing the spinal column; their action is similar to that of the ligamentum nuchæ, and assist in bringing the vertebral column to an erect position.

SYNOVIAL MEMBRANE.

The synovial membrane is a delicate structure connected with movable joints and covering the inner side of the ligaments. It is not found between the articular surfaces of the bones composing the joints. The synovial membrane secretes a thickish, glairy fluid, resembling in appearance the white of an egg, and it is known as synovia or "joint oil," which, passing into the joints, lubricates the cartilages and prevents friction. The synovial membrane may become inflamed as the result of injury or disease, producing stiffness of the joint, or anchylosis.

MUSCLES.

Muscles are bundles of reddish-brown fibers having the power of contraction, and are divided into two kinds, viz., voluntary or striped, and involuntary or unstriped; the terms striped and unstriped refer to the microscopical appearance of the fibers composing the muscle.

The *voluntary* muscles are under the control of the will, and comprise the bulk of the muscular system; they are attached to the different parts of the skeleton, and act on the bones as levers; they are the agents of locomotion and of the movements of all portions of the body; they also protect the different structures beneath them, and give
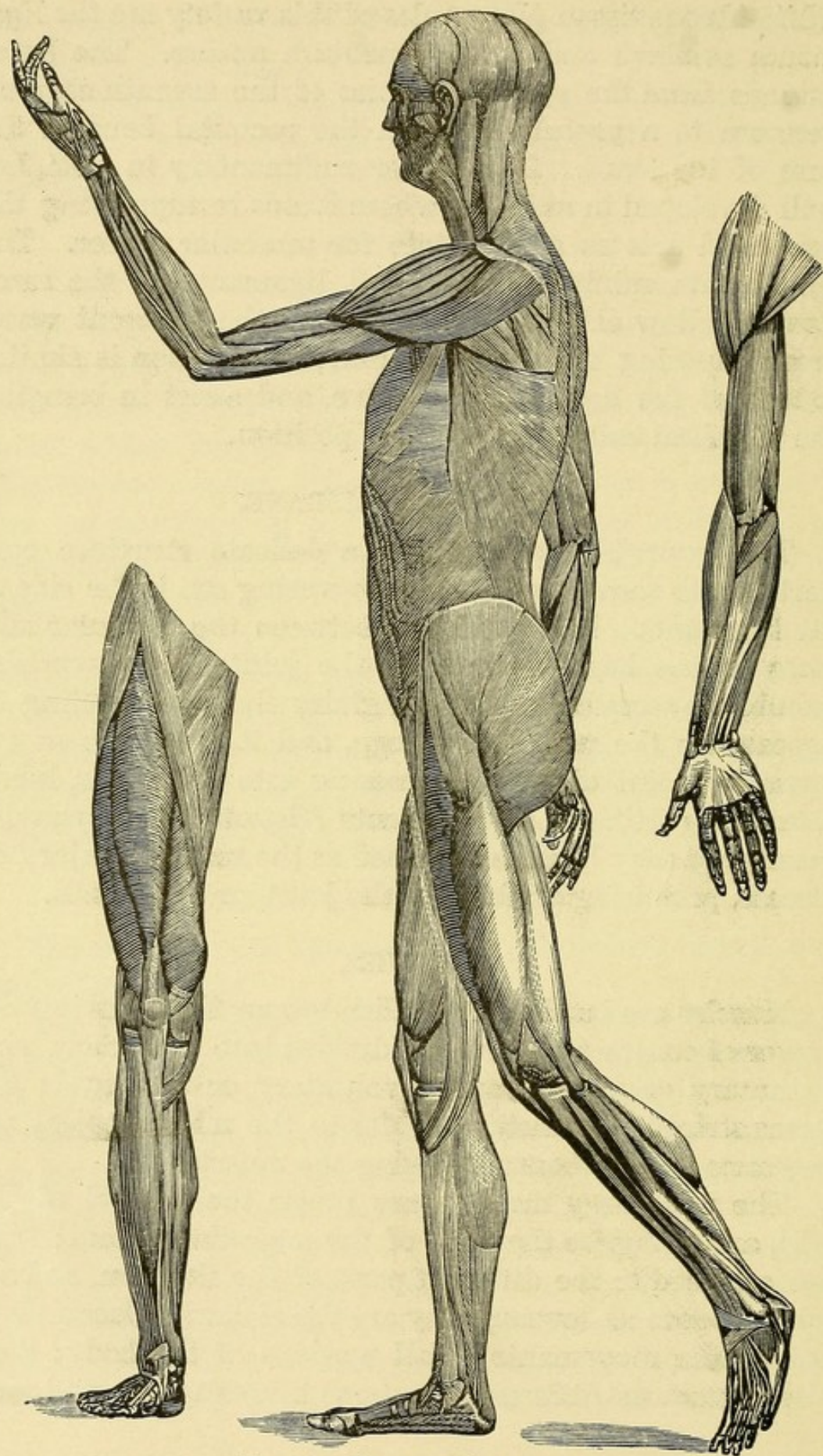
FIG. 17.—The muscular system.

grace and symmetry to the form (Fig. 17). When muscles become diminished in size or illy developed, the person is angular or bony.

The lean meat used for food is muscular tissue.

Muscles are of different lengths and shapes—long, short, broad, etc. They are arranged in pairs—that is, there are corresponding muscles on each side of the body, although some exist singly. There are over four hundred muscles in the human frame. In many situations the outlines of muscles are apparent to the eye, and are utilized as guides to the location of important blood-vessels and nerves.

Muscles are surrounded by a thin, web-like tissue known as fascia, which serves as a support for them and allows of their movements without undue friction.

Muscles are composed of a belly and two extremities. The more fixed extremity is called the origin, and the movable one the insertion ; however, in some muscles the origin and insertion are equally movable. During contraction their origins and insertions approximate, and muscles shorten and thicken; this can be illustrated by raising a heavy weight with the hand, when the biceps muscle in the arm will be seen to thicken and bulge forward. Muscles gradually diminish in size toward their extremities, the muscular tissue being replaced by an extremely firm and resisting substance called white fibrous tissue, constituting a *tendon*.

The tendons are directly and intimately connected with the periosteum covering the bone, and sometimes directly with the bone. They differ from muscular tissue in appearance—being white and glistening.

An *aponeurosis* is simply an expanded tendon, and is found where the muscle has a broad attachment.

Muscles are abundantly supplied with blood-vessels, nerves, and lymphatics, but tendons have few blood-vessels and no nerves.

The nerves connected with the muscles transmit to them a stimulus from the brain and spinal cord, which

calls their function into action. In the disease known as tetanus, or "locked-jaw," the stimulus is sometimes so great, and the contraction so intense, that the muscular fibers are ruptured.

The stiffness that ensues after death (rigor mortis) is due to a solidification of some of the fluid portions of the muscle, which is succeeded after a short time, however, by relaxation of the body. It is said that this rigidity is not present in one killed by lightning.

If a muscle is not sufficiently used it becomes diminished in size (atrophy), and from continued non-use may undergo degeneration, from which there is no recovery ; consequently a muscle should not be confined or unused too long. Hypertrophy represents the opposite condition to atrophy, the muscles being increased in size, and may be the result of constant exercise ; it is often noticeable in athletes. The contraction of a voluntary muscle is very rapid and abrupt.

The *involuntary* or unstriped muscles are not connected with bones, but form the muscular portion of the stomach, intestines, and other internal organs, and also the muscular coat of the blood-vessels. The contraction of this form of muscular fiber is slow, unequal, and does not affect all portions of the muscle simultaneously. The involuntary muscles are not, as a rule, under the control of the will ; they have no tendons ; the muscular fibers simply interlace with each other. Although the muscular fibers of the heart are striped, like *voluntary* muscular fibers, this organ is an *involuntary* muscle, and not under the control of the will, this being the only exception to the rule.

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Reference will frequently be made in the following chapters to organs, glands, mucous and serous membranes, and also to secretion and excretion, so then for the sake of convenience these terms will now be explained.

An organ is a part of the animal organism having a

special function to perform, as the brain, heart, stomach, kidneys, etc.

A gland is an organ, but it also has the additional function of abstracting from the blood, material which it discharges from the body unchanged (excretion), as urine, or, it manufactures from certain parts of the blood, a fluid (secretion) which has a particular function, as the gastric juice.

Mucous and serous membranes line the interior of cavities, sacs, tubes, etc. *Serous membranes* line cavities and tubes which are closed and have no communication with the outer world (examples: pericardium, pleura, and blood-vessels); while *mucous membranes* line structures which open externally (examples : respiratory and alimentary tracts). Both membranes secrete a small amount of fluid or vapor, which keeps their surface moist and pliable, and prevents friction ; in addition to this, some mucous membranes have small glands in their structure which produce a secretion having a distinctive function, as the mucous membrane lining the stomach, which secretes the gastric juice.

A *secretion* is a fluid formed in and by a gland or organ for a special purpose. It is peculiar to the organ that produces it, and is found in no other part, and consequently never exists in the blood; examples—gastric juice, bile, etc.

An *excretion* represents certain material which is always present in the blood, composed principally of waste matter ; it is not formed in a gland, but is simply removed from the blood and discharged from the body through channels known as excretory organs. The urine is an example of an excretion, the kidneys being excretory organs.

CHAPTER III.

THE BLOOD AND CIRCULATORY ORGANS.

BLOOD is the great nutritive fluid of the body. It distributes to the different tissues material necessary for their proper maintenance and activity. It supplies heat and also oxygen, receiving the latter from the air. It is absolutely necessary that the tissues should be constantly furnished with oxygen, otherwise death would ensue from suffocation, as in drowning. The blood has also the important function of removing from the body through certain organs, principally the kidneys, lungs and skin, worn-out and waste matter, which, if retained in the body, would produce serious disease or death.

Blood is composed of a liquid and a solid portion, about equally divided. The liquid portion or " plasma " is almost colorless when separated from the solid matter or " corpuscles," and contains the principal elements of nutrition, which it distributes to the different tissues in its course throughout the system, receiving in return waste material which is to be discharged from the body.

The corpuscles or solid portion float in the plasma, and constitute about one half of the bulk of the blood. They are divided into red and white. The red corpuscles are by far the most important and numerous; they resemble in appearance a thick coin which has been made thin in the center on both sides, or biconcave. These little bodies are exceedingly small; thirty-five hundred of them laid side by side on their flat surface would be required to cover the space of one inch. They are, of course, not visible to the

naked eye. When examined by the microscope, they appear straw-colored; but when vast numbers are crowded together, as in the normal condition of the blood, they give to it the characteristic red color. Physiologists have calculated that there are over fifty billions of them in the human body. The red corpuscles are the agents that receive oxygen from the air in the lungs and distribute it to the tissues throughout the body. The white corpuscles are comparatively few in number, but are larger than the red, and are globular in form. Their function is not definitely known (Fig. 18).

The total quantity of blood in the body represents about one tenth of its weight, or about fourteen pounds or pints. It is an alkaline fluid, and somewhat
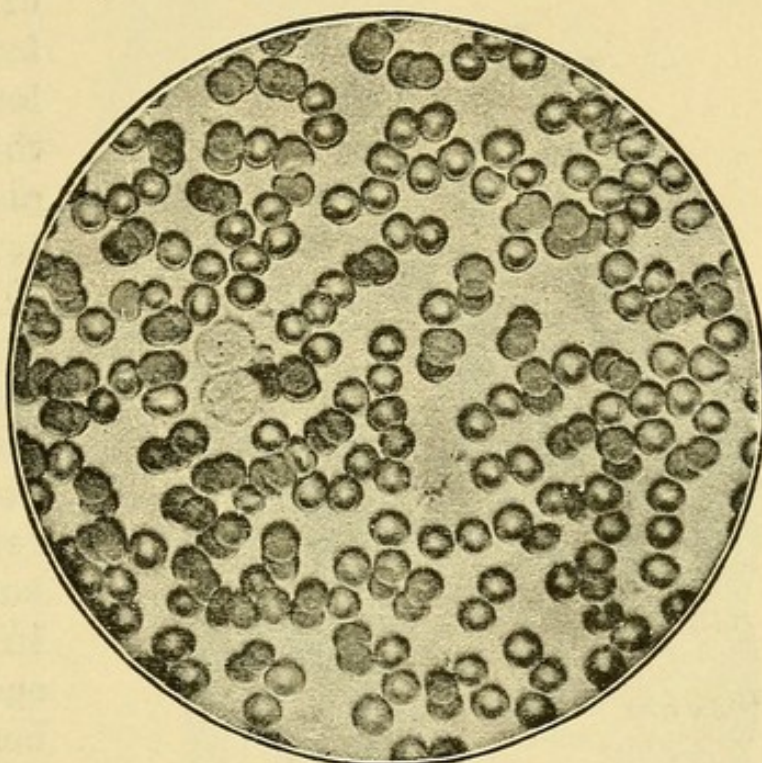
FIG. 18.—Human red-blood corpuscles, and two white corpuscles.

heavier than water. Arterial blood, or that which has been purified in the lungs, is of a rich red color, while the venous blood is dark blue or purplish.

Some tissues, such as the hair, cartilage, nails, etc., are not supplied with blood, but receive their nutrition by absorption (imbibition) from surrounding parts.

Coagulation, which occurs when a blood-vessel is opened, is an effort of Nature to arrest hæmorrhage. It also takes place in the blood-vessels in certain abnormal conditions of the blood. Blood circulates throughout the body by

means of blood-vessels, which are divided into arteries, veins, and capillaries. The motive power or force that propels the blood through these vessels is furnished by contractions of the heart.

THE HEART.

The *heart*, which is likened to a pump, is a hollow, muscular organ, conical or pear-shaped, about the size of a closed fist, four or five inches long, three inches through, and weighs about eight to twelve ounces (Fig. 19). It occupies a position in the thorax or chest, just behind the sternum or "breast-bone," and between the lungs, but mainly on the left side. The large end or "base" of the heart is directed upward and toward the right side, while the smaller end or "apex" is downward and to the left. A line drawn across the sternum at the upper border of the cartilage forming the extremity of the third rib would in-

FIG. 19.—The heart and large blood-vessels. *A*, right ventricle ; *B*, left ventricle ; *C*, right auricle ; *D*, left auricle ; *E*, aorta ; *F*, pulmonary artery.

dicate the base of the heart. The apex is found in the space between the fifth and sixth ribs, two inches below

the left nipple, and one inch to the right of it. At this point the pulsation of the heart may be distinctly felt (Fig. 20).
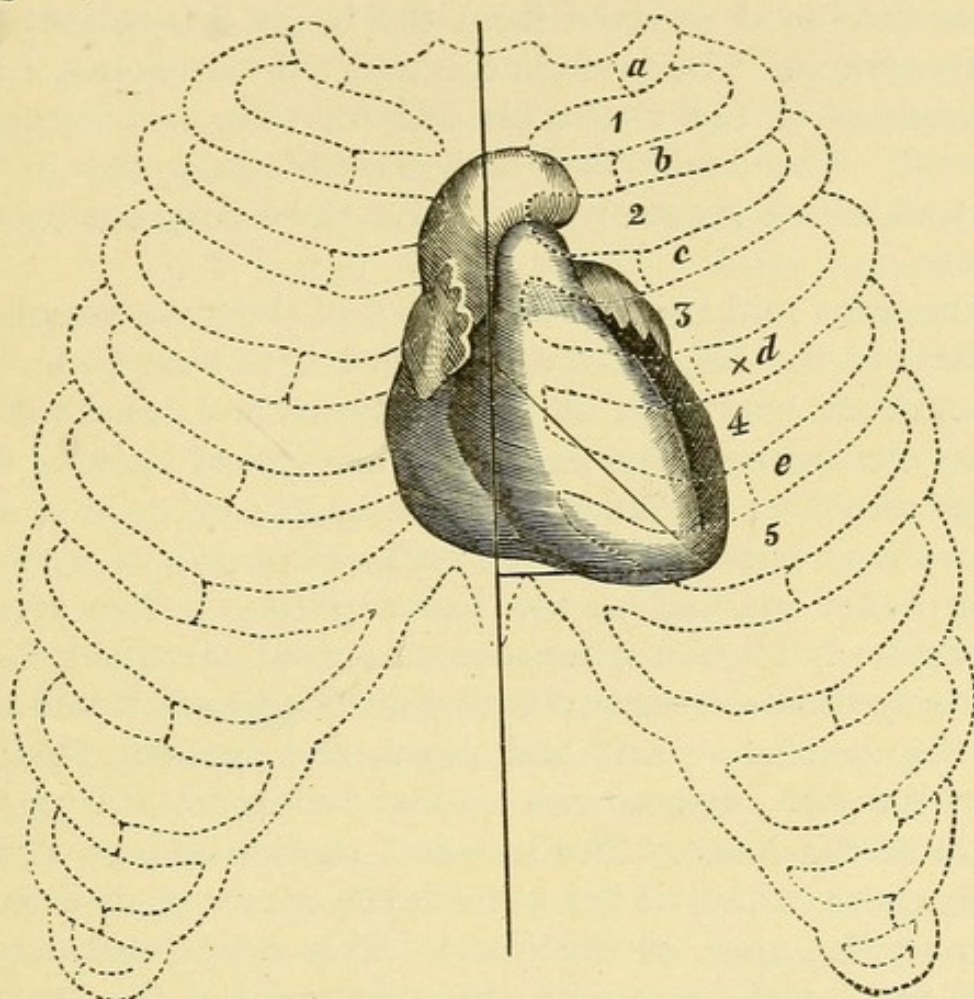
FIG. 20.—Heart and ribs. *a, b, c, d, e,* ribs; 1. 2. 3, 4, 5, intercostal spaces; *x*, position of nipple (fourth rib).

The heart contains four cavities or chambers—two auricles and two ventricles; the auricles are above and the ventricles are below, or, the heart may be divided into a right and left side, each having an auricle and a ventricle. The ventricles do not connect with each other, nor do the auricles, but an auricle connects with the ventricle of the corresponding side. The openings between these cavities are guarded by the auriculo-ventricular valves, and they are so arranged that the blood may pass from the auricles to the ventricles; but it can not in the normal condition return. If this were possible, the circu-

3

lation of blood would be constantly interfered with. The
ventricles are larger than the auricles and their walls are
stronger, particularly the walls of the left ventricle, which
drives the blood received from the lungs throughout the
entire system. The auricles contract simultaneously; the
contraction of the ventricles follows after a very short
interval. This double action represents a pulsation of the
heart, of which there are from sixty to eighty during the
minute.

The heart and also the beginning of the great vessels at
the base of the heart are surrounded by a closed sac (the
pericardium) composed of fibrous tissue and lined with a
serous membrane. The inner wall or visceral layer of this
serous structure is adherent to the heart; between it and
the outer or parietal layer exists more or less of a space,
being better marked at the lower portion. The serous
membrane lining the space secretes a fluid, of which there
is usually about one or two teaspoonfuls present, thus keep-
ing the membrane soft and moist, and limiting friction
when the two surfaces rub against each other during the
action of the heart. The broadest portion or base of the
pericardium, which is the outer layer, corresponds in situ-
ation to the apex of the heart. This arrangement pre-
vents any interference with the movement of the apex of
the heart, which would ensue if the apex or smaller por-
tion of the pericardium were below. The base of the peri-
cardium is attached to a portion of the upper surface of
the diaphragm or " midriff."

The circulation of the blood in the system is effected
in the following manner: The venous blood throughout
the body is collected by two large veins—the superior
and inferior vena cava; the superior vena cava receiving
the blood from the head, upper extremities, and parts
above the diaphragm, while the inferior vena cava collects
the venous blood from those parts below the diaphragm.
These vessels are connected with and discharge their con-
tents into the right auricle, which then contracts, and the

blood is forced into the right ventricle through the right auriculo-ventricular opening. The contraction of the ventricle which follows, closes the valves guarding this opening; the blood, being then unable to return to the auricle, is forced out of the ventricle into the pulmonary artery, a large blood-vessel connected with the right ventricle; valves also guard the opening into this vessel. The pulmonary artery divides into two branches, carrying the blood to each lung; after reaching these organs, the branches of the artery grow smaller and exceedingly numerous, and at last they become minute vessels known as capillaries, which surround the air-vesicles of the lungs. The venous blood has now been carried from the heart to the lungs, and it is at this point that the blood in the capillaries surrounding the air-vesicles frees itself of carbonic acid and some other impurities, and receives in return oxygen from the air contained in the vesicles. The blood is now changed in character: the color, instead of being blue or venous, is now red or arterial, and thus enriched and purified, and in the condition to nourish the tissues, is carried from the lungs to the left auricle of the heart by four large blood-vessels, the pulmonary veins. These vessels are continuous with the pulmonary artery through the medium of the capillaries which surround the air-vesicles, and have been already referred to. The left auricle, after receiving the blood from the pulmonary veins, contracts and its contents pass into the left ventricle, which, being filled, immediately contracts and forces the blood into the aorta and closes the left auriculo-ventricular valve, thus preventing the return of the blood to the auricle. The opening from the ventricle into the aorta is also guarded by valves which bar the return of the blood to the ventricles. The aorta begins at the left ventricle, is the main artery of the body, and through it passes the arterial blood into the smaller arteries and capillaries throughout the system. In these latter vessels the nutrition contained in the blood is given direct to the

tissues, and the blood receives in exchange the waste elements which are to be discharged from the body. After performing this function, the blood passes from the capillaries into the veins, the latter discharging their contents into the right auricle through the superior and inferior vena cava, as already described ; the blood has then made the circuit of the body, or, in other words, the circulation is completed.

The heart is endowed with enormous power. The strength developed in twenty-four hours would raise a ton-weight about one hundred and twenty-five feet from the ground.

A very smooth and delicate serous membrane (the endocardium) lines the heart, and is continuous throughout the vascular system, forming the internal coat or lining of the arteries and veins, and is the only coat of the capillaries.

THE BLOOD-VESSELS.

The *blood-vessels*, by which the blood is carried throughout the system in response to the contraction of the heart, are divided into *arteries*, *capillaries*, and *veins*.

Arteries.—Arteries are the vessels that carry blood *from* the heart. The aorta (the largest artery in the body), which is the beginning of the arterial system, is connected with the left ventricle, the contents of which pass through the aorta into the smaller arteries, and thence into the system.

The walls of arteries are composed of three coats or layers, the external, the middle, and the internal. The external coat consists of white fibrous tissue, which is very strong and tough, and protects the vessel. The resistance of the fibrous coat is well illustrated in the phenomena that follow the ligation, or tying, of an artery. The ligature, which is passed around the vessel and tightly drawn together and tied, severs the middle and internal but not the external coat. The middle coat is composed of mus-

cular and yellow elastic tissues, which assist in propelling the blood throughout the system, and regulating its supply to the different parts of the body. The yellow elastic tissue is the principal cause of the greater thickness of the walls of the arteries compared with veins; it also accounts for the elasticity which is characteristic of arteries, and the fact that arteries remain open when empty. The latter condition gave rise, years ago, to the belief that these vessels contained air, and they were accordingly named arteries, or "air-carriers."

Arteries pulsate, and, when opened, the blood escapes in spurts or jets, the color being scarlet.

Capillaries.—When arteries become very small and lose their external and middle layers, they consist of but one coat, and are known as capillaries. These vessels are often so minute that the red blood-corpuscles, in order to pass through them, are obliged to "double up" and pass through one by one. The thinness of the capillary walls, and the slow and uniform current of blood in these ves-
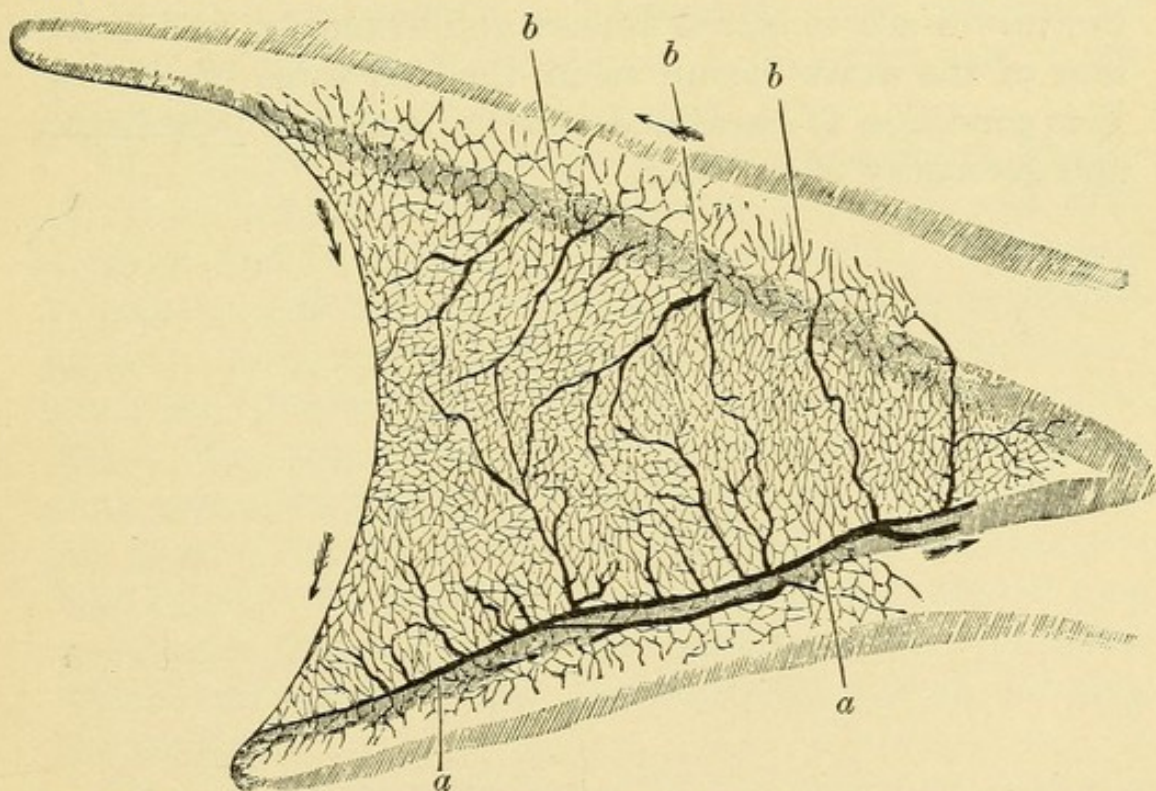
Fig. 21.—Web of frog's foot, magnified. *a, a,* veins; *b, b,* arteries, with capillaries between them.

sels, enable them, as has already been described, to give
direct to the tissues the elements of nutrition which they
contain, and receive in exchange the waste of the body
(Fig. 21).

Veins.—Veins carry blood *toward* the heart. These
vessels, like arteries, are composed of three coats, the ex-
ternal and internal being similar to arteries. The middle
coat, however, contains but very little yellow elastic tis-
sue, which accounts for the comparative thinness of the
walls of veins, and also the fact that they collapse when
empty.

Veins, with the exception of those in the cranial, tho-
racic, and abdominal cavities, are supplied with valves,
which are formed by a duplication of the internal coat,
and allow the blood to flow in but one direction—toward
the heart. This is essential, as the current of blood in
veins is mainly upward, toward the heart and against the
force of gravity; and also as the pressure of blood in the
veins is only about one fourth that of arteries. Sometimes
the valves are rendered useless, and distention and distor-
tion of the vessel occur, as in varicose veins of the leg.
This condition is associated with more or less prominence
and deformity of the vein.

CHAPTER IV.

RESPIRATORY APPARATUS AND RESPIRATION.

RESPIRATION is the function which provides for the proper entrance of oxygen into the blood, and the exit from the blood of carbonic acid and certain waste matter. The respiratory apparatus for the transmission of air to the lungs includes the following structures : the mouth and nose, larynx, trachea, bronchial tubes, and air vesicles or cells, the lungs being chiefly composed of the latter. An examination of the throat will show two openings, the back or posterior one being the upper part of the œsophagus or "gullet"; in front of this, and just behind and below the base of the tongue, is the upper part of the windpipe, known as the larynx (Fig. 22).

The *larynx* is a cartilaginous box, containing fibrous bands, stretching from before backward, two on each side, superior and inferior, and called vocal cords. The upper or superior pair have no special function that is at present known. The lower or inferior cords are extremely important; the vibration of these during expiration produces the voice. The larynx may be easily located; externally the prominence known as the "Adam's apple" forms the upper portion, the lower border being about one inch and a half below. The opening into the larynx is covered by a leaf-shaped piece of cartilage, known as the epiglottis, which prevents food and other substances from entering the windpipe.

The *trachea* or "wind-pipe" is the continuation downward from the larynx of a tube about four or five inches
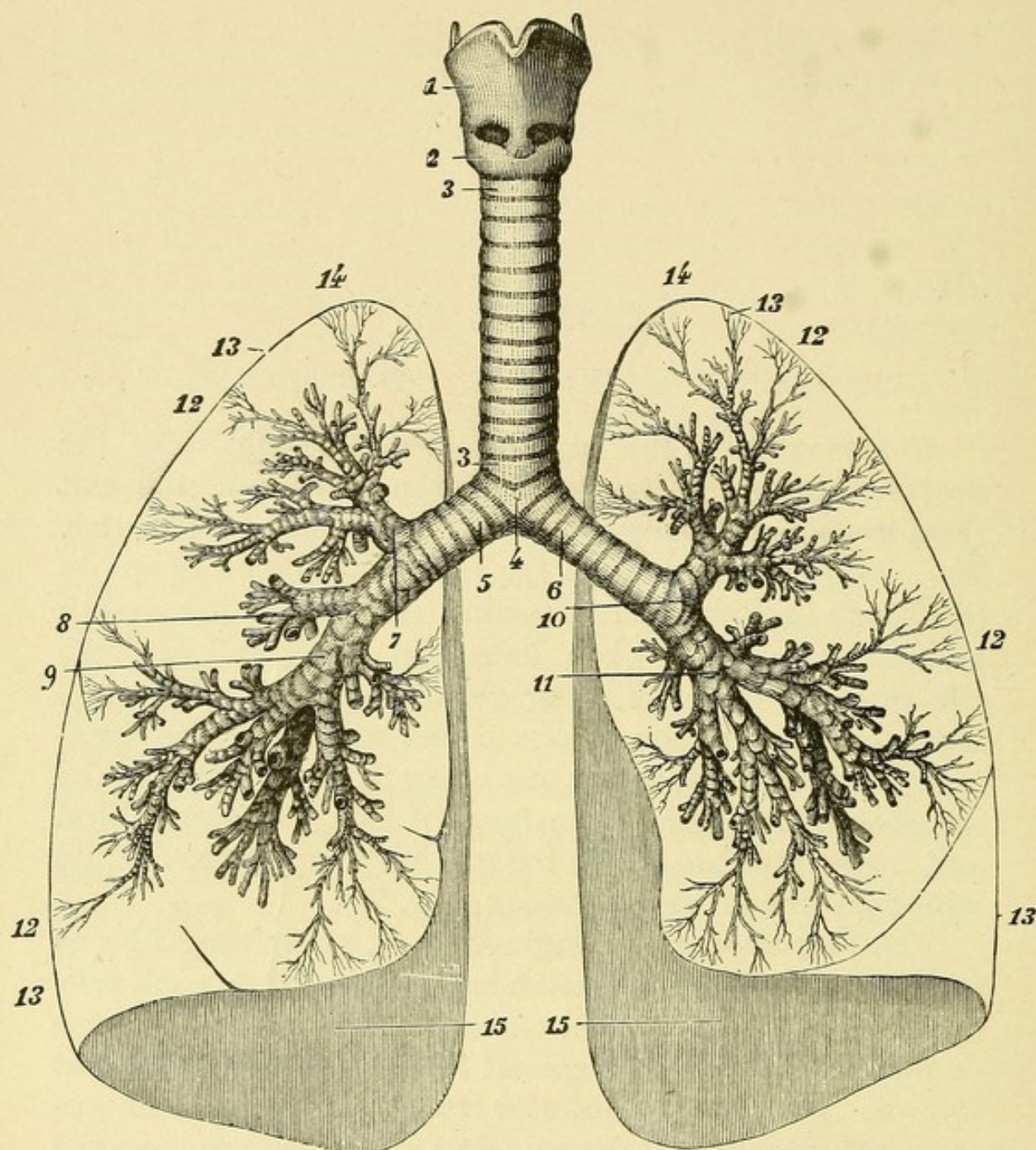
FIG. 22.—Trachea and bronchial tubes (Sappey). 1, 2, larynx; 3, 3, trachea; 4, bifurcation of the trachea; 5, right bronchus; 6, left bronchus; 7, bronchial division to the upper lobe of the right lung; 8, division to the middle lobe; 9, division to the lower lobe; 10, division to the upper lobe of the left lung; 11, division to the lower lobe; 12, 12, 12, 12, ultimate ramifications of the bronchi; 13, 13, 13, 13, lungs, represented in contour; 14, 14, summit of the lungs; 15, 15, base of the lungs.

long and three quarters of an inch in diameter, composed of cartilaginous rings, fibrous membrane, and a small amount of muscular tissue. These rings have the same use as the

cartilage forming the larynx—to keep their respective walls separated at all times. The trachea begins opposite the fifth cervical and ends at the third dorsal vertebra, where it divides into two branches, the right and left bronchus. These tubes after entering the lungs divide into a great number of branches, or bronchial tubes, which further divide and subdivide until they become exceedingly minute and end in little pouches known as air-cells or vesicles, which are very small and numerous and will be again referred to in describing the lungs. The respiratory tract is lined throughout by a mucous membrane, which is kept moist and prevents friction during the passage of the air through the tube. Its construction is peculiar,
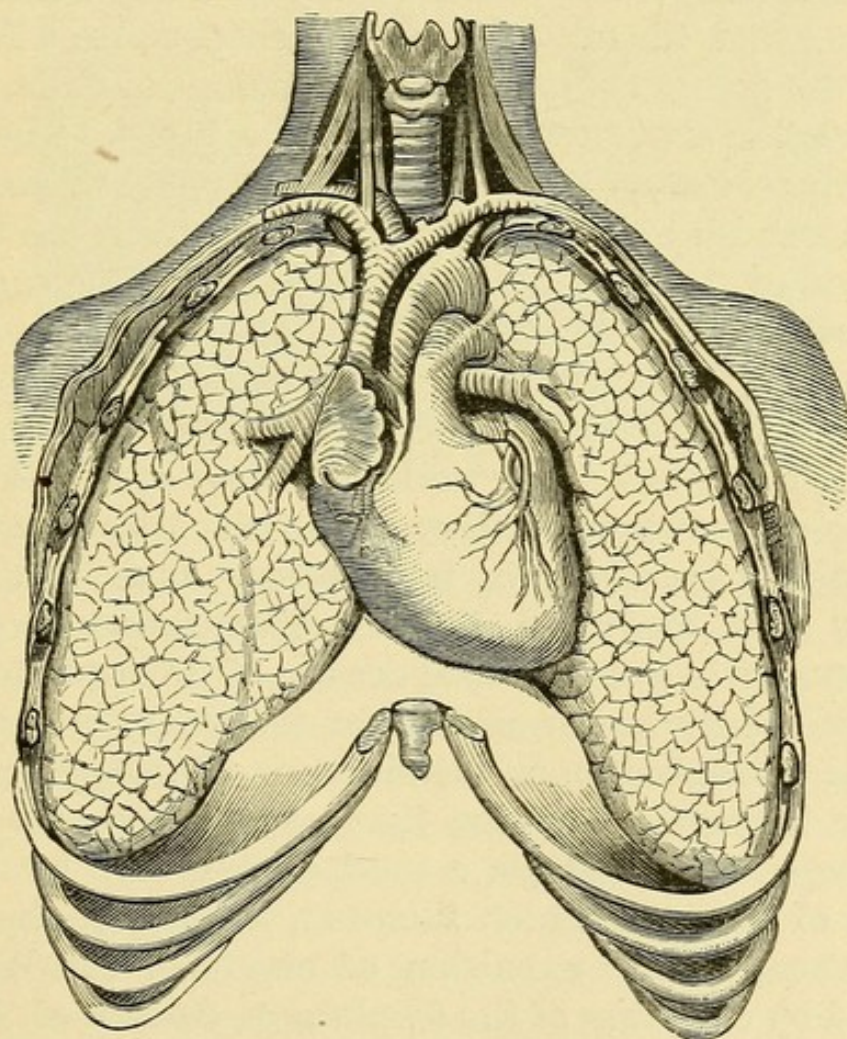
Fig. 23.—Showing the relative position of heart and lungs in the cavity of the chest.

having little hair-like processes which are constantly waving toward the outer world, assisting in preventing the entrance into the lungs of dust and irritating particles.

The *lungs* (Figs. 22 and 23) are two pyramidal or cone-shaped organs, longer in the back than in the front, situated in the chest, each weighing about twenty ounces, the right one being a little heavier than the left. They are divided by deep fissures into lobes, the right lung having three and the left two lobes. The small or upper portion or apex, extends to or just above the clavicle or collar-bone; the larger or lower portion or base, descends in front to about the sixth rib, on the side to the eighth, and in the back to the tenth. Each lung is covered by a closed sac called the *pleura*, one of its layers being adherent to the lung and the other lining the chest-walls. The cavity of the pleura contains a small amount of fluid, to prevent friction during the action of the lungs. The lungs are composed of millions of air-cells or pouches, about one two-hundredth of an inch in diameter, which are the termination of the bronchial tubes (Fig. 24). The enormous space represented by the air-cells would, if spread out, cover an area of about six hundred square feet. This will give some idea of the vast surface exposed to the air passing into the lungs. The walls of the air-cells and of the capillaries surrounding them are so very thin that the interchange of gases readily takes place. It is here, as has already been explained, that the purification or change from venous to arterial blood occurs. The respiratory act, of which there are from sixteen to twenty per minute, consists of inspiration and expiration. During inspiration the air is carried into the lungs by the descent of the diaphragm, which exerts a suction-force, and by the elevation of the ribs, which increases the size of the chest. Expiration, or the expulsion of air from the lungs, is effected by elevation of the diaphragm, descent of the ribs, and a partial collapse of the lungs. Although these are the principal agents of inspiration and expiration, there
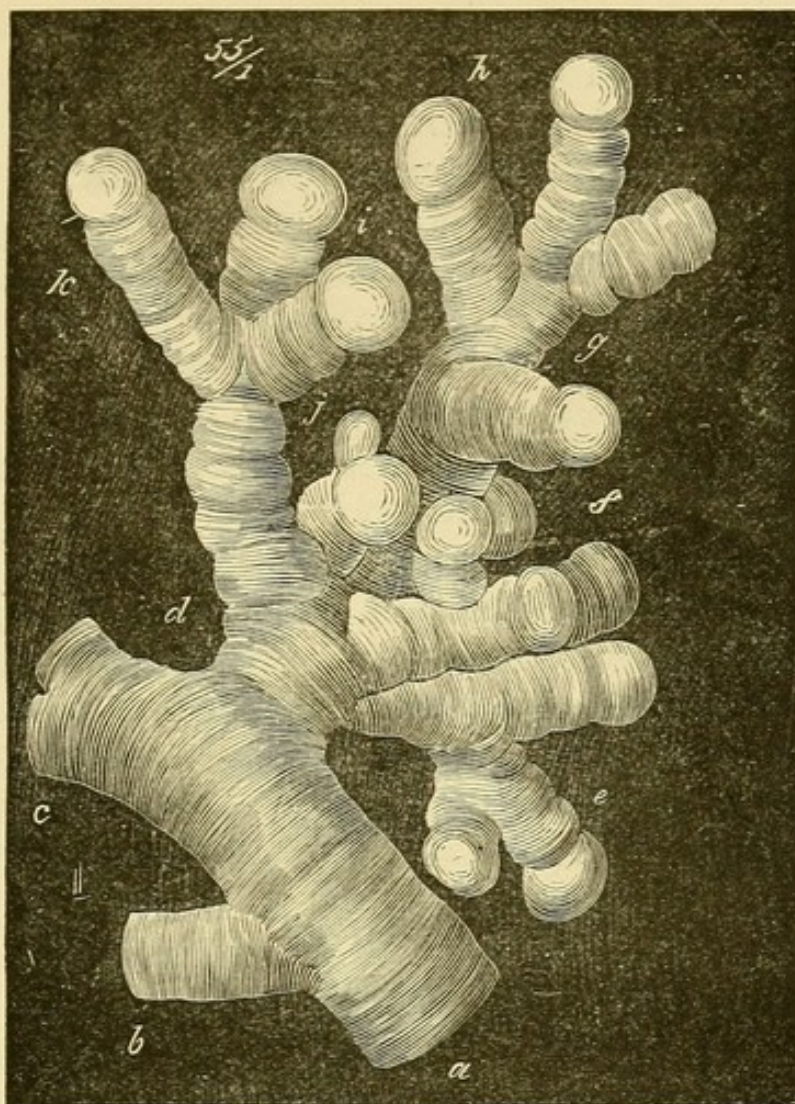
FIG. 24.—Terminal bronchial tubes ending in air-cells.

are other elements, notably the assistance of certain muscles, which, although of lesser importance, aid this function; and, when there is difficulty in breathing, as in some diseases of the lungs, the action of the auxiliary muscles about the neck and shoulders becomes very apparent.

The lungs during life are never entirely collapsed, this being prevented by about one hundred cubic inches of air which can not be expelled, and is called "residual air." Another hundred cubic inches of air, known as "reserve air," usually remains in the lungs after expiration, and is used by these organs during any increased physical exertion, as in running, etc., which requires an extra amount of air.

The "tidal air" represents the amount of air taken into the lungs at each ordinary inspiration, and consists of twenty cubic inches. During violent exercise, however, an additional one hundred and ten cubic inches is taken into the lungs at each inspiration, and is known as "complemental air." The extreme capacity of the lungs would, consequently, be the sum of the residual (100), reserve (100), tidal (20), and complemental (110) volumes of air, amounting to three hundred and thirty cubic inches.

The air which we breathe is composed of two gases— oxygen (21 parts) and nitrogen (79 parts). There are also, in varying quantities, vapors, traces of ammonia, etc., the amount depending on location. It is the addition of poisonous elements to the air, as in large cities, or where bad sanitary conditions exist, that furnish the causes of certain diseases.

CHAPTER V.

ALIMENTATION AND DIGESTION.

The alimentary tract or canal comprises the several structures or organs through which food and drink pass to be properly digested and absorbed. That portion of the food or material which is not needed for nutrition, or can not be acted upon by the different secretions, is discharged from the body. The alimentary canal, which is about thirty feet long, begins at the mouth; then follows the pharynx or "throat;" below it is the œsophagus or "gullet," then the stomach, then the small and large intestine, the canal terminating at the lower end of the latter, at the external opening called the anus, the "fundament," or "body."

These structures will be spoken of separately in their order from above downward. Other organs upon which the function of digestion is dependent, and which are connected with and discharge their secretions into the alimentary tract, will be described in their proper connection.

Mastication is the first step in digestion. This takes place in the mouth, and is performed by the teeth, which are so fashioned and arranged that the food may be cut, torn, and ground, showing that man is adapted to all kinds of food. In animals, such as the cow, that secure their food principally by grazing, the molars or "grinders" are particularly well developed, while in dogs and animals that depend principally upon meat for sustenance, the sharp or tusk-like teeth called canines are very prominent, and enable them to tear the meat from the bone. The teeth are inserted in the superior and inferior maxil-

læ, or upper and lower "jaw-bones," along their edge, or alveolar process. There are thirty-two teeth in all—sixteen in each jaw—and arranged in the manner shown in the diagram (Fig. 25). That portion of a tooth projecting beyond the gums is called the crown ; the root is imbedded in the bone. The crown is covered with enamel, the hardest structure in the body, which protects the teeth and prevents them from wearing out as the result of the friction during mastication. The enamel is also protected by a wonderfully thin membrane, which is very easily dissolved and removed, and very readily reformed, provided the acid or agent which disorganizes it is

FIG. 25.—The jaws and the teeth. 1, 2, incisors ; 3, canines ; 4, 5, bicuspids ; 6, 7, 8, molars ; *a*, vein ; *b*, artery ; *c*, nerve ; *d*, vein, artery, and nerve.

not too constantly present.   A familiar example of the rapid removal of this membrane is when lemon-juice is taken in the mouth.   The teeth are then said to be "on edge." The teeth cut up and grind the food so that all parts of it may be exposed to the different digestive secretions.   Improper mastication, or an absence of teeth, will be followed by imperfect digestion.   As mastication progresses, the

food is made soft and wet by an alkaline secretion known as saliva or "spittle," which is secreted by three salivary glands—*parotid*, *submaxillary*, and *sublingual*. These open by small ducts into the mouth (Fig. 26). The parotid is the largest one, and is situated behind the angle of the jaw. The characteristic deformity in the disease known as "mumps" is the enlargement of this gland. The secretion of the parotid is used mainly to moisten the food, while that of the submaxillary and sublingual is more viscid or
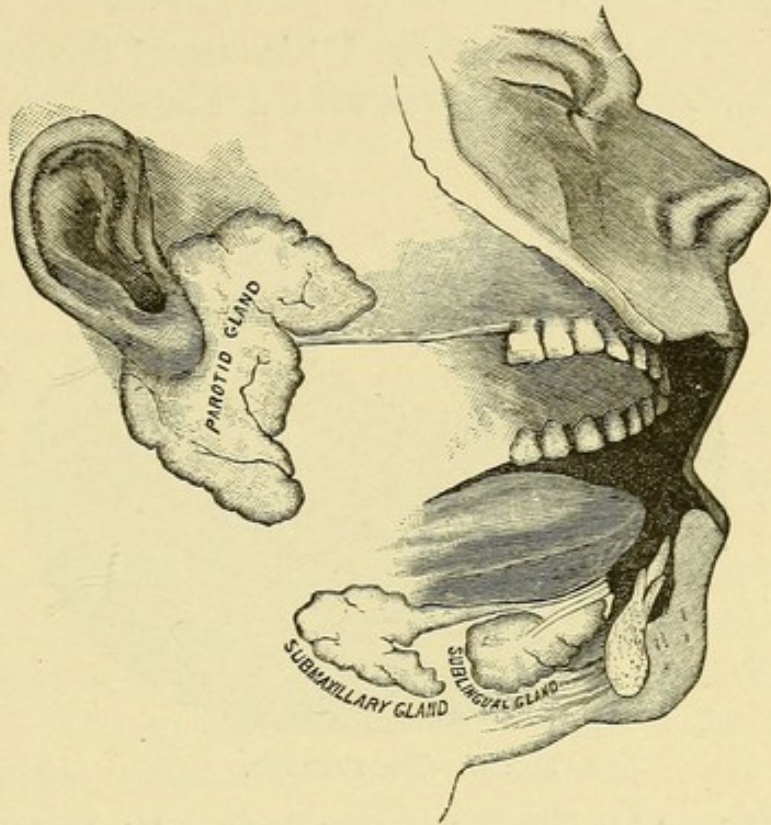
FIG. 26.—Salivary glands (Tracy).

slippery, coating and allowing it to pass down the œsophagus to the stomach with great ease. In reptiles, where there is no mastication, it is this slimy secretion that enables them to swallow substances of very large bulk. Saliva also acts chemically on food and changes the starchy matter into sugar. During mastication the cheeks, lips, and tongue keep the food between the teeth.

The *pharynx*, or throat, is the continuation of the mouth, and has no special digestive action while the food is in this portion of the tract.

The *œsophagus*, or gullet, the next portion, is a muscular tube about eight or nine inches long, and is collapsed when not in use. It begins at the lower border of the pharynx, opposite the fifth cervical vertebra, passes down-

ward through an opening in the diaphragm, and becomes continuous with the cardiac end of the stomach opposite the ninth dorsal vertebra. This tube by its muscular action accelerates the passage of food downward to the stomach.

The *stomach* (Fig. 27) is one of the principal organs of digestion. It appears to be a dilated portion of the alimentary canal. In shape it somewhat resembles a bag-pipe, having a greater and lesser curvature it lies crosswise in the abdominal cavity, and has two openings, one on the left side, which is continuous with the lower
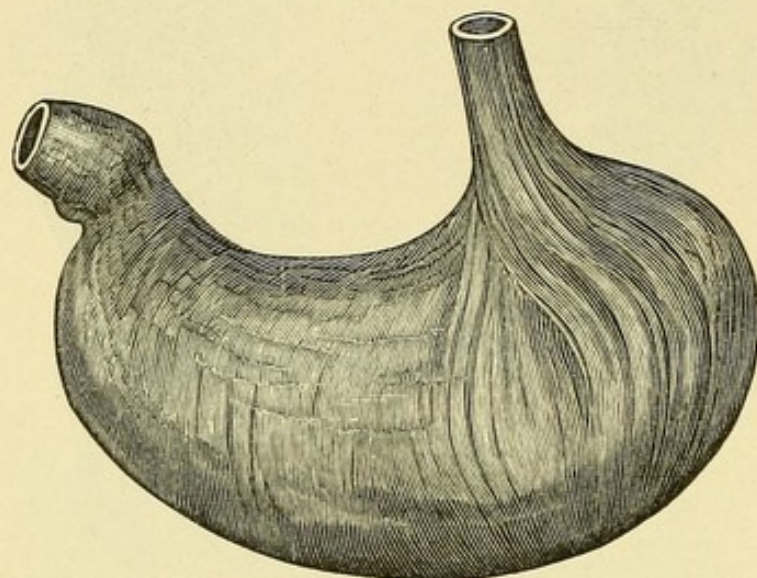
FIG. 27.—The stomach.

end of the œsophagus in the vicinity of the heart, and called the cardiac opening, the other or pyloric opening being on the right side ; this opening is the beginning of the small intestine, and is guarded by a valve-like constriction, the pylorus, or " gate-keeper."

The stomach is about fourteen inches long, five inches in diameter, and weighs four ounces ; its capacity being about five pints. It is composed of three coats or layers: the external, fibro-serous ; the middle, muscular ; and the internal, mucous. The external coat prevents friction during the movement of the stomach and also adds strength. The muscular portion produces the movements necessary for the proper digestion of the contents of the stomach. The internal coat or mucous membrane is the most important layer. In the substance of this membrane are found numerous little glands which open upon the surface of

the membrane. These peptic or gastric glands, secrete the gastric juice, which is so necessary to digestion. When foods begin to enter the stomach, the contents of these glands, which are considerable, appear on the surface of the membrane, the muscular coat becomes active, and the food is manipulated in such a manner that all portions of it shall be acted upon by the gastric juice. The food is then changed in character and made to assume a uniform mass, part of which in a fluid state is absorbed by the capillaries of the stomach, the remainder passes down to be digested and absorbed in the small intestine. The position and shape of the stomach change considerably, particularly during digestion, and consequently can not be well mapped out externally. However, the upper or cardiac end is about on a level with the seventh rib on the left side.

The stomach is collapsed when empty, but when full it lies immediately against the abdominal walls, and also presses upward, and may interfere with the action of the heart and lungs. The distress that often occurs after a full meal is often due to distention of the stomach.

The gastric juice is an acid secretion, differing from all of the other digestive fluids, which are alkaline. There is a large quantity secreted in twenty-four hours, probably about fourteen pints.

The *small intestine* (Fig. 28), the most important organ of digestion, is the next portion of the alimentary tract, and begins at the pyloric extremity of the stomach. It is a tube about sixteen feet long and one inch in diameter, and composed of the three coats arranged in the same manner as the coats of the stomach. It is divided into three portions: the first and shortest portion being called the duodenum, which is about eight inches long; this is followed by the second portion or jejunum; the last portion being known as the ileum. The jejunum is generally empty after death, and receives its name from this fact.

In the mucous membrane of this portion of the canal

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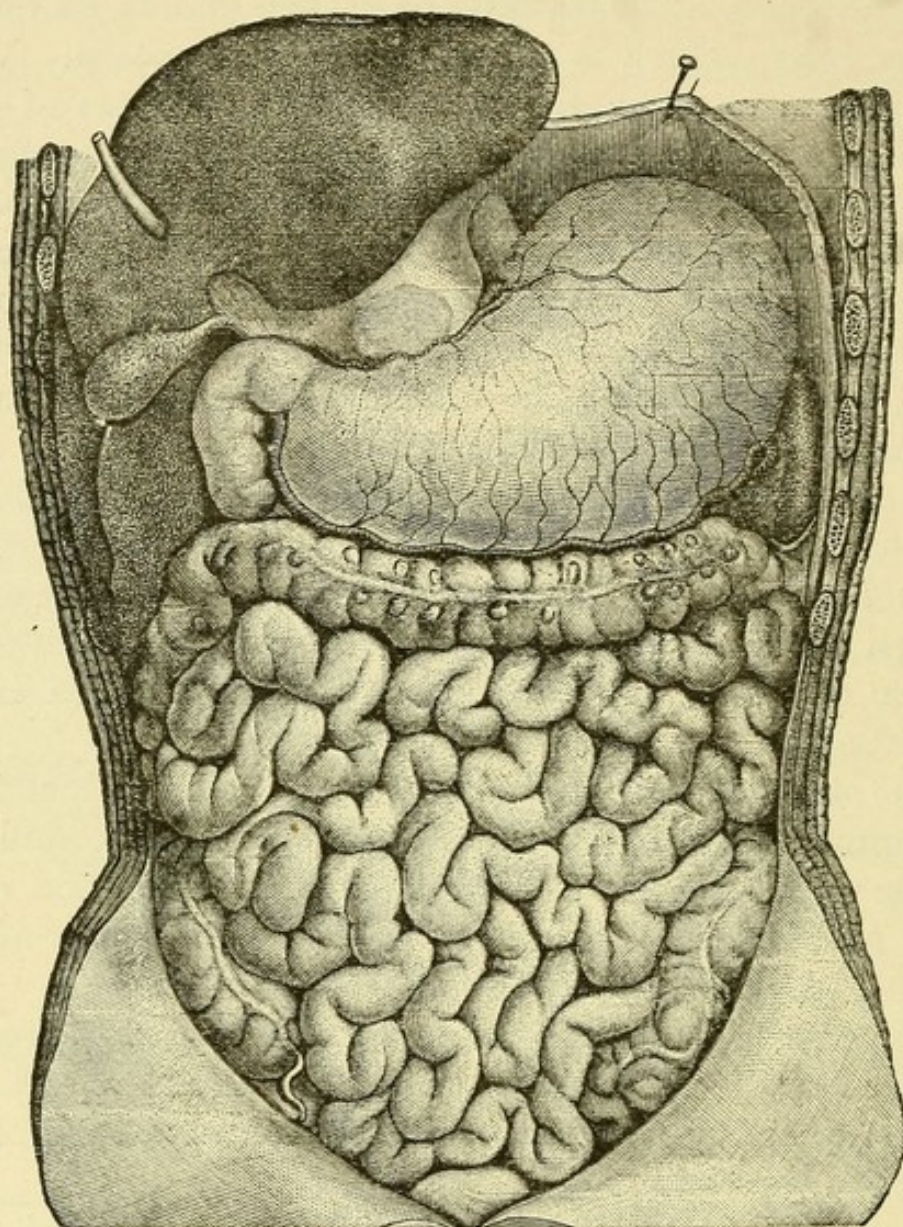
Fig. 28.—Position of abdominal contents.

are found glands yielding secretions which tend to dispose of certain articles of food incompletely digested, or unaffected by the secretion of the stomach.

The *large intestine* begins on the right side of the body, and is continuous with the ileum, or final portion of the small intestine, and, in its construction, is similar to that portion of the canal, although its diameter is considerably larger. It is divided into ascending, transverse, and descending colon, sigmoid flexture, and rectum, the latter terminating at the opening known as the anus. The

large intestine has very feeble if any digestive power, and is mainly a temporary receptacle for undigested and refuse matter which is to be discharged from the body. The transverse colon, which is about on a level with the umbilicus or "navel," is often the seat of intense pain known as "colic."

The *liver* (Fig. 29) is the largest organ in the body. It is situated in the abdominal cavity, below the diaphragm and above the stomach, principally on the right side, its long--
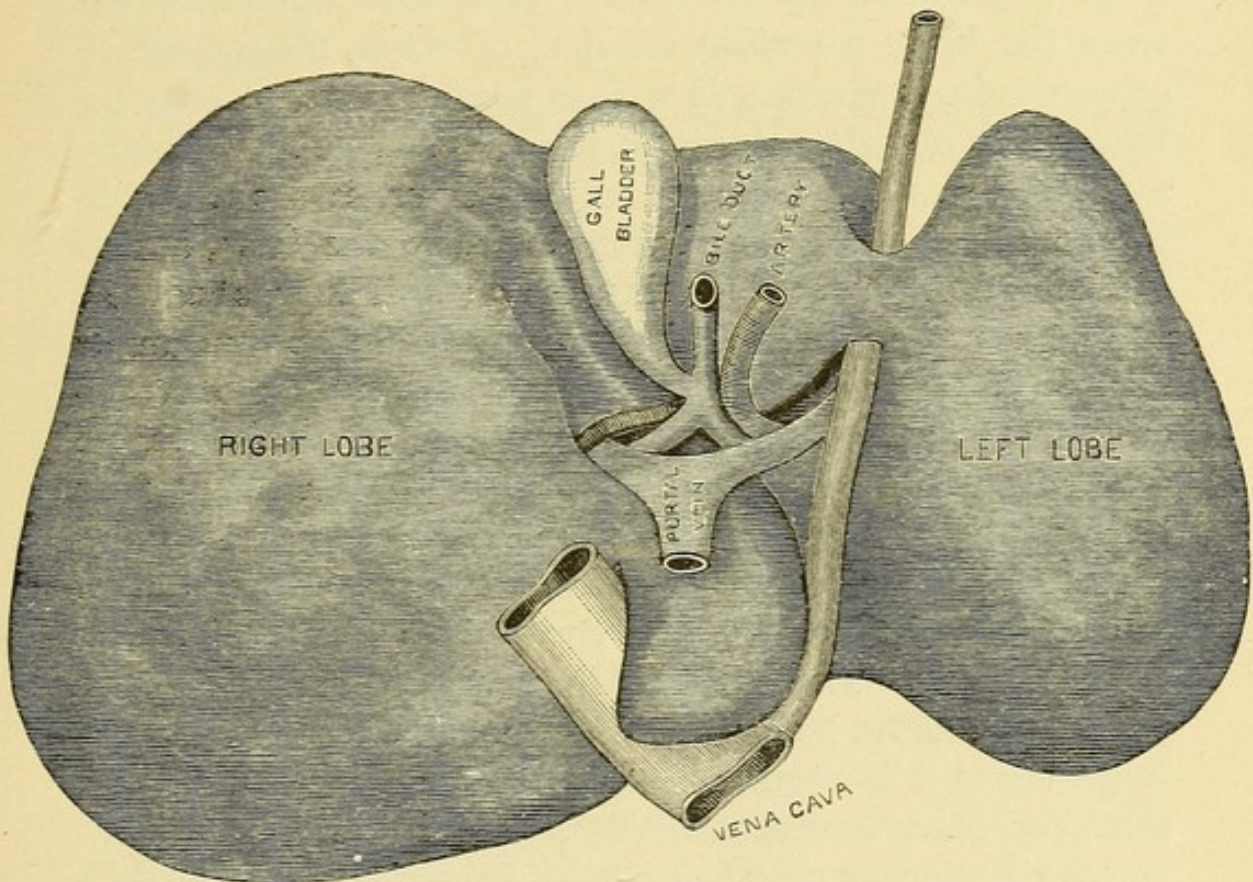
Fig. 29.—Under surface of the liver, showing the gall-bladder and a section of blood-vessels.

est diameter being from right to left. This organ weighs from four to five pounds, being about twelve inches long, six inches wide, and three inches at its thickest portion. The surfaces of the liver are smooth and the edges are rounded, and it is of a dark-brown color. In the normal or healthy condition the liver extends downward on the right side as far as the lower border of the ribs. However,

under certain conditions, as in tight lacing, it may be pressed below this point. Above and on the same side the liver extends to about one inch below the nipple. It also reaches to the left side of the median line of the body, to midway between the lower end of the breastbone and the "navel." The liver has three distinct and separate functions : First, it renders very important aid to digestion, through the action of the bile which it secretes. It also produces sugar, which becomes chemically changed and helps to generate the body-heat ; and, finally, it discharges from the body a certain amount of waste matter, or, in other words, it excretes as well as secretes, a peculiarity belonging to no other organ in the body. The bile, already referred to as the secretion of the liver, is a yellowish-brown alkaline fluid, and very bitter to the taste, and is discharged from the liver through a small tube, about the size of a goose-quill, which opens into the duodenum, or first portion of the small intestine; in this manner it reaches the food upon which it is to act. Connected with the under surface of the liver is a pouch or sac about four inches long and one inch in width, called the gall-bladder (Fig. 28). It is formed of fibrous tissue and lined with mucous membrane, which is continuous with that lining the bile-ducts. The gall-bladder acts as a reservoir where bile accumulates, being expelled during digestion, when a large amount is required. A certain amount of bile is, however, being continually discharged into the intestine.

The *pancreas* or "belly sweet-bread"* (Fig. 30) is a

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* There are three kinds of sweet-breads, viz.: the thyroid-gland, or throat sweet-bread, which is tough, almost like India-rubber ; the pancreas, or belly sweet-bread, which is more tender, and is quite commonly used ; and the thymus-gland, or breast sweet-bread, which exists only in young animals, wasting away as they grow up. The thymus-gland, situated just behind the upper portion of the breastbone, attains its greatest size in human beings at the age of two years, and disappears before the sixteenth year. Its use is not known. This gland, taken from calves and lambs, is the most tender and palatable sweet-bread of all. (Tracy.)

glandular organ situated at the upper and back part of the abdominal cavity, opposite the first lumbar vertebra, and
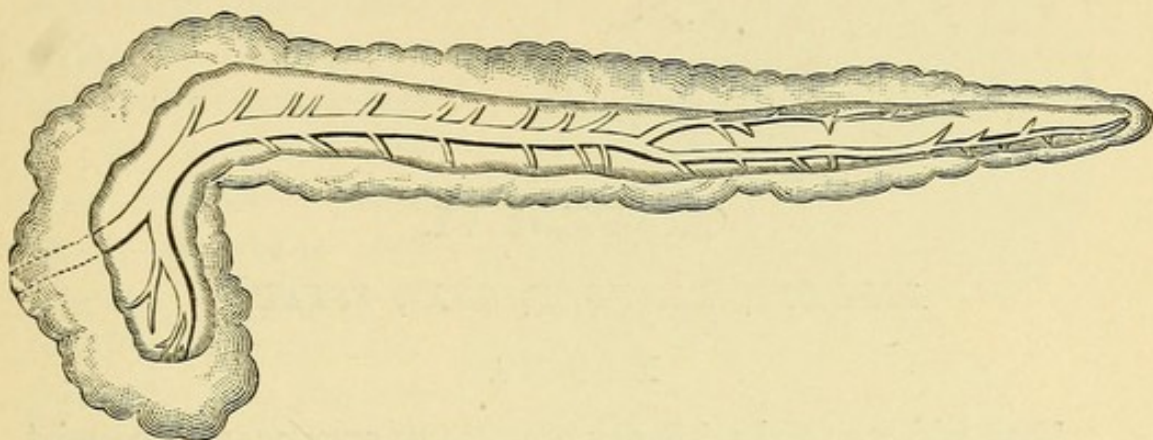
FIG. 30.—The pancreas, partly cut away, so as to show the duct which collects the pancreatic juice and empties it into the duodenum.

is mainly on the left side, and behind the stomach. The pancreas is about seven inches long and one inch in thickness, secretes an alkaline fluid, the pancreatic juice, and discharges it through a small duct which enters the duodenum at the same opening which receives the tube conducting the bile from the liver. One function of the pancreatic juice is to prepare the oil and fats of the food for absorption by the process known as emulsification. As the result of this transformation the oils and fats are converted into chyle, a fluid resembling milk in appearance, which is absorbed by lymphatic vessels along the intestinal tract, and named lacteals or milk-carriers, on account of their white appearance when filled with chyle. This fluid is carried by the lymphatic vessels to the receptaculum chyli, a pouch situated in front of the body of the second lumbar vertebra, and thence, by means of the thoracic duct, to a large vein on the left upper side of the chest, through which it reaches the circulation, and forms a very important element of nutrition. The pancreatic juice also assists the other digestive secretions in their function.

CHAPTER VI.

KIDNEYS, BLADDER, SKIN, SPLEEN.

KIDNEYS.

THE *kidneys* (Fig. 31) are excretory organs, and consist of two large tubular glands situated in the back part of the abdominal cavity in the lumbar region on each side of the spinal column. They extend from the eleventh rib downward nearly to the upper borders of the pelvis or "haunch-bones." The right kidney is a little lower than the left. They are bean-shaped, about four inches in length and two in width, and each weighing about four to six ounces. It will be remembered that the excretory organs simply abstract from the blood elements of waste tissue, and discharge the same from the body. They do not in any manner change this waste material, but act simply as an outlet for it. The material excreted by the kidneys is known as the urine, and consists of water holding in solution waste and poisonous matter, as urea, etc. The amount of urine removed by the kidneys in twenty-four hours is about three pints. It is an acid fluid when first discharged, but rapidly becomes alkaline as the result of decomposition. The ureters are two small tubes (one from each kidney) about the size of a goose-quill, and sixteen or eighteen inches long, which conduct the urine from the kidneys to the bladder, entering that organ at its lower portion. Oftentimes, small concretions, varying in size from grains of sand to those of larger diameter, called renal calculi, familiarly known as "gravel," are formed in the kidneys, and during the passage of these little bodies through the

ureters on the way to the bladder, the larger ones may cause such irritation and press- ure along these tubes as to produce the most intense pain. This condition has received the name of renal or kidney colic. Sudden and intense pain on the side, along the course of the ureter involved, would be the princi- pal symptom. The sudden beginning of the pain would de- note the entrance of one or more of the little bodies into the ureter, and the abrupt ending of the pain in- dicate that they had entered the bladder.

FIG. 31.—Vertical section of a kidney, showing the minute tubes which excrete the urine; also the pelvis, or basin of the kidney, which receives the urine before it passes downward to the bladder. The beginning of a ureter is also shown.

THE BLADDER.

The *bladder*, or reservoir which re- ceives the urine, is a sac having three coats or layers ar- ranged in a manner similar to that of the layers of the stomach and intestine—fibro-serous externally, muscular tissue forming the middle coat, and the internal being com- posed of mucous membrane. When moderately distend- ed the bladder is about five by three inches and contains about one pint ; however, it may hold considerably more. When a sufficient amount of urine has accumulated, it is

discharged from the bladder, mainly by the contraction of its muscular walls ; this act, which is voluntary, usually occurs four or five times during the twenty-four hours. The bladder is situated in the lower part of the pelvic cavity, just behind the pubic bone.

SKIN (INTEGUMENT).

This structure, which covers all portions of the body and protects the deeper parts, is an organ of excretion and absorption, and also of the sense of touch, the latter function being highly developed at the finger-ends. The skin is composed of two layers, the outer and inner ; the former being called the epidermis, cuticle, scarf, or false skin, and the latter receiving the name of derma corium, or true skin (Fig. 32). The epidermis contains no blood - vessels nor nerves, and is simply a scaly layer
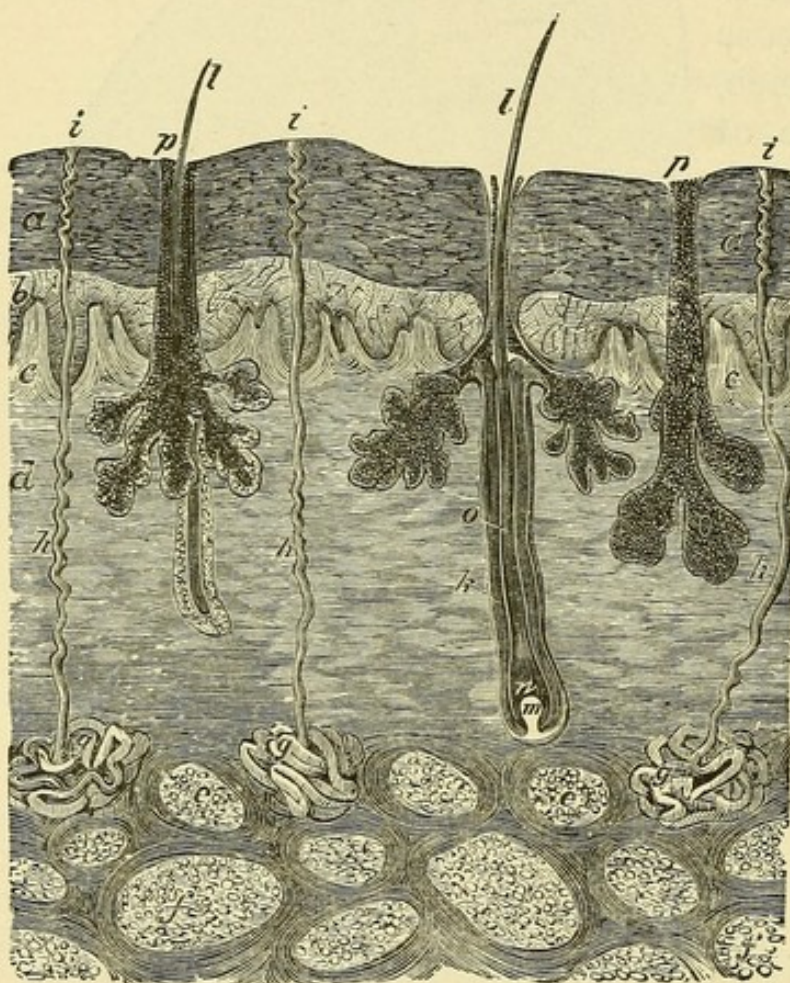
FIG. 32.—Vertical section of the skin, magnified. *a*, Scarf-skin ; *b*, pigment-cells ; *c*, papillæ ; *d*, true skin ; *e*, *f*, fat-cells ; *g*, sweat-glands ; *h*, outlets of sweat-glands ; *i*, their openings on the surface of the skin ; *k*, hair-follicle ; *l*, hairs projecting from the skin ; *m*, hair-papilla ; *n*, hair-bulb ; *o*, root of hair ; *p*, openings of oil-glands.

which protects the true skin underneath, and becomes easi-

ly detached from it under certain conditions.   A blister
shows the separation of the two layers of skin, with a
small amount of fluid between them.   The derma or true
skin is richly supplied with blood-vessels, nerves, and lym-
phatics, and in this layer reside the functions above alluded
to.   The skin contains millions of minute tubes known as
sudoriferous or "sweat" glands ; also the sebaceous or fat
glands, and hair-follicles.   The sweat-glands, by constantly
removing from the body a watery vapor known as per-
spiration or " sweat," in which they are aided by evapora-
tion, help to regulate the body temperature.   It is the
wonderful activity of these organs, and the large quan-
tity of perspiration thrown off, that enables one to endure
a very high degree of heat.   In addition to the action just
described, they have the important function of eliminating
from the system waste material similar to that excreted
by the kidneys (urea) ; for this reason the skin, through
the sweat-glands, is regarded somewhat as a supplement-
ary organ to the kidneys.   In warm weather, when the
skin is most active, the amount of perspiration is largely
increased and the amount of urine correspondingly dimin-
ished, while in winter the condition is reversed.   An aver-
age amount of perspiration formed in twenty-four hours
is about two pints.   It is very important that the similarity
in action of the skin and kidneys should be recognized, and
that the one may be induced to relieve the other, for, when
the kidneys are impaired, either temporarily or permanent-
ly, much relief may be obtained by stimulating the skin.

The importance of keeping the skin in a healthy con-
dition by proper clothing, exercise, and bathing, can not be
overestimated.   The product of the fat or sebaceous glands
protects the skin, and keeps it more or less oily and pliable.

With few exceptions the hair-follicles are found in all
portions of the body ; in some parts, however, the hair is
so fine as to be hardly noticeable.   The hairs, and also the
nails, are regarded as appendages of the skin, affording
additional protection.

SPLEEN.

The spleen is a soft and spongy organ, situated in the abdominal cavity, on the left side, near the cardiac end of the stomach, and extends from the ninth to the eleventh ribs. It measures about five inches long by three inches wide, and two inches thick, weighing about eight ounces. It is called a ductless gland, not having the characteristics of a secretory or an excretory organ. Its function has not yet been definitely settled.

CHAPTER VII.

NERVOUS SYSTEM.

THE activity of the mind and body, the correct working of the several organs, and the sympathy existing between the different parts of the organism, depend upon the nervous system, which is divided into the cerebro-spinal axis and the sympathetic system.

CEREBRO-SPINAL SYSTEM.—This system comprises the brain, spinal cord, and nerves (Fig. 34).
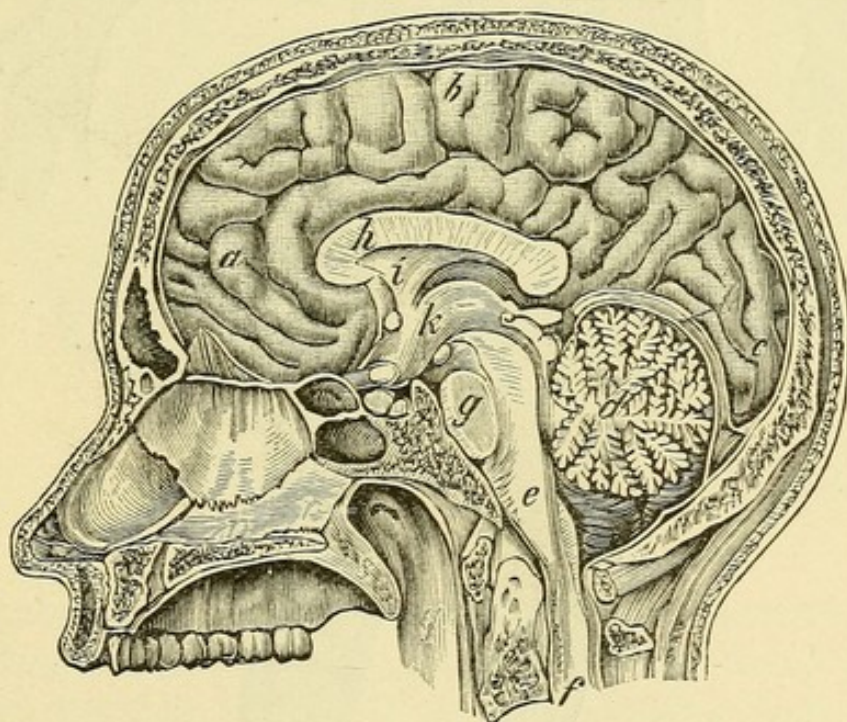
FIG. 33.—The brain inclosed in its membranes, and the skull : *a, b, c,* convolutions of the cerebrum ; *d,* the cerebellum ; *e,* medulla oblongata ; *f,* upper end of the spinal cord ; *g,* pons Varolii : *h, i, k,* central parts.

The *brain* (Fig. 35), which is the seat of the intellect, the will, and the emotions, is contained in the cranial cav-
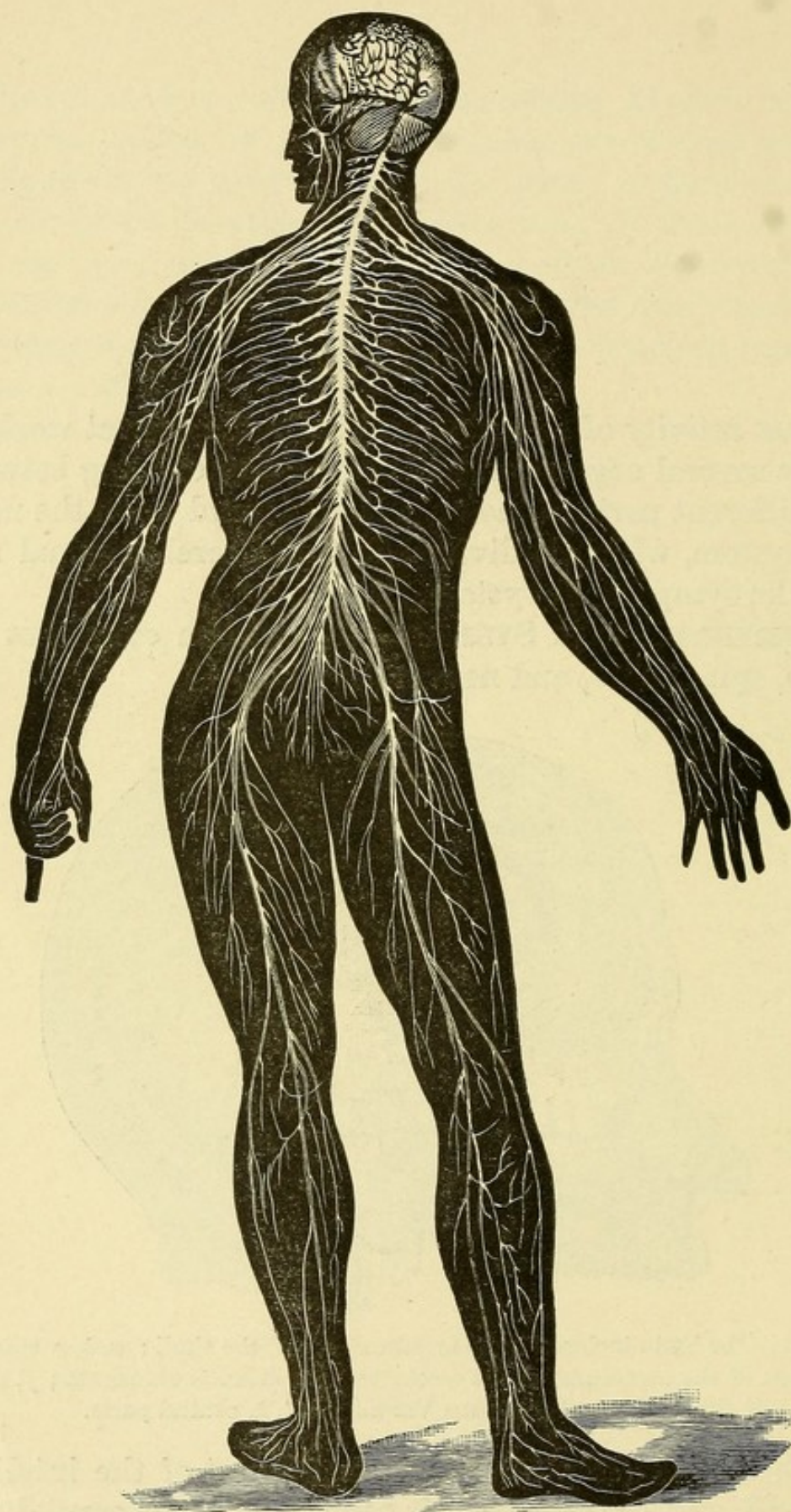
FIG. 34.—The cerebro-spinal system of nerves.

ity (Fig. 33). It is divided ino four principal parts, viz., the cerebrum, the cerebellum, the pons Varolii, and the medulla oblongata.
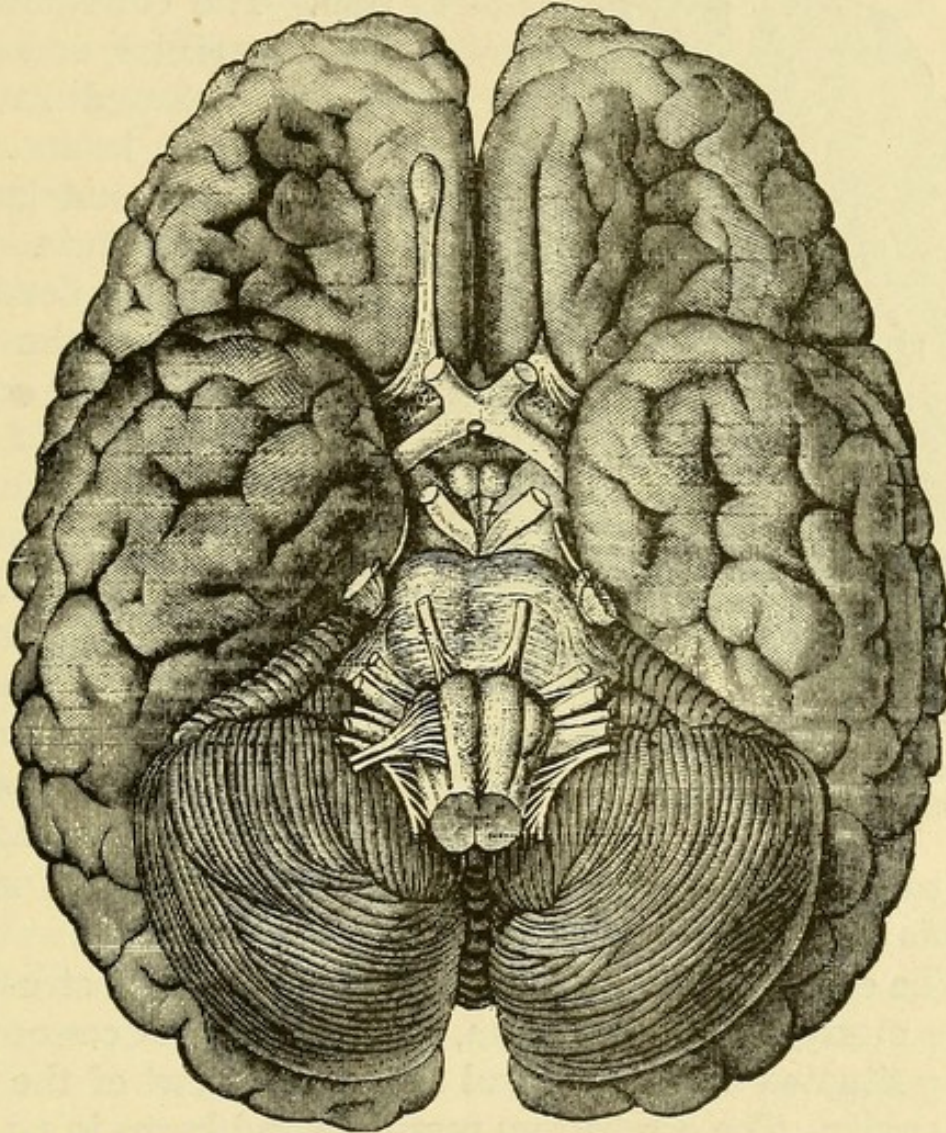
FIG. 35.—Under surface of brain, showing the cerebrum, cerebellum, pons Varolii, and medulla oblongata.

The cerebrum (Fig. 36) constitutes over four fifths of the entire brain. It is nearly globular in form, being divided into two portions by a deep groove, running from before backward, and occupies the upper and greater portion of the cranial cavity. It is composed of gray and white matter, about the consistence of "sweet-breads"; the white matter forms the internal and greater portion of the cerebrum, the gray matter forming the external layer. The surface

of the cerebrum is not smooth, but thrown into folds, called convolutions. This arrangement increases its area, and consequently its function. The convolutions are superficial and not so well marked in the brain of an infant, but grow deeper and larger until the brain has reached its full development, at about the fortieth year. The cerebrum is the seat of the mind and of its different functions which distinguish man from the lower animals. The exact point in the cerebrum where these functions are located may at some future time be definitely settled, considerable progress having already been made in this direction.

Fig. 36.—Upper surface of the cerebrum, showing the convolutions of the brain and its double structure.

The cerebellum, or little brain, corresponds in structure quite closely to the cerebrum, with which it is connected, being situated beneath it and at the back part of the cranial cavity. The cerebellum regulates and keeps in perfect harmony the different movements of the body. (Figs. 34 and 35.)

The pons Varolii, or "bridge," is a small portion of the brain, and situated in front of the cerebellum. It binds together the different parts of the brain already enumerated, and also transmits the different nerves passing between the brain and spinal cord.

The medulla oblongata is below the pons Varolii, and appears to be the upper end of the spinal cord somewhat expanded. In the substance of this organ the motor-nerve

fibers passing from the brain to the spinal cord cross each other or decussate ; consequently a motor-nerve fiber having its origin in the right side of the brain crosses to the left when it reaches the medulla oblongata, and becomes identified with the left side of the spinal cord, and furnishes motion to that side of the body. This will explain why an injury to one side of the brain will produce paralysis on the opposite side of the body, as in apoplexy. The medulla also presides over the function of respiration.

The human brain weighs about fifty ounces, being heavier than that of any of the lower animals, with the exception of the elephant and the whale. The brain of the elephant weighs about eight pounds, that of the whale somewhat less. The human brain probably reaches its highest development at about the fortieth year. After this period it gradually diminishes in weight, about one ounce in ten years, so that in old age both the size and function of the brain are considerably lessened.

The deep convolutions spoken of are characteristic of the human brain, being present in a lesser degree in the lower animals.

The *spinal cord* is that portion of the cerebro-spinal axis contained in the spinal or vertebral canal. It is cylindrical in shape, extending downward from the medulla oblongata to the first lumbar vertebra, being from fifteen to eighteen inches long, and is composed of gray and white matter, the white matter, however, being outside and consisting of nerve-fibers which act as conductors of sensory and motor influence. The motor fibers of the cord are found in the front and at the sides, and the sensory fibers in the back or posterior portion.

The spinal cord, through the medium of its branches, to be presently described, transmits nerve influence to and from the brain. It is, to a certain extent, capable of acting as a separate nerve-center and generating force independently of the brain.

Nerves are classified as those having a motor and sen-

sory influence, and nerves of special sense. Motor nerves
are fibers which conduct from the brain (and to a certain
extent, from the spinal cord) the necessary force to ani-
mate muscular fibers, thus producing the different move-
ments of the body; motor nerves therefore transmit an in-
fluence from within outward. Sensory nerves are fibers
which convey from different portions of the body certain
sensations to the brain. For instance, when a finger is
burned or injured, the sensation of pain experienced indi-
cates an impression made upon a sensory nerve at the
point of injury, and which is received at the great nerve-
center or brain. Nerves of special sense, as the name im-
plies, have separate functions. They do not transmit
motion or common sensation just described, but preside
over the special senses, as sight, hearing, taste, etc.

Cranial Nerves.—From the under surface or base of
the brain, on each side, are given off nine nerves, which
are known as the nine pairs of cranial nerves. They are
composed of white, glistening fibers, and are numbered
anatomically from before backward. These nerves are so
very important that a brief description of them will be
necessary.

The *first* pair, or olfactory nerves, supply the special
sense of smell, and are distributed to the mucous mem-
brane lining the nose. The *second* pair, or optic nerves,
supply the special sense of sight, and are distributed to
the eyes. The *third, fourth,* and *sixth* pairs are motor
nerves, and animate the muscles moving the eyeball. The
fifth pair are the largest of the cranial nerves and have a
mixed function. They supply common sensation to the
teeth, portions of the face, mucous membrane of the eye,
nose, and portions of the mouth and throat. They also
supply motion to the muscles of mastication. The *seventh*
pair supplies principally the muscles of the face with mo-
tion, and also presides over the special sense of hearing,
and the special sense of taste to the front part of the
tongue. The *eighth* pair are also mixed nerves, furnish-

ing the special sense of taste to the back part of the tongue (the seventh pair supplying the front part), and presiding

over the function of the larynx, which, it will be remembered, produces the voice. There are, in addition, motor and sensory branches supplying certain organs and muscles. It is through branches of this pair —the pneumogastrics —that the action of the heart is kept regular and uniform. The *ninth* pair are motor nerves, and supply the tongue with motion.

The cranial nerves that supply structures outside of the cranial cavity pass through small openings in the skull on the way to their destination.

Spinal Nerves (Fig. 37).—There are thirty-one nerves given off from each side of the spinal cord, each nerve

Fig. 37.—Brain and spinal cord, with the thirty-one pairs of spinal nerves.

forming with its fellow on the opposite side a pair similar to the arrangement of the cranial nerves. They also resemble these nerves in appearance. Each pair of nerves are composed of fibers arising from the anterior and posterior columns of the cord, and consequently contain motor

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and sensory fibers. At a short distance from the spinal cord the nerves divide into anterior and posterior branches, the anterior branches supplying the trunk and extremities, diaphragm, and certain organs. The posterior or smaller branches supply principally the muscles and skin of the back.

The brain and spinal cord are each protected by a closed sac, surrounding them, after the manner of the pericardium which envelops the heart, and the pleura covering the lungs.

The portion of the nervous system just described presides over the functions of animal life—the intellect, general sensation, the special senses, and motion.

SYMPATHETIC SYSTEM. — Organic life, or that which relates to secretion and excretion, the proper distribution of blood and nutrition to the tissues, the control of the involuntary muscular tissue which is found in the alimentary tract, blood-vessels, etc., must be unaffected by the outside world. Were it subject to the will, and to such influences as govern the cerebro-spinal axis, the functions of organic life would soon be disturbed, and the most seri-

FIG. 38.—The sympathetic or ganglionic nervous system.

ous consequences would ensue. This system must work on uninterruptedly, in health and disease, night and day—at all times. For this purpose Nature has supplied a sepaɪate and independent nerve-force known as the *sympathetic* or ganglionic system (Fig. 38), which consists of a series of little bodies or ganglia which begin at the under surface of the brain, and continue downward on each side of the spinal or vertebral column to its lower extremity. Although this system is independent of the cerebro-spinal axis, in its special function, it communicates with, and accompanies the cranial and spinal nerves to organs which are supplied by both systems. It also brings the different organs in communication with each other, and admits of the sympathy which exists between them. This relation between the different organs explains why a disordered stomach will produce headache, or why death may follow a blow at the pit of the stomach, which injures the large sympathetic ganglia back of this organ, the shock conveyed to the heart being so great as to arrest its action.

CHAPTER VIII.

BANDAGES, DRESSINGS, ETC.

BANDAGES are used to retain dressings in position, arrest hæmorrhage, and support and render immovable different portions of the body. For general use they are divided into roller, and Esmarch or triangular bandages.

The roller bandage when properly applied is not only a valuable means of employing this form of dressing, but is also attractive in appearance; considerable skill, however, is essential in order to make its application effective. The choice and preparation of material necessary for its construction render its use impossible at all times and places; for this reason the Esmarch or triangular bandage, which can be made from a handkerchief, shirt, or some other material that can be procured at once, is accepted as being best adapted for emergencies.

The materials utilized for bandages include linen, flannel, calico, and muslin. Rubber tissue is also often used by surgeons for special purposes, as support in varicose veins of the leg, and flannel where warmth is required. For ordinary purposes, unbleached muslin of a medium texture is the best fabric that can be employed.

Bandages should not contain starch, nor should they be pieced, as either condition produces considerable irritation of the skin, and also prevents their proper application.

ROLLER BANDAGES are usually made from three to eight yards long and from three fourths of an inch to four inches wide, depending upon the part of the body to which they are to be applied—three fourths of an inch for the

finger, two inches for the upper extremity, three inches for the lower extremity, and three or four inches for the chest and abdomen. Bandages should always be *torn* from the piece, unless the material from which they are constructed is very thin. The selvedge along the edge of the fabric should always be removed before the bandages are rolled.

In rolling a bandage the following directions are to be observed : One end of the strip should be folded for a distance of about six inches ; this lap should then be folded on itself, and the process continued until the folded portion assumes the form of a roll or cylinder, which should then be held by the thumb and index-finger of the right hand, the loose strip of the bandage lying over the back of the left hand between the thumb and index - finger. The hand holding the bandage should now be turned toward the right, when the roll will begin to increase in size ; this manipulation is to be continued until the bandage is entirely rolled ; it is

FIG. 39.—Method of rolling a bandage.

very important that the bandage should be wound tightly, particularly at the beginning, otherwise it can not be evenly adjusted (Fig. 39).

A bandage usually has one head or roll, although it may be made double-headed (by rolling from both ends) for special purposes, as in the knotted bandage.

The application of a bandage should always be commenced by laying the *outer* surface against the skin. If

used to retain a dressing, it may be begun at any part of an extremity, the soft dressing underneath preventing any undue interference with the circulation ; but when the bandage is applied for support or pressure, it must be commenced at the extreme end of the limb and bandaged *toward* the body, otherwise the constriction, particularly if the bandage is drawn tightly, may be followed by strangulation and gangrene of the tissues below the bandage. A bandage should be closely applied to a limb, but not made tight, and the degree of pressure should be uniform. Should any evidence of strangulation occur, which would be manifested by swelling and discoloration, and also a reduced temperature of the limb below the bandage, the dressing must be at once removed. It is partly for this reason that the toes and the ends of the fingers are left uncovered in bandaging an extremity—that they may serve as an index to the general circulation of the arm or the leg. A bandage applied dry and wetted afterward is followed by considerable shrinking, and sometimes strangulation of the tissues.

A bandage should not be applied to a limb until the latter is placed in the position in which it is to remain. For example, an arm should never be bandaged while straight, and then bent afterward, otherwise serious constriction will be made at the flexure.

For ordinary use the application of the roller bandage is divided into three methods : the *circular*, the *spiral reverse*, and the *figure of 8* (the latter including spica bandages).

The circular variety is the simplest manner in which a roller bandage can be applied, and, when possible, should always be employed. It is indicated when the diameter of the part is nearly uniform, and consists of a succession of circular turns from below upward, each turn overlapping the upper third of the one below.

The spiral reverse bandage is used where the diameter of the part becomes increased or decreased in size, as in the forearm (Fig. 40).

The figure-of-8 bandage is used about joints or where an abrupt enlargement occurs. The hip and shoulder spica are varieties of this bandage. The manner in which the different layers cross each other give to it something of the appearance of a figure of 8; hence the name.

In order to illustrate the different varieties of bandages named above, it may be supposed, for example, that the left lower extremity, including the hip, is to be bandaged, which generally necessitates the use of the different forms already enumerated.

Several bandages, having a width of about three

Fig. 40.—Spiral reverse bandage.

inches, are procured. The operator places himself directly in front of the limb to be bandaged, which is somewhat elevated, the patient being seated or in bed. The operator, holding the bandage in his right hand, unrolls about six inches of it, the outer side of which is laid obliquely across the dorsum or top of the foot from within outward, and continued around the lower part of the ankle to the inner side, and then again over the dorsum of the foot, crossing the first portion applied, and carried downward to the base of the toes on the outer side; from this point two or three circular turns are made around the foot, extending upward, and thence again to the ankle, where the circular form is employed until the calf of the leg is reached. If the circular turns are continued at this point, the lower border will be seen to gape; for this reason the spiral reverse method should now be substituted (Fig. 40). From
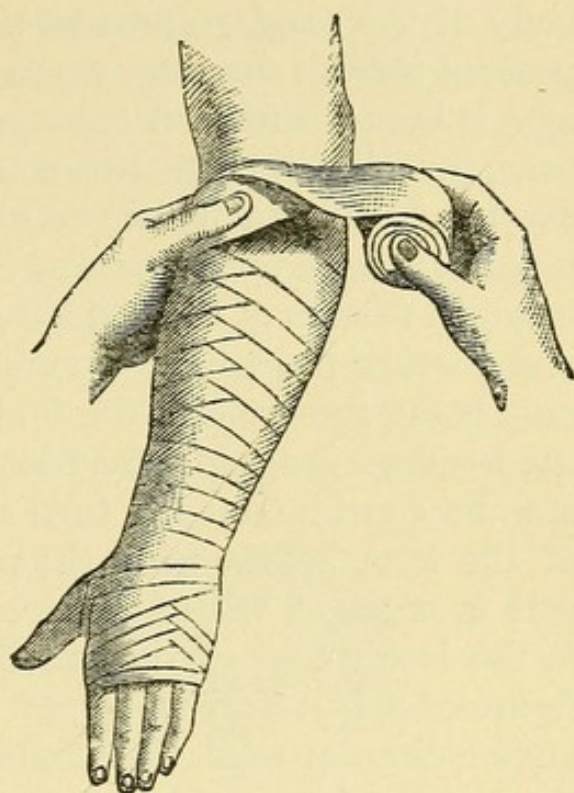
the last circular turn, the bandage should be carried spirally upward and outward for about five or six inches. The operator then presses with the thumb of his left hand the body of the bandage against the median line of the leg, to prevent it from slipping, while the right (holding the bandage) is brought toward the operator with a slight inward turn, thus folding downward (reversing) the upper edge of the bandage to a point just above the thumb of the left hand, and held for a moment in this manner until the disengaged fingers of the left hand are carried behind the leg and receive the roller or cylinder from the right, which, now being free, retains the fold or reverse in position until the bandage is again passed to it for another reverse. This is to be continued (each turn overlapping the upper third of the turn below) until the portion of the leg above the calf is reached, where the circular turns can be made up to the lower edge of the patella or "knee-cap," where the figure-of-8 bandage is begun in the following manner: after a circular turn, the bandage is carried obliquely over the patella from within outward and upward, making a circular turn above the knee, then to the inner side of the leg and downward and outward, crossing the portion of the bandage over the patella. A circular turn is now made around the knee below the patella (to retain the spiral or oblique turns already made), and then carried again obliquely upward and outward, overlapping the upper half or one third of the preceding turn in this direction, and continued in this manner until the entire knee is covered. Above the knee, the circular form can be used for a short distance and then changed to a reverse as it ascends the thigh, and continued to a point just below the groin; from this point the application of the hip spica begins, the bandage is carried upward and around the hip to the opposite side of the body, just above the great trochanter of the right femur; this bony prominence marks the upper extremity of the thigh-bone, and can readily be found, particularly if the patient be made to move the leg.

Following this course, the bandage is carried over the belly to the point where it started from (left thigh), crossing the first turn and passing downward and backward around the thigh. This procedure is to be repeated in an ascending manner until the hip is covered. The bandage, when applied, should not extend above the upper border of the haunch-bones (crest of the ilium). It will be noticed that, in bandaging the foot, the toes and heel are left uncovered. This is the usual mode of applying the bandage, unless an injury exists at these parts.

The shoulder spica is applied in a manner similar to the spica of the hip. When the bandage is carried to the opposite side, it passes beneath the arm and back again over the shoulder, from where it began. It also is an ascending bandage (Fig. 41). In the spica bandage of the hip and shoulder, the overlapping is greater at the opposite side than at the hip or shoulder which is being covered. The spica bandages (hip and shoulder) are used to retain dressings and apparatus.

The double-headed knotted bandage is made of a strip of muslin about eight yards long and two inches wide, and rolled into two

Fig. 41.—Ascending spica of the shoulder.

heads or cylinders. The knotted bandage is generally used to arrest hæmorrhage from the scalp by making pressure upon the temporal artery, which is situated just in front of the ear and extending upward into the scalp. The pulsation of this vessel can easily be felt. Before applying the bandage, a firm compress should be placed over the artery at a level with the upper border of the ear. A piece of

cork, for example, about half an inch thick and the diameter of a silver half-dollar, should be enveloped in a piece of soft muslin and applied over the artery. The operator then, holding a roller in each hand, places the outside of the bandage against the compress and carries one roller around the head just above the eyes in front, and the other below the occipital protuberance or "bump" on the back of the head, and to the opposite temple; at this point the hands of the operator change rollers and return them to the compress, over which they form a knot by twisting and changing their direction, one roller being carried over the top of the head and the other beneath the chin, and meeting at the opposite side. At this point the rollers are again changed and returned to the compress, over which a second knot or twist is made in the same manner; two or three knots over the compress are usually sufficient to arrest the hæmorrhage (Fig. 42).

FIG. 42.—Knotted bandage.

There are a number of bandages which can not be classed with either the roller or triangular bandage. The following are examples :

The FOUR-TAILED BANDAGE is made of a strip of muslin about one yard and a half long and four inches wide, folded and torn from the ends to within two inches of the center of the bandage. One pair of tails is usually made broader than the other. This bandage is employed to support the lower jaw after a fracture or dislocation. It is to be applied by placing the center of the bandage against the chin, with the wide tails below, when the latter are turned upward and tied on top of the head; the upper or narrow tails are carried backward and tied at the nape of the neck (Fig. 43) ; two handkerchiefs, each folded in the form of

a cravat, may be used for this purpose. A four-tailed band-
age, for the purpose of protection and retaining dressings
about the head, can be made of a
piece of muslin, about one yard
and a half long and one foot or
more in width, folded, and torn
from the ends to within six inches
of the center. The bandage is
placed on the head, the anterior
tails being carried backward and
tied at the nape of the neck, while
the posterior tails are tied under
the chin (Fig. 44). If it is required
that the bandage should be applied
to the back of the head, the ante-
rior or upper tails are tied beneath
the chin, while the posterior or

Fig. 43.

lower tails are tied upon the forehead. A four-tailed
bandage may also be used at the knee. It should be
made of a strip of muslin
about eight inches wide and
one yard long, and applied by
placing the center of the band-
age over the patella; the up-
per tails are carried backward,
crossed behind the knee, then
brought forward and tied in
front below the patella ; the
lower tails are manipulated in
a similar manner, but tied
above the patella.

The entire head may be
covered by the application of a
six-tailed bandage, made from

Fig. 44.

a piece of muslin about forty inches long and fifteen inches
wide and folded. The ends should be torn into three tails,
extending to within six inches of the center of the band-

age ; the middle tail should be made wider than the outer ones. The bandage being placed on the head, the middle tails are tied under the chin, the anterior at the nape of the neck, and the posterior on the forehead.

The large square handkerchief-bandage is a very valuable means of covering the head and neck, and is applied by folding a piece of muslin about one yard square, in such a manner that the upper portion or layer is narrower than the lower portion, their borders being two or three inches apart. The bandage is so placed on the head that the border of the upper portion is on a level with the eyebrows, while the lower layer rests on the tip of the nose. The ends of the upper portion are tied beneath the chin ; the border of the lower portion is then turned up-
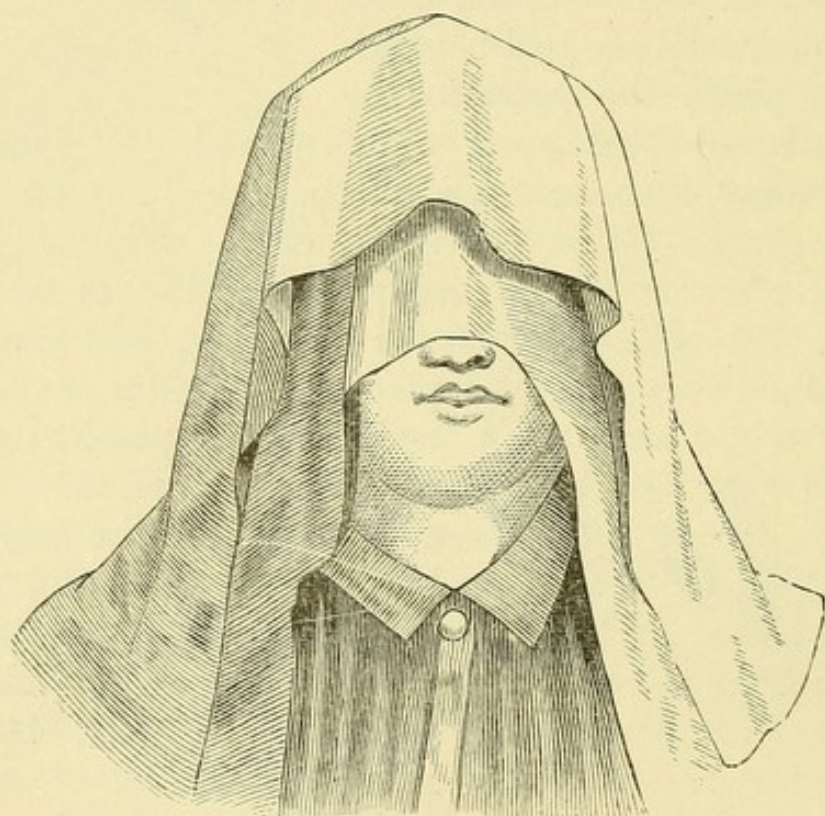
FIG. 45.

ward against the forehead, thus exposing the eyes, while the ends of this portion are carried backward and tied behind the neck (Figs. 45 and 46).

ESMARCH OR TRIANGULAR BANDAGES (see diagram, Fig.

47).—The triangular bandage, which has been brought to the notice both of the medical profession and the laity by Prof. Esmarch, of Germany, are not on-ly easily made from material which is gen-erally procured with-out difficulty, but are effective as a dress-ing and easily applied, and act as a substitute for the roller bandage in all cases except where uniform press-ure is the essential element.

If a choice of material is permitted by the existing cir-cumstances, the un-

FIG. 46.

bleached muslin used for roller bandages should be se-lected ; however, a large handkerchief, or a shirt or skirt, may be used.
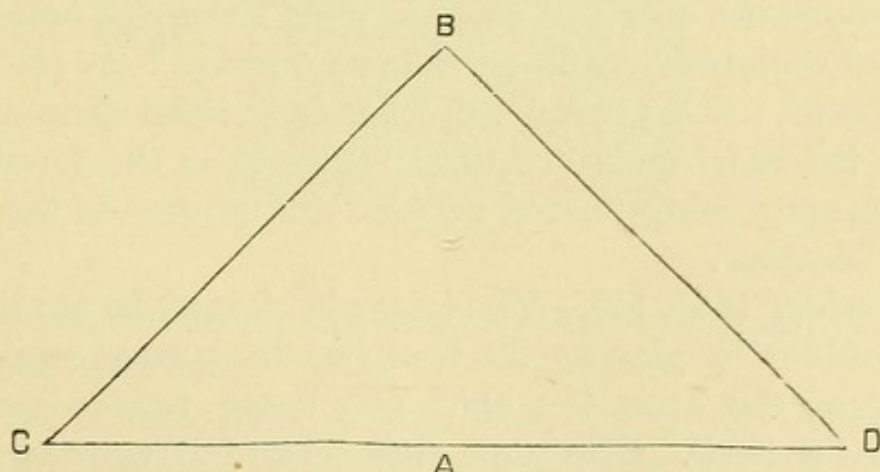
FIG. 47.—Esmarch bandage. A, base ; B, apex ; C, D, basal ends.

It will be unnecessary to enumerate the sizes given for the different triangular bandages. A proper knowledge

of their application will sufficiently indicate this when being used on different portions of the body.

The ends of a triangular bandage should be fastened either by tying with a "reef" or flat knot, or with safety-pins; the knot, however, is generally used (see KNOTS).

Head (Figs. 48, 49, and 52).—The base (*A*) is placed downward over the brow, with the apex (*B*) at the nape
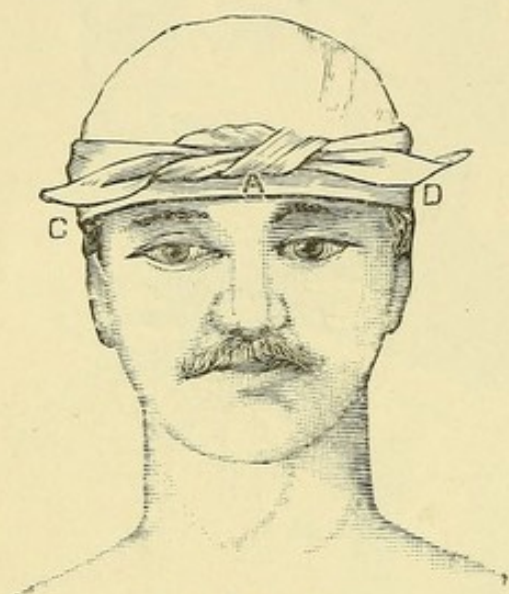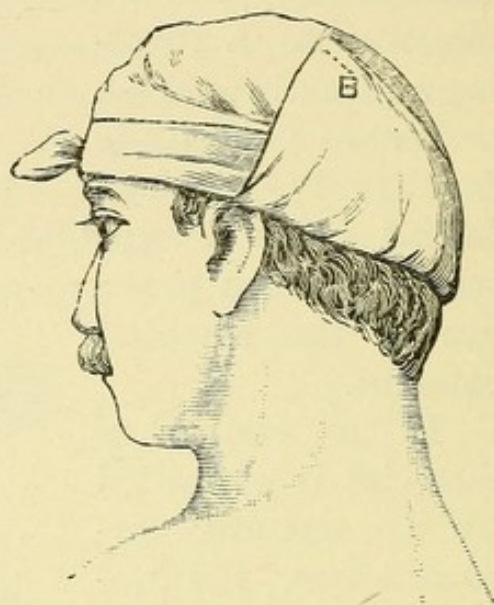
FIG. 48.   FIG. 49.

of the neck. The basal ends (*C* and *D*) are carried backward above the ears and crossed over the apex *below* the external occipital protuberance, the "bump" on the back of the head ; this prevents the bandage from slipping upward; the basal ends are then returned to the front and tied, the apex being turned upward and pinned to the body of the bandage.

Shoulder (Fig. 50).—The triangle should be applied to the shoulder by placing the base (*A*) downward across the middle of the arm, the apex (*B*) being turned upward against the neck. The basal ends (*C* and *D*) are carried to the inner side of the arm, crossed, and returned to the outside and fastened. The apex (*B*) is tied or pinned to a cravat or sling placed around the neck.

Hand (Fig. 50).—In injury to the posterior part, or

dorsum, the hand may be bandaged by placing the base of
the triangle (*A*) upward at the back part of the wrist, the
hand lying on the bandage ; the apex (*B*) is turned over
the fingers upon the palm and carried to the wrist; the
basal ends (*C* and *D*) are then carried to the front and
crossed, and returned to the back of the wrist and tied, or
crossed again, and tied in front.   In injury to the palmar
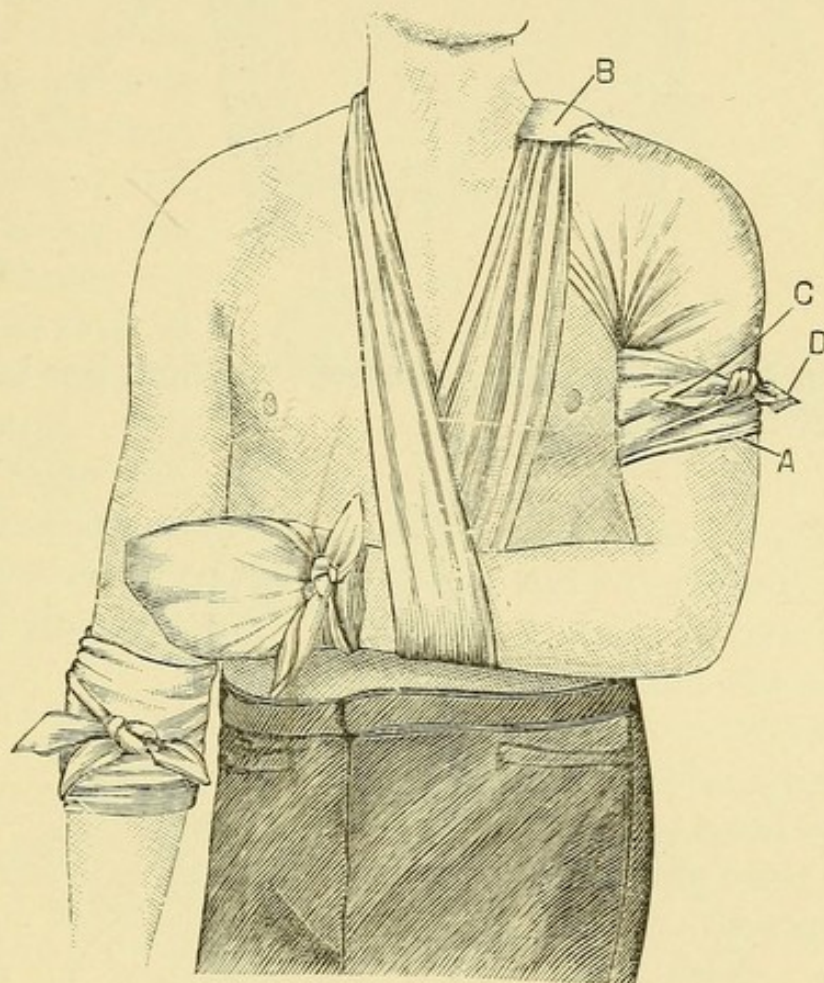
Fig. 50.

surface of the hand, the base should be first applied to the
front of the wrist.

Chest (Figs. 51 and 52).—The triangular bandage is
applied by placing the base (*A*) downward across the low-
er border of the chest, with the apex (*B*) over the shoulder
of the affected side, the basal ends (*C* and *D*) being carried
around the sides to the back, and tied together in such a
manner that one end of the knot is longer than the other.
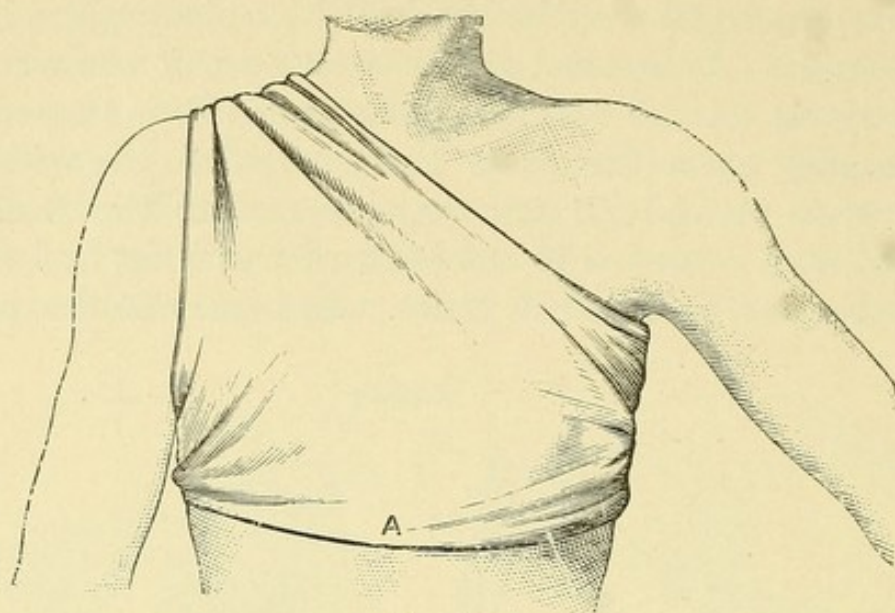
FIG. 51.

The long end is then tied to the apex, which has been carried over the shoulder.
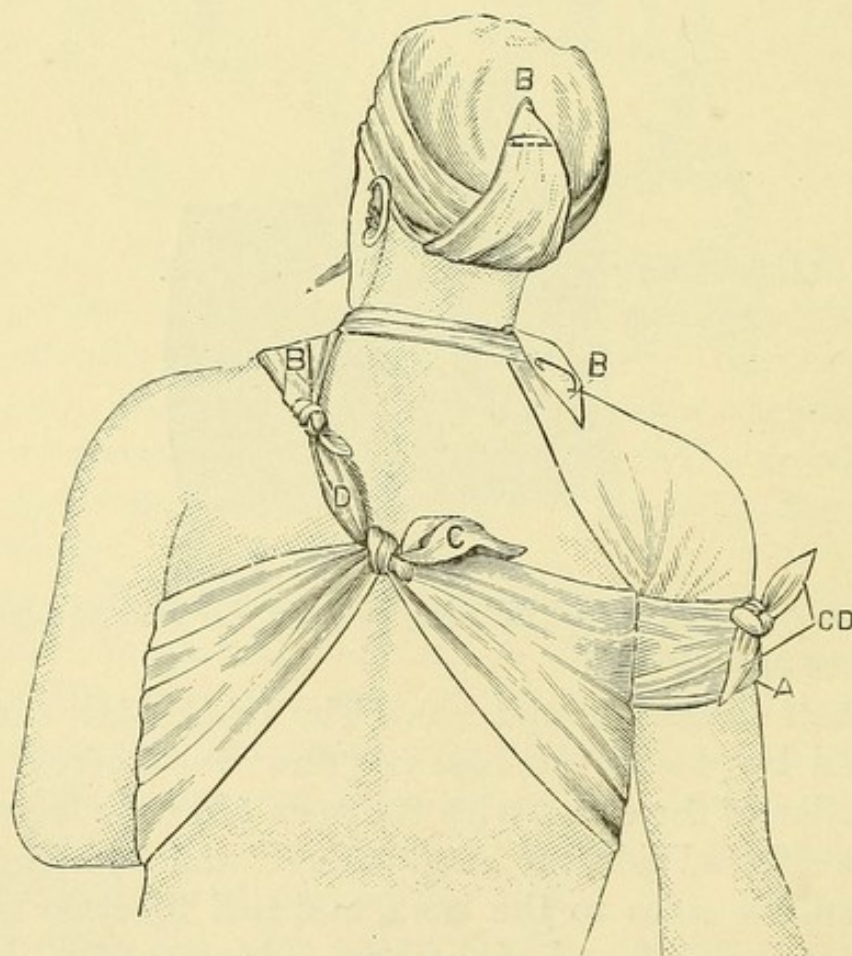
FIG. 52.

SLINGS. — The ordinary form of an arm - sling made of a triangular bandage is as follows (Fig. 53): For example, suppose that the left arm alone is injured; the base (A) is placed vertically along the outer border of the right side of the chest, with the basal end (C) thrown over the
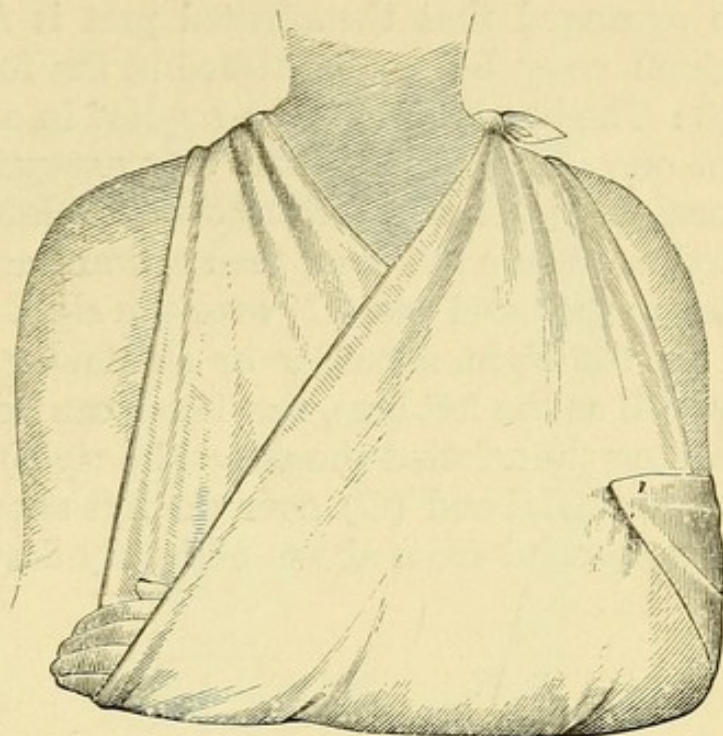
FIG. 53.

right shoulder, and the apex (B) placed behind the left elbow, the left arm being bent at a right angle and held in front of the bandage. The basal end (D) is now carried around the forearm and over the left shoulder, and tied to the basal end (C) at the back of the neck. The apex (B) is then carried around the elbow and pinned to the bandage in front.
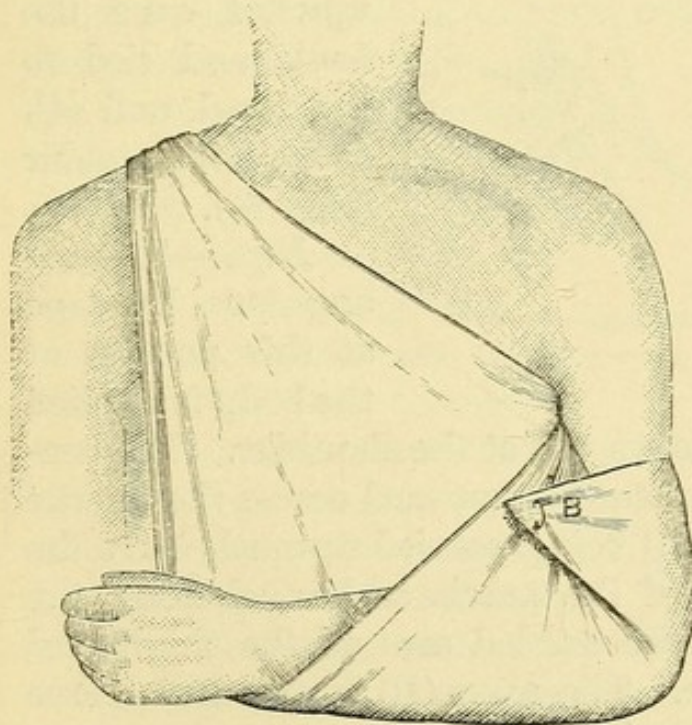
Should it happen that the left shoulder or clavicular (collar-bone) region is injured as well as the arm, the sling should be

FIG. 54.

so arranged that the affected part is free from pressure, which may be accomplished in the following way (Fig. 54): The bandage is to be applied in a manner similar to the one just described, with this exception—instead of the basal end (*D*) being carried over the left shoulder, it is carried under the left arm, then upward across the back, and tied to the basal end (*C*) over the right shoulder.

If the right shoulder or clavicular region be injured as well as the left arm, the latter can be placed in a sling, leaving the affected shoulder (the right) uncovered by laying the basal end (*C*) over the left shoulder, the base (*A*) being carried from above obliquely downward and to the right, the apex of the bandage and the arm being in the same position as in the slings just enumerated. The basal end (*D*) is now carried under the left arm and upward over the back, and tied to the basal end (*C*) at the left shoulder (Fig. 55).
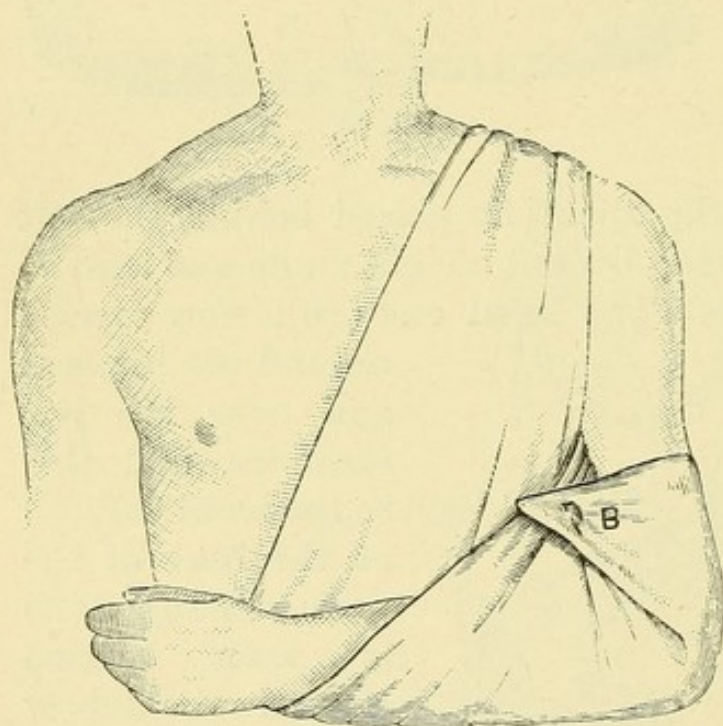
FIG. 55.

Hip. — The triangular bandage at this portion of the body is applied in very much the same way as at the shoulder. The center of the base (*A*) is placed downward across the middle of the thigh, the apex (*B*) being carried upward above the crest or upper border of the pelvis or haunch-bone, the basal ends (*C* and *D*) are carried around the thigh, and fastened at the outside. The apex (*B*) is attached above to a cravat around the waist (Fig. 56).
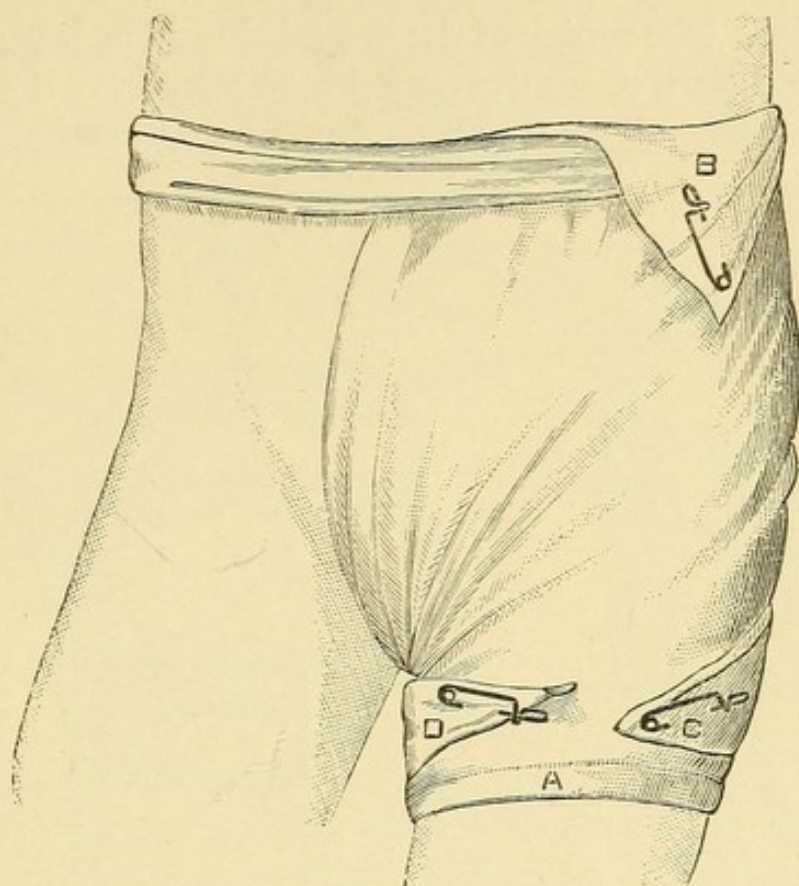
FIG. 56.

Foot.—The foot should be placed on the triangle with the base (*A*) backward, and laid behind the ankle, the apex being carried upward over the dorsum or top of the foot. The basal ends (*C* and *D*) are brought forward, crossed, then carried around the foot, and tied on top (Fig. 57).

CRAVAT-BANDAGES (Figs. 50, 58, 59).—A triangular bandage folded in the form of a cravat makes a very effective means of arresting hæmorrhage and retaining splints, dressings, and poultices. The width of the cravat, or the number of folds, depends upon the use for which
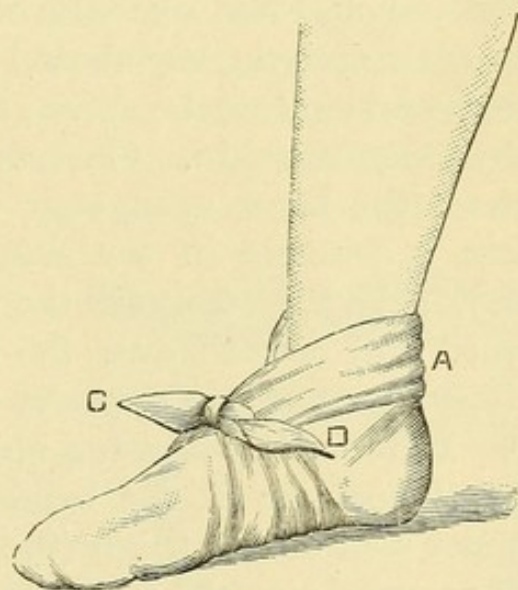
FIG. 57.

it is applied. The center of the cravat should be laid against the affected part, or on the poultice, or whatever the cravat is used to retain, the ends of the cravat being carried around
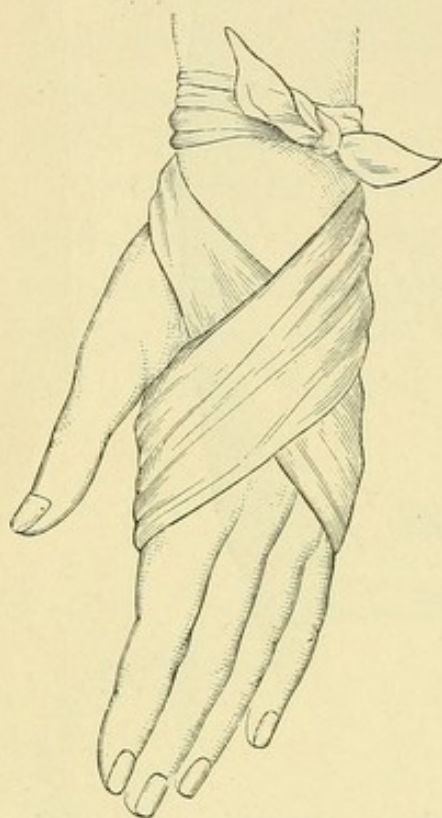
FIG. 58.
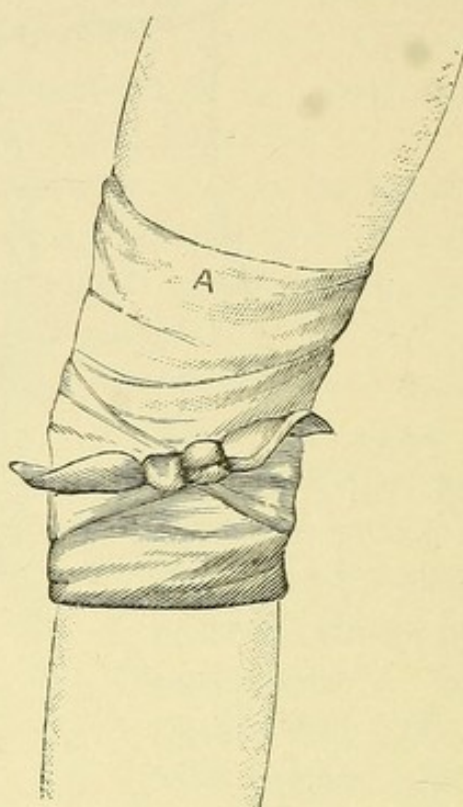
FIG. 59.

the limb and tied over the center of the base.   When used to retain splints, they should be tied on the outer side of the limb and against the splint, thus preventing the knot from irritating the skin.   Cravats are used to retain dressings about the head, eyes, ears, neck, etc.   When used to retain a dressing in the arm-pit, the center of the cravat should be placed under the arm, and the ends carried upward and crossed over the shoulder, and tied in the axillary space of the opposite side, thus forming a figure of 8.   In retaining dressing about the groin and in that vicinity, the middle of the bandage is placed at the inner and upper part of the thigh (the "crotch"), the extremities being carried upward and outward and crossed at the hip, the ends being brought over to the hip at the opposite side and tied.

The cravat may also be used as a sling for the arm where simply support, but not protection, is necessary.

KNOTS.—The ends of a triangular and cravat-bandage are fastened by tying with a "reef" or square or flat knot (Figs. 60 and 61). This
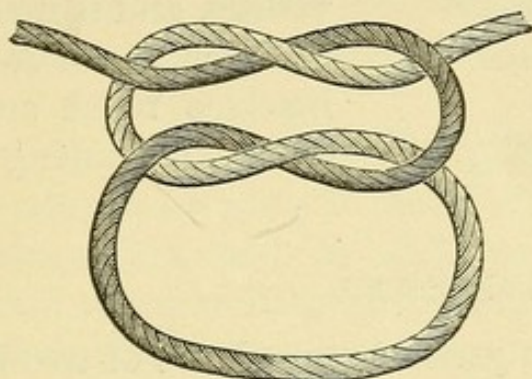
FIG. 60.—Reef knot.

FIG. 61.—Reef knot.

knot is very secure, and does not slip; it is used by surgeons in ligating vessels. However, unless care is observed, a "granny" knot (Figs. 62 and 63), which is quite insecure, is often substituted. The reef knot is made by holding an extremity of the bandage in each hand, and then passing the end in the *right* hand over the one in the left and tying; the end now in the *left* hand is passed over the one in the
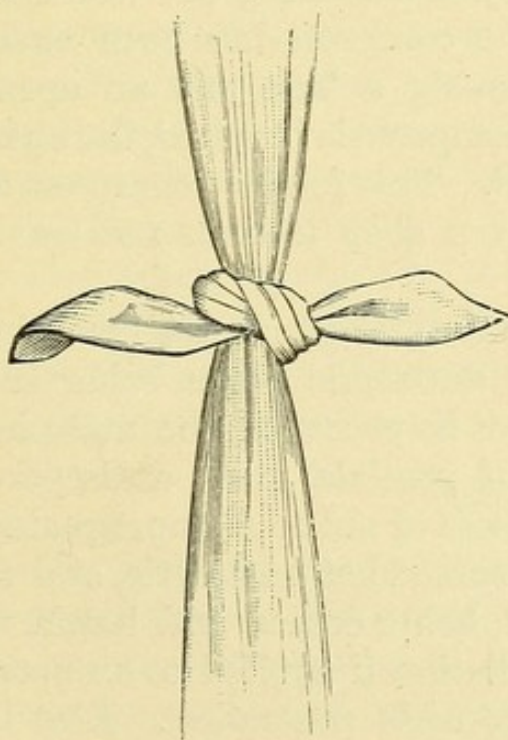
FIG. 62.—Granny knot.
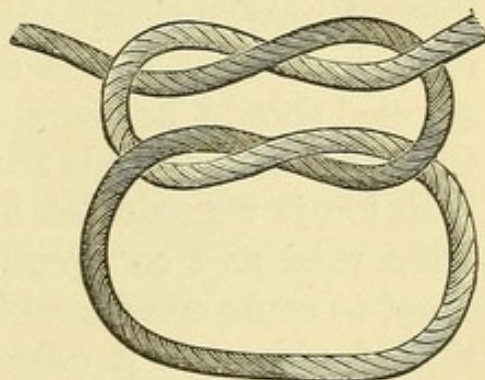
FIG. 63.—Granny knot.

right and again tied. In the "granny" knot the end
in the right hand is
carried over that in
the left both times
and tied (Fig. 63).
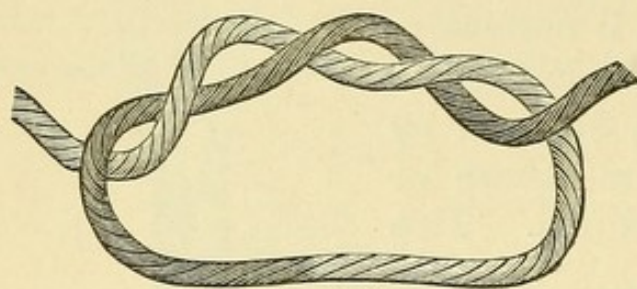
A surgeon's knot is
used in ligating blood-
vessels, and is made by
turning the ends of a
ligature twice around

FIG. 64.—Surgeon's knot.

each other before tying (Fig. 64), and then securing it as
in the reef knot.

COMPRESSES.

Compresses or pads, as generally used, are of two kinds
—simple and graduated.

A simple compress consists of a number of even folds
of muslin or other similar material, applied to a part
to assist in arresting hæmorrhage (by pressure), to hold
the edges of a wound together, and also for protection. A
graduated compress is made by diminishing the width of
each successive layer until the compress has been made
pyramidal or pointed, and having a base and an apex.
When applied, the graduated compress is inverted, the apex
being placed first in the wound. This form of compress is
used to arrest hæmorrhage from deep wounds and cavi-
ties.

Compresses are made of antiseptic gauze, lint, muslin,
linen, flannel, oakum, etc., the antiseptic gauze being the
most desirable. If this can not be procured, the material
selected should be clean, and, if possible, made antiseptic.
Oakum, which is made from pieces of old rope impregnated
with tar, is regarded as being somewhat antiseptic, and is
often used as a compress; but, being coarse and harsh, it
is apt to cause considerable irritation if applied to an open
wound, although it affords valuable protection. Lint is
objected to, as the surfaces—particularly one of them—are

downy, and adhere to the wound. The common picked lint is objected to for the same reason. A compress may be prevented from adhering to the wound by smearing it with vaseline or oxide-of-zinc ointment. A compress made of a fabric such as gauze, which admits of absorption of the fluids from a wound, is more valuable than one which resists it.

A compress should not be allowed to remain applied after it has become offensive or soaked with discharges.

TAMPON.

A tampon or plug is made of the same material used for compresses, and, in addition, absorbent cotton, lamp-wicking, common muslin bandages, etc., are often utilized. A tampon has no special size or shape, but is formed in such a manner that it can be pressed deeply into a wound in order to arrest hæmorrhage, for which it is principally employed. It is of the utmost importance that a tampon should be clean, and also made antiseptic if possible, in order to prevent the entrance of poisonous germs. It should be remembered that, although it is necessary in order to arrest hæmorrhage by tamponing that the wound should be thoroughly filled from the bottom, too forcible manipulation may be followed by serious consequences, and that even the proper application of a plug usually prevents union by first intention. A tampon as well as a compress is kept firmly in place by a bandage, which exerts more or less pressure as the case requires. Without the indorsement of a surgeon, a tampon should not be left in a wound longer than twelve hours.

POULTICES.

Poultices are used to supply and retain heat and moisture, and thereby relieve internal congestion and pain ; also to hasten the removal of a slough or dead tissue, and to clean the surface of foul ulcers.

Poultices are supposed to favor the development of

bacteria when applied to a wound, and consequently are not used in this form of injury unless dead tissue is to be removed. They should then be made antiseptic.

Poultices are usually made of ground flaxseed (linseed), although, if this can not be procured, hominy, corn-meal, or bread (not the crust) may be substituted. A bread-poultice, however, becomes sour in a very short time.

Flaxseed-Poultice.—A receptacle containing boiling water should be placed on the fire. The flaxseed-meal should then be gradually added, and constantly stirred, until the batter is jelly-like, and about the consistence of oatmeal porridge. This should be evenly spread, with a thickness of about one half inch, on a cloth prepared for the purpose by folding in two or three layers to within three inches of its borders ; over the surface of the flaxseed should be laid some white tarlatan, cheese-cloth, mosquito netting, veiling, or a fine cambric handkerchief ; while these fabrics do not interfere with the action of the poultice, they prevent the flaxseed from adhering to the skin. If one of the above materials can not be obtained, the surface of the poultice may be covered with a small amount of vaseline or sweet-oil as a substitute. After the poultice is applied to the body it should be covered, if possible, with oiled silk, which aids in retaining the heat ; in this way a poultice can be kept warm and moist for two or three hours, or even longer. In lieu of the oiled silk, flannel or cotton wadding may be used.

A poultice can be made a deodorant, by adding to the boiling water into which the meal is thrown one or two teaspoonfuls of carbolic acid to each pint of water, or by adding to the *dry* meal, before it is thrown into the water, one half of its bulk of powdered charcoal. This mixture should be thoroughly rubbed together, and then added to the water in the manner already described. The addition of the carbolic acid makes the poultice more or less antiseptic.

Poultices made of bread, corn-meal, or hominy have

nothing in their favor when compared with flaxseed, save that they may be the only available substances when needed. Poultices of these materials are made in the same manner as when flaxseed is used. A teaspoonful of salt should be added to each application, particularly when corn-meal or hominy is used, otherwise considerable irritation of the skin (covered by the poultice) may ensue.

The addition of mustard to a poultice renders it more effective in diminishing or relieving deep-seated pain, as in the chest or abdomen, and is far better, for ordinary purposes, than mustard-plasters, which are too indiscriminately used. Mustard, properly applied in this manner, is seldom followed by undue irritation of the skin. The mustard should not be added to the flaxseed in the form of powder, but should be carefully mixed with a small amount of warm water, and then stirred into the flaxseed just before it is spread upon the cloth. The amount of mustard added depends upon the degree of pain, the age of the patient, etc. ; the proportion ranges from a tablespoonful to one third, or even one half, of the bulk of the poultice, one or two tablespoonfuls, however, being usually sufficient. Hot water and vinegar lessen the efficacy of mustard.

Mustard-plasters are used to obtain a rapid and decided effect, as in shock, poisoning, etc. Care should be taken, however, that the mustard does not blister the skin.

As a rule, mustard-plasters should not be applied to children and old people, as they generally blister the surface, and, if the plaster is quite large, well-marked constitutional symptoms may follow, as elevation of temperature.

In making a mustard-plaster, it is preferable to mix the powder with the white of an egg, although water may be substituted ; a small amount of flour may be added, and the paste should then be thinly spread over a piece of muslin or brown paper, and covered with some thin material.

MOIST AND DRY HEAT.

MOIST HEAT.—A hot fomentation consists in the application of moist heat, and is used to relieve pain, produce relaxation, etc., and in a manner acts as a substitute for a poultice. A hot fomentation is made by wringing out of hot water a piece of flannel, old blanket, etc., which is applied immediately to the affected part and properly protected, to prevent evaporation and the consequent cooling of the dressing. For the latter reason a hot fomentation is not used when heat alone is desired. By stirring in the hot water from one to three tablespoonfuls of spirits of turpentine, the stimulant and anodyne or quieting effects of the fomentation are increased. A hot fomentation applied to the forehead and temple, when headache exists, is often followed by immediate relief.

DRY HEAT.—Dry heat is employed when the application and retention of heat are the essential elements, as in shock, syncope, drowning, etc. Dry heat is used in the form of bottles or India-rubber bags filled with hot water, or bran, salt, or sand, which has been heated in the oven and put in bags. Bran is to be preferred, as it retains heat longer, and is very light. Hot bricks, stones, flatirons, stove-lids, plates, etc., may also be used; the latter agents should be covered with a towel or some similar substance before being applied.

In shock and some other conditions the sensation is so blunted that the skin may be burned by one of the appliances just enumerated (except the bran, salt, and sand) without being appreciated by the patient.

CHAPTER IX.

ANTISEPTICS AND DISINFECTANTS.

An antiseptic is an agent which has the power of destroying the poisonous germs (micro-organisms, bacteria) existing in the air, and which may infect a wound and interfere with its proper healing by producing putrefaction in the injured tissue. Blood-poisoning (pyæmia, septicæmia) may follow the absorption of these micro-organisms through an open surface. There is no opening too small to admit them.

Antiseptics are far more effective if they are applied to the wound immediately after an injury has been received. Through the recommendation of Prof. Esmarch, the German soldiers are each supplied with a small and compact package containing an antiseptic compress and bandage, and in addition a triangular bandage, upon which are illustrations describing the manner of its application on different parts of the body. The soldiers are taught that when a comrade has been wounded, the seat of injury should be immediately covered with the compress and bandages, unless the character of the wound or the hæmorrhage makes it impossible to do so. It has been undoubtedly proven that this precaution has saved the lives of many who have been wounded in battle.

It is not only important that a wound should be cleaned with an antiseptic solution, but also that it should be covered with a dressing which protects it from the air and the subsequent entrance of micro-organisms. An unclean compress introduces this form of poison, and should con-

sequently always be avoided. Antiseptic gauze, if possible, should be selected as the proper covering of the wound. (See COMPRESSES.) This material, however, is not always available ; consequently it will often be necessary to use other material, which, under the circumstances, will answer the purpose very well, provided it is *clean*, and, if possible, saturated in an antiseptic solution.

It is safer, where the facilities for cleaning the wound are inferior and the hands of the attendant are not clean, to apply the compress (whether antiseptic or not) at once, leaving the wound to be made antiseptic by the surgeon.

It must not be inferred from the foregoing that a wound which is not treated by the antiseptic method is necessarily followed by serious results, for if it is properly cleaned and protected, especially if the wound be superficial, it will usually do well, cleanliness being the essential element. The antiseptic treatment, however, undoubtedly offers greater protection.

Some of the most valuable antiseptics are among the deadliest poisons, even in very small quantities ; they should therefore be used with the greatest care, and the bottle or box in which they are contained should always be appropriately and conspicuously labeled.

The number of grains or teaspoonfuls indicated in parenthesis, of the following antiseptics, represent the quantity to be added to each pint of water in order to make an efficient antiseptic solution. It will be found that thymol and salicylic acid are not perfectly dissolved in cold water; consequently two or three tablespoonfuls of hot water or a smaller quantity of glycerin should first be added in order to thoroughly dissolve these antiseptics, sufficient water to make the pint being added afterward. Hot water or glycerin should also be added to corrosive sublimate, carbolic acid, etc., in order that they may hasten the solution.

CORROSIVE SUBLIMATE or BICHLORIDE OF MERCURY (three grains) is the most valuable antiseptic known. It

occurs in the form of small white granules. It is also very poisonous.

CARBOLIC ACID or PHENOL (two teaspoonfuls) occurs in the form of white, flaky crystals at an ordinary temperature, having the characteristic odor. Druggists usually add a small amount of water or glycerin to keep it in a liquid state; it then has the appearance of an almost colorless (sometimes reddish) oily fluid, very poisonous and corrosive.

SALICYLIC ACID (ten grains) occurs in white crystals, similar to quinine. This agent is harmless in the quantity mentioned (ten grains), being commonly used for internal administration.

SULPHATE OF COPPER, BLUE-STONE, BLUE VITRIOL (ten grains).—Large blue crystals, comparatively harmless; the above amount being often given as an emetic.

THYMOL (ten grains).—Large white crystals, having an aromatic and pleasant odor. Not very poisonous.

OIL OF EUCALYPTUS (teaspoonful).—Colorless fluid, with an aromatic odor. Not very poisonous.

IODOFORM does not at the present time enjoy its former reputation as an antiseptic; however, it can be dusted over the wound, and at least affords protection to the injured part.

BRANDY, WHISKY, etc., contain alcohol, and when diluted with two or three parts of water, may be used as an antiseptic, although not particularly effective. They also tend to arrest capillary and venous hæmorrhage in a wound.

SUGAR is an article which was considerably used in ancient times to prevent decomposition in wounds. It has antiseptic properties, and may be used in solution or dusted over the wound.

ALUM and TANNIN are mild antiseptics, and can be used in the proportion of about thirty grains to a pint of water.

The different forms of antiseptic materials (gauze, etc.) are made by treating tarlatan, absorbent cotton, etc., with

one of the above agents. It is found in the shops in compact form, and should be hermetically sealed, as in closed tin boxes, otherwise its antiseptic properties would soon become impaired.

DISINFECTANTS.

A disinfectant is an agent which has the power of neutralizing the infectious matter emanating from one suffering with an infectious disease, as small-pox, or from a variety of other sources. The infectious matter produces similar results in other persons who are exposed to the poison.

Disinfectants are used to destroy the infectious matter contained in the apartment of the sick, and in clothing, privies, cess-pools, etc. Fumigation is the use of a disinfectant in the form of a gas, as the sulphurous acid generated by burning sulphur.

Before describing the manner in which disinfection should be performed, it will be proper to indicate the necessary measures to be taken and precautions to be observed in a case of infectious disease. At the outset the patient should be removed to a room at the top or a remote portion of the house in which he is dwelling.

Good ventilation is one of the most important requisites, and is also a valuable disinfectant. The room should be divested of everything not essential to the comfort of the patient, such as the carpet, drapery, unnecessary furniture, etc. This diminishes the subsequent danger, and simplifies the process of disinfection at a later period.

Communication between the patient and other members of the family (save the attendant) should be prohibited. The clothing removed from the patient, and the linen from the bed, should not be taken from the room until disinfected (see DISINFECTION OF CLOTHING). The same attention should be paid to disinfecting dishes which have been carried to the room. If recovery follows, the patient should be bathed daily with a warm antiseptic solution (corrosive sublimate, two grains, or carbolic acid,

two teaspoonfuls, to each pint of water) for three or four days before leaving the apartment.

A dead body should be wrapped in a sheet saturated in a solution of corrosive sublimate, sixteen grains, or carbolic acid, six teaspoonfuls, to each pint of water.

The rules suggested by the Health Department of the city of New York for disinfection and fumigation are so practical and comprehensive that they are embodied in this article, and are as follow :

I. DISINFECTANTS TO BE EMPLOYED.

1. *Roll-sulphur* (brimstone) for fumigation.
2. *Sulphate of iron* (copperas) dissolved in water in the proportion of a pound and a half to the gallon ; for soil, sewers, etc.
3. *Sulphate of zinc and common salt* dissolved together in water in the proportion of four ounces sulphate of zinc and two ounces of salt to the gallon ; for clothing, bed-linen, etc.
4. *Corrosive-sublimate solution*—made by dissolving corrosive sublimate (bichloride of mercury) in the proportion of eight grains to the pint of water ; used for receiving the discharges from a person sick with cholera, typhoid fever, etc. It is useful also to disinfect spittoons used by consumptive persons, etc. To the discharges of a sick person should be added an equal quantity of the solution. As the solution is a dangerous poison, it should be used with great caution under the direction of a physician or chemist, by whom it should be prepared.

II. HOW TO USE DISINFECTANTS.

1. *In the Sick-Room.*—The best and most available agents are fresh air and cleanliness. The clothing, towels, bed-linen, etc., should, on removal from the patient, and before they are taken from the room, be placed in a pail or tub of the zinc solution, boiling hot. All discharges should be received in vessels containing the corrosive-sublimate or

copperas solution. When that is impracticable, they should be covered immediately with the solution. All vessels used about the patient should be cleansed with the solution.

Unnecessary furniture (especially that which is stuffed), carpets, and hangings should be removed from the room at the outset ; otherwise they should remain for subsequent fumigation and treatment.

Persons in contact with patients sick with diphtheria should use disinfectant gargles under the direction of a physician.

2. *Fumigation* with sulphur is the most practicable method for disinfecting the house. For this purpose the rooms to be disinfected must be vacated. Close the rooms as tightly as possible, stopping up chimneys, ventilators, etc. ; place the sulphur in iron pans supported upon bricks placed in wash-tubs containing a little water ; set it on fire by means of hot coals, or with the aid of a little alcohol poured over it. Allow the room to remain closed for twenty-four hours, then open all windows, and air thoroughly.

Heavy clothing, blankets, bedding, and other articles which can not be treated with the zinc solution, should be hung in the room during the fumigation, their surfaces thoroughly exposed. Care should be taken to have woolen and cotton goods free from moisture, or sulphur-fumes will injure them. Garments with pockets should have the pockets turned inside out. Afterward they should be hung in the open air and thoroughly beaten and shaken.

Pillows, beds, stuffed mattresses, upholstered furniture, etc., should be cut open, the contents spread out and fumigated. Carpets are best fumigated on the floor, but should afterward be removed to the open air and thoroughly beaten.

For fumigation, at least three pounds of sulphur should be used for every thousand cubic feet; thus, a room ten feet square would require three pounds of sulphur.

3. *Body and Bed Clothing, etc.*—It is best to burn all articles which have been in contact with persons sick with contagious or infectious diseases. Articles too valuable to be destroyed should be treated as follows :

(*a*) Cotton, linen, flannels, blankets, etc., should be treated with the boiling-hot zinc solution; introduce piece by piece to secure thorough wetting, and boil for at least half an hour.

(*b*) Heavy woolen clothing, silks, furs, stuffed bed-covers, beds, and other articles which can not be treated with the zinc solution, should be treated as described under the directions for fumigation.

DISINFECTION OF PRIVY-VAULTS, CESS-POOLS, ETC.— Use one pound of corrosive sublimate for every five hundred pounds (estimated) of the contents of the vault, etc. (Sternberg.)

To keep a privy-vault disinfected during the progress of an epidemic, sprinkle chloride of lime freely over the surface of its contents daily. (Sternberg.)

DEODORANTS.

A deodorant is an agent which either masks or neutralizes the offensive odors emanating from decomposing materials, and is not necessarily an antiseptic or disinfectant, although some agents, such as carbolic acid, are antiseptic, disinfectant, and deodorant.

Common dry earth (sand being utterly worthless) and charcoal are valuable deodorants, and may be used to deodorize fecal matter, etc.

Among the chemical deodorants are chloride of lime, which may be used in the sick-room, in the proportion of four ounces to a gallon of water, to deodorize discharges, soiled linen, etc. ; it is also a disinfectant ; its bleaching properties should not be forgotten. Labarraque solution (hypochlorite of soda) is a valuable deodorant.

Chloride of zinc, about half an ounce to a pint of water,

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may be used as a spray about a sick-room, or to deodorize discharges, etc.

About one third of an ounce of permanganate of potassium to a pint of water may also be used to deodorize discharges.   It, however, stains linen and other like fabrics.

CHAPTER X.

CONTUSIONS AND WOUNDS.

CONTUSIONS—BRUISES.

A CONTUSION is an injury inflicted upon a portion of the body by a blow from a blunt instrument, also from a fall, or severe pressure, and resulting in the laceration of blood-vessels (usually small) and other structures beneath the skin, the latter remaining unbroken.

The subcutaneous escape of blood is immediately followed by swelling and discoloration of the skin; the color being at first black and blue or purplish, then green, yellow, and so on until the extravasated blood is removed by absorption, and the affected part regains its normal color and appearance—usually within two weeks. A "black eye" is a familiar example of a simple contusion.

In severe contusions, although the skin may be at first unbroken, the soft tissues are often so badly injured that death (gangrene) of the affected structures follows.

In contusions which extend deeply into the tissues, the discoloration may not appear for a number of days.

When a contusion is followed by very rapid and extensive swelling, in which pulsation can be detected, it indicates that a large artery has been divided.

TREATMENT.—Slight contusions need no special consideration. In those of a severer nature the treatment depends upon the time that has elapsed since the injury, and its gravity. If seen early, the indications for treatment are— (1) to prevent the further escape of blood in the tissues; (2) to counteract the pain, shock, or inflammatory action

that may follow ; (3) to preserve the vitality of the part, which may be endangered in severe contusions; (4) to promote the absorption of the blood which has already escaped.   The first indication can be met by the use of *hot* (not warm) or cold applications, the latter usually proving more effective—particularly if used in the form of ice broken into small pieces and placed in a rubber bag made for this purpose, or in a bladder or towel, and applied to the part and retained *only* until the hæmorrhage is controlled.   Although ice is a valuable agent to check the extravasation of blood, it should be used with care, and not in all cases.   In slight contusions it is particularly valuable and unattended with danger; in a severe form of contusion, however, where the vitality of the affected tissues is impaired, the use of ice, by still further reducing the vitality, may cause gangrene of the parts.   Compresses soaked in dilute alcoholic solutions of whisky, brandy, cologne, arnica, camphor, etc., or, solutions containing acetate of lead (sugar of lead), carbolic acid, alum, vinegar, lemon-juice, or common salt, are also very efficacious. Pressure carefully employed, in addition to the applications just referred to, will render the treatment still more effective.   Elevation of the affected part diminishes the tendency to further extravasation of blood.   If shock accompanies the contusion, it is to be treated according to the directions given in another chapter.

The pain that is commonly present in a contusion is usually quieted by the applications used to fulfill the first indication.   The tendency to subsequent inflammation is treated by judicious use of cold, rest, elevation, etc.

In severe contusions, where the vitality of the part is greatly impaired by the obstruction to the circulation due to the escape of blood into the tissues and consequent swelling, the temperature of the part is lowered, and cold should not be used.   The local application of warmth is then indicated ; and should be applied in a dry form, as bottles filled with hot water; a bag filled with bran or

oatmeal which has been heated in the oven, or whatever form of dry heat can be easily and quickly obtained, will answer. The part should also be surrounded by woolen cloths or any fabric that will retain the heat, and if a limb is the part affected, it should be slightly elevated. If, in spite of this treatment, gangrene should ensue, warm antiseptic flaxseed poultices should be applied to hasten the sloughing and remove the dead tissue.

The local treatment for a contusion which has existed for some time, consists in stimulating the absorption of the extravasated blood, and may be accomplished by continuous mild pressure, gentle friction alone or combined with the stimulating solutions already mentioned, which are useful for this purpose.

WOUNDS.

A wound is an injury of the outer tissues in any part of the body, associated with more or less division of the skin and deeper soft structures, and produced by a mechanical agent.

Wounds are classified as follows : Incised, lacerated, punctured, gunshot, poisoned, and contused.

Incised wounds are made by sharp cutting instruments, as knives or razors. The edges of the wound, when applied to each other, fit accurately, and completely close the opening. Hæmorrhage constitutes one of the principal dangers of this form of injury.

Lacerated wounds are made by stones, clubs, or implements which are rough or blunt, and produce more or less destruction of tissue about the wound, the edges of which are ragged and torn. Considerable local inflammation and constitutional disturbance often follow lacerated wounds.

Punctured wounds are inflicted by bayonets, daggers, swords, arrows, or other weapons which are sharp and narrow-pointed. Although the openings are quite small, these wounds usually penetrate to a considerable depth, and may injure important blood-vessels and vital organs.

Gunshot wounds, in a general way, include all injuries resulting from the explosion of gunpowder, the direct cause being bullets, cannon-balls, and other missiles ; also splinters of wood, pieces of stone, etc. The degree of danger resulting from gunshot wounds depends upon the hæmorrhage—particularly that occurring internally—the structure or organ involved, the amount of tissue destroyed, together with the shock, and the subsequent inflammation and suppuration, and blood-poisoning which may result.

The conical ball used at the present day is more dangerous than the round one. The latter is quite commonly deflected or turned aside from its original course by bony prominences, fasciæ, or tendons, and thus often prevents injury to internal organs, and when imbedded in the deeper structures is more apt to become encysted—that is, the ball is provided, by the tissues adjacent to it, with a covering or capsule, which prevents the missile from irritating the contiguous structures. Thus protected, the ball may remain indefinitely without causing harm.

Foreign substances, such as bits of clothing, are often carried into the body by bullets and other missiles (frequently beyond observation), and constitute an additional element of danger. The point of entrance of a ball is smaller than the exit.

Poisoned wounds are caused by the introduction into the tissue, through the skin, of some form of virus, as in a snake-bite. These wounds are usually punctured, although they may be lacerated, as in the bite of a rabid dog.

Contrary to the general belief, the bite of the venomous snakes in this country, such as the rattlesnake, moccasin, copperhead, and one or two others, is not generally fatal, and, although the virus acts with great rapidity and intensity, only about one out of every seven or eight bitten succumb to it. Snakes are most dangerous in warm weather and after fasting. A person who has been bitten by a poisonous serpent becomes faint and greatly depressed within a few minutes, the pulse feeble, and the pupils di-

lated; more or less delirium occurs, and the extremities become cold and clammy. Considerable swelling and discoloration usually take place about the wound; intense pain is also present. In a certain proportion of cases death ensues within a few hours.

A contused wound is one in which the division of the soft structures is associated with more or less contusion at the site of injury.

HEALING OF WOUNDS. — Although the healing of wounds is divided by surgeons into a number of different varieties, it will be sufficient in this description to recognize but two of them—*primary union*, or union by first intention ; and *granulation*, or union by second intention.

In primary union the sides of the wound quickly adhere leaving only a fine line or scar. This form of healing occurs when the edges of the wound fit accurately, and are not displaced by hæmorrhage or improper dressing; when foreign bodies are removed, and the wound properly cleaned, and the injured part kept quiet. It is always desirable, if possible, to obtain primary union.

Wounds associated with considerable destruction of tissue, as in lacerated wounds, burns of the third degree, etc., heal by granulation. The first step in this form of repair is the removal by nature of the destroyed and useless tissue about the wound by the processes known as suppuration or "maturation," and sloughing. After the wound has been thus cleaned, granulation becomes apparent; little conical shoots about the size of a pin-head, and pinkish in color, are found filling up the cavity of the wound. These little bodies are very vascular, and when excessive in size, and too rapid in growth, they rise above the surrounding part, and are commonly known as "proud flesh." After granulation has entirely filled the wound, the upper surface becomes smooth, shining, and red, which appearance is the result of the process of cicatrization, and is known as a "scar" or cicatrix. The scar gradually becomes even whiter than the normal skin, and undergoes more or less

contraction. The glands of the destroyed skin are not reproduced in the scar, consequently hair does not grow from the new formation.

Granulation is accompanied by more or less suppuration—a term applied to the condition recognized by the presence of pus or "matter," which is instrumental in separating and removing the slough or dead tissue from the wound. Pus constitutes the bulk of the discharge from a wound, and is also present in certain inflammations, and in healthy granulating surfaces not accompanied by sloughing.

The proper healing of wounds is often interfered with by severe local inflammation and constitutional disturbances. Surgeons believe such phenomena to be due to the existence of microscopical particles in the air, called "micro-organisms," or bacteria, which infect fresh wounds. The theory has developed within recent years a method known as the antiseptic treatment, which means the employment, about the wound, of agents supposed to destroy the micro-organisms (see ANTISEPTICS). The success of this treatment depends not only on the application of antiseptics to the wound, but to everything that comes in contact with it, even the hands of the attendant, the dressings, and instruments. Surgeons now use antiseptic sutures (stitches) of different substances, most commonly those made of catgut, which are absorbed in the wound—their removal being unnecessary—a very important consideration. If drainage is essential, antiseptic tubes are introduced into the wound to favor the free exit of discharges. The wound is then covered with antiseptic gauze, secured by bandages, and left undisturbed until healing has taken place (about three days), provided the dressings do not become soiled or offensive. It is not expected that members of the ambulance corps, or other non-medical persons, will be able to comply with the details just given, but the principle should be remembered and followed as nearly as the circumstances will permit.

TREATMENT OF WOUNDS.—The treatment of a wound consists of the following indications : arrest of hæmorrhage ; examination of the wound, and removal of all foreign matter therefrom; support and protection of the injured part; rest.

The variety of hæmorrhage should be determined, whether arterial, venous, or capillary, and arrested in the manner described in the chapter devoted to that subject.

A wound should be examined as to its variety—whether incised, lacerated, etc.—also the structures involved. A careful search should be made for all foreign bodies, which, if allowed to remain, would interfere with the proper healing of the part. Pieces of clothing, splinters, etc., should be picked out with clean fingers, and the wound then cleansed with an antiseptic solution (see ANTISEPTICS). If this is not available, pure water, or, still better, water which has been boiled (thus destroying the germs it contains), may be used.

The further treatment depends upon the character of the wound. If incised, the edges should be brought closely and accurately together and retained in apposition, which may be done by the use of strips of adhesive plaster (a poor substitute, however, for the sutures introduced by the surgeon) and a compress, or the compress alone. If adhesive plaster is used, it should be cut into strips about one half an inch in width, and immersed in a *hot* antiseptic solution, if possible. They should not entirely surround a limb, as they would then interfere with the circulation. The strips should be applied with intervals between them, to allow the free exit of any matter or pus which may form at the site of the injury; one end of the strip being placed on one side of the wound, the edges of which are held closely together, the remainder of the strip is carried over the wound and fastened to the opposite side. In removing adhesive plaster, both ends of the strip should be loosened at the same time and carried from the skin toward the wound, thereby preventing the separation of its edges.

Compresses which support and protect the wound should be made of some clean, soft material, as linen, muslin, lint, flannel, absorbent cotton, oakum, or, best of all, antiseptic gauze, which can now be purchased in any drugstore. If the antiseptic gauze can not be procured, the material used for the compress should, if possible, be made antiseptic; otherwise it should be applied dry, as simple water favors putrefaction. (See COMPRESSES.)

The compress should be held in place by a bandage, which also helps to keep the edges of the wound together and prevents hæmorrhage (see BANDAGES). The dressings should remain undisturbed until healing takes place, unless they become offensive.

Lacerated wounds, which are associated with more or less destruction and loss of tissue, heal by granulation; consequently no effort need be made to bring the edges in direct apposition, which might subsequently interfere with the proper escape of discharges; otherwise the same kind of dressing should be applied as in incised wounds. Lacerated wounds should be cleansed and fresh dressings applied whenever indicated by the presence of an offensive odor, or a soiled condition of the compress and bandages. Owing to the very vascular condition of the face and scalp, lacerated wounds of these parts, if not too severe, often heal by primary union, and may be treated as incised wounds until some evidence of suppuration or sloughing appears.

The *immediate* local treatment of a punctured wound is very simple, and consists in applying a soothing antiseptic lotion. The result of such a wound is extremely uncertain, and depends upon the implement causing the injury, and should be carefully watched for any evidence of subsequent inflammation. Punctured wounds made by arrows are generally serious, because the arrow-head usually remains in the tissues. In this case the arrow should, if possible, be withdrawn by a rotary movement, or, if near the surface, it can be pushed out through sound tissue, its

exit being accelerated by making a small cut or incision over the arrow-point. If the shaft has been broken off, and the arrow-head remains in the tissues, it will be necessary for the surgeon to cut down and extract it.

In gunshot wounds the first effort should be to arrest hæmorrhage, to protect the wound from the air, and treat the accompanying shock. However, all foreign bodies which are about the surface of the wound and are not retained by blood-clots can be removed. No exploration for the bullet should be made except by a surgeon. The wound should, if possible, be dressed antiseptically and splints applied to prevent movement of a limb, and the patient at once conveyed to a place where he can secure the proper surgical treatment.

When a person has been bitten by a snake, the wound should be immediately applied to the mouth, and the poison removed by suction. If the wound be inaccessible to the patient himself, this operation should be performed by some one else. It is believed that the venom has no effect upon the mucous membrane of the mouth unless cuts or abrasions are present. If an extremity is bitten, in addition to suction, the part should be immediately surrounded by a tight bandage *between the wound and the heart*, and in this way prevent the absorption of the virus into the system. It should not be forgotten that the bandage must occasionally be loosened to prevent any serious interference with the general circulation of the part. Cauterization would be of no value in this variety of poisoned wound. The depression that follows the absorption of the poison demands the free use of stimulants—whisky or brandy ; however, it is not necessary that the patient should be made intoxicated. Ammonia is a very valuable remedy, and may be given in the form of the carbonate of ammonia, ten or fifteen grains in whisky every half-hour, or the spirits of ammonia (hartshorn) may be substituted; one half to one teaspoonful may be administered in the same manner (in whisky). If necessary, stimulants may be

given by the rectum, but always in larger doses. A very valuable method of administering the different stimulants is that commonly used by physicians, viz., by the hypodermic syringe, and is often resorted to when a patient can not easily swallow, or where the prompt action of the remedy is demanded.

The treatment of a wound caused by the bite of a dog supposed to be suffering from hydrophobia is substantially the same as in snake-bites, although, if suction is impracticable, the wound may be cauterized by heating the blade of a penknife, button-hook, or piece of wire, red-hot and applying it to the wounded surface. The poison introduced does not develop rapidly, and the constitutional symptoms may not appear for weeks; therefore stimulants are only indicated when shock is present. The suspected animal should not be killed, but placed in confinement, and carefully watched in order to be certain whether or not he is suffering from hydrophobia.

The wounds caused by tarantulas, centipedes, spiders, bees, wasps, and other insects, are very rarely dangerous. The local application of ammonia is regarded as the most effective remedy, and generally relieves the pain at once. Wet fresh earth, common salt, or a slice of an onion are also valuable, or some soothing application, such as solutions containing sugar of lead, laudanum, etc., that may be procured, can be substituted. Stimulants may be indicated in some cases.

Wounds of the abdominal walls are very dangerous, particularly so if the injury extends to the abdominal cavity (which is frequently the case), the external opening being often sufficiently large to allow of the escape of the bowels or intestines. Should this take place the protruded mass must be gently cleaned with a warm antiseptic solution and carefully examined *with clean hands*, to ascertain if the bowel has been injured ; if not injured, it should be carefully returned to the cavity and retained there by a large compress placed over the wound, secured

by a bandage firmly applied. Should it be discovered that an opening exists into the intestine, the affected portion *should not be returned to the cavity*, but kept at the external opening until the arrival of the surgeon. In the mean time the exposed bowels should be protected by some warm and clean covering. A wound of the abdominal walls which does not enter the cavity, although dangerous, should be treated as an ordinary wound. The shock which accompanies abdominal wounds must receive appropriate treatment.

Wounds of the thorax or chest are often associated with injury to the lung. Should this complication exist, it can be recognized by pain and irritation, coughing, difficult breathing, hæmoptysis (spitting of blood), and the appearance of blood and mucus, and sometimes air at the external opening.

When this condition is present, the external wound should be closed and a compress and bandage firmly applied, and the patient placed in a recumbent position and treated in the manner already described (see HÆMOPTYSIS). Should great distress follow, the dressing must be removed, and the patient turned on the side corresponding to the wound, thus favoring the escape of accumulated blood in the chest, which probably caused the oppression.

Rest is essential to the proper healing of wounds, and should be insisted upon, particularly if the injury is of a serious nature. The limbs may be kept quiet by the use of splints or slings.

CHAPTER XI.

HÆMORRHAGE.

HÆMORRHAGE is the escape of blood as the result of an injury to a blood-vessel, and is classified as *arterial, venous,* and *capillary.*

In arterial hæmorrhage the blood is thrown from the injured vessel in jets or spurts, and has a bright-red or scarlet color.

In venous hæmorrhage the blood flows from the wound in a slow, steady stream, the color being dark blue or purple.

In capillary hæmorrhage the blood oozes from the general surface of the wound and not from one point, as in arterial or venous hæmorrhage—the color being dark red.

Hæmorrhage is arrested in two ways—by *natural*, and by *artificial* means.

THE NATURAL MEANS.—The natural means of arresting *arterial* hæmorrhage is as follows : After an artery has been entirely divided, its muscular coat produces a contraction and retraction of the vessel at the seat of injury. The contraction diminishes the diameter of the artery, while the retraction draws the end of the divided vessel backward into its sheath. The blood at the mouth of the bleeding vessel forms a coagulum or " clot," which aids in preventing the further escape of blood. Exposure of the bleeding surface to the air, and in severe hæmorrhage the weakened force of the heart and circulation, which often results in syncope or fainting, greatly favor the formation of the clot, and consequently help to arrest

the hæmorrhage. The clot at the mouth of the injured vessel subsequently becomes organized and firmly attached, and permanently stops the bleeding. When an artery is only partly divided, the contraction and retraction can not properly take place, and the hæmorrhage is very persistent. If an artery is severed by a dull or rough instrument, or torn across, the fibers at the end of the vessel being ragged and uneven, more effectually close the opening and assist in the formation of a clot, and may arrest hæmorrhage even in large arteries. This is illustrated in machinery accidents, where an arm has been torn from the body and followed by very little or no bleeding.

The manner in which nature arrests *venous* hæmorrhage is by the contraction and retraction of the end of the bleeding vessel, with the formation of a clot, as above detailed in arterial hæmorrhage, and also the collapse of the vein at the point of injury (see VEINS). The blood-pressure in veins being about one fourth that of arteries, the hæmorrhage is much less vigorous and more easily controlled.

In *capillary* hæmorrhage the minute size of the vessels and the contraction that follows their division, together with the rapid formation of a clot, particularly when the bleeding surface is exposed to the air, usually check the hæmorrhage in a very short time.

In some persons a condition of the blood exists which retards or prevents the formation of a clot; for this reason the most trivial wound may be followed by a hæmorrhage which can not be arrested, and terminates fatally. These subjects are known as *bleeders*. Cases of this kind are fortunately rare.

THE ARTIFICIAL MEANS.—The artificial means of arresting hæmorrhage are as follows : Position, pressure, cold and heat, torsion, rest, styptics, and ligation.

Treatment of Arterial Hæmorrhage. Position.—As arterial blood flows from the heart, it follows that if the injured part be elevated the current of arterial blood in

the vicinity of the wound will be impeded, and the formation of the clot in the bleeding vessel hastened.

Pressure.—This method of arresting hæmorrhage is, next to ligation, the most important means that can be employed for this purpose. It may be applied directly to the bleeding surface, or along the course of the artery. In the latter instance the pressure should be always made *between the wound and the heart.* In the first variety of pressure the finger (digital pressure), or a pledget or tampon (see TAMPONS), is pressed into the wound, and constitutes a valuable means of checking the flow of blood, particularly from small arteries. Pressure with the finger can only be of avail for a short time, unless the one making the pressure can be relieved at brief intervals. For this reason, a tampon—if properly applied—is more effective than digital pressure, provided the surgeon is not expected for some time, or in case it is necessary to move the patient.

In tamponing, the wound should be thoroughly filled from the *bottom.* A tampon improperly applied is worse than useless. The material used for this purpose must be absolutely clean, and if possible made antiseptic (see ANTISEPTICS). Should the surroundings permit, choice should be made of one of the following : small strips of antiseptic gauze, linen, or muslin, or absorbent cotton. After the above has been complied with, the tampon should be held firmly in place by a bandage (see BANDAGES), but should not be allowed to remain longer than twelve or fifteen hours without the advice of a surgeon. If the hæmorrhage recurs at the expiration of this time, it may be necessary to clean the wound and apply a fresh tampon, otherwise it should receive the attention of an ordinary wound.

The second variety of pressure (along the course of an artery) is used particularly in hæmorrhage from large arteries, and is most serviceable when the vessel can be pressed against a bone. Either the finger (digital press-

ure), or a pad or compress (see COMPRESSES), may be used for this purpose.

If the surgeon is expected to arrive in a short time, digital pressure is the simplest, quickest, and best means that can be employed. However, if considerable time must elapse before the patient can receive the proper surgical attention, or if he is to be removed some distance, the pad should be utilized.

In digital pressure, the thumb should preferably be used.

The function of a pad applied over the course of a bleeding artery is similar to that of a tourniquet. A tourniquet is an instrument used by surgeons to arrest arterial hæmorrhage by compression.

An excellent tourniquet can be extemporized by folding a large handkerchief in the form of a cravat, placing between the folds a smooth stone, piece of wood, cork, potato, etc., or a good-sized knot may be tied in the handkerchief; the latter, however, is inferior to the stone, etc. The handkerchief is then bound *loosely* around the limb and tied, the portion acting as the pad being placed over the artery, *between the wound and the heart*, and held securely in this position, while a bayonet, sword, cane, umbrella, stick of wood, etc., should be passed between the handkerchief and the skin at the side of the limb opposite the pad and twisted until the hæmorrhage ceases (Fig. 72). As the constriction resulting from this form of pressure interferes with the return or venous circulation, the handkerchief should be occasionally loosened if there is evidence of serious obstruction, as swelling and blueness of the part below the constriction ; digital pressure should be substituted while the handkerchief is loose. A handkerchief is given as an illustration of what may be at once secured, although parts of clothing, neck-ties, suspenders or rubber tubing, rope, etc., are equally valuable, provided they fulfill the requirements. Hæmorrhage may be checked without the pad by simply constricting the part with one of the agents just enumerated. This, however, is less effective.

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Prof. Esmarch has recently devised a suspender made of elastic webbing, and so constructed that, after detaching it from the trousers, the apparatus (straps, etc.), by which it is attached, can be easily and quickly removed, leaving a long elastic ribbon which is to be used in constricting a bleeding limb (Fig. 65).

Torsion is a method used by surgeons to check bleeding from small arteries. It consists in catching the end of the injured vessel with forceps or pincers and twisting it until the hæmorrhage ceases.

Ligation or ligaturing (tying) is the procedure by which the end of the bleeding vessel is tightly constricted and securely closed by an agent called a ligature, which consists of a thread of silk, catgut, etc. A ligature is commonly employed to arrest hæmorrhage (particularly in arteries), and is the most valuable method of accomplishing this result. The use of this means, however, should remain within the province of the surgeon.

Treatment of Venous Hæmorrhage. Venous hæmorrhage is easily controlled if the following rules are observed :

FIG. 65.—Suspender devised by Prof. Esmarch.

1. Remove everything *between the wound and the heart* that retards the flow of blood, as garters, tight clothing, etc.

2. Elevate the injured part.

3. Apply a good firm compress directly to the wound.

Constriction of the limb *beyond or below* the seat of hæmorrhage is valuable, but inferior to the method just described.

The importance of the first and second rules will be apparent in rupture of varicose veins in the leg, which often bleed freely; the valves of these disabled veins being rendered useless, the blood escapes from both ends of the divided vessel. In rupture of varicose veins of the leg a bandage should be applied over the compress, beginning at the toes and extending upward to a short distance above the seat of hæmorrhage. In ordinary venous hæmorrhage the free return of blood to the right side of the heart, aided by elevation of the limb, relieves the blood-pressure in the veins in the immediate vicinity of the wound, and consequently the hæmorrhage is not so profuse.

Treatment of Capillary Hæmorrhage. Capillary hæmorrhage is usually harmless, except in case of "bleeders," and generally ceases when the bleeding surface is exposed to the air. If such means are not successful, hot or cold applications or a compress should be employed.

Cold is a very valuable means of controlling venous and capillary hæmorrhage, and *aids* in arresting the bleeding from an artery. It may be applied in the form of cold air (exposure of the bleeding surface), cold water, ice, and snow.

Hot applications are equally good. A piece of flannel wrung out in water as hot as can be borne by the skin, and applied directly to the bleeding surface, is followed by a diminution or a cessation of hæmorrhage. Both hot and cold applications contract the bleeding vessels and hasten the formation of the clot.

The application of alcoholic solutions, or the spirits of turpentine, to the wound by a cloth saturated with either, although very irritating, are sometimes used to check hæmorrhage.

Styptics, or astringents, although powerful agents for arresting hæmorrhage, are used by surgeons with great

reluctance and only in special cases, or where other means are not available or less effective. Styptics are objectionable, for the reason that the stronger ones, as perchloride of iron (Monsel's solution), nitrate of silver, and some others, injure the wounded surface, and may be followed by sloughing. The weaker styptics or astringents, such as tannin, gallic acid, matico, cobwebs, and alum, prevent healing by primary union. Alum is the least objectionable of the latter group. The application of styptics to mucous membranes (mouth, nose, etc.) is followed by more favorable results than when applied to a raw, wounded surface.

Rest is extremely important in all varieties of hæmorrhage, as it favors the formation and retention of the clot.

Hæmorrhage occurring in the scalp may be easily arrested by the use of a compress and bandage (see BANDAGES), which press the bleeding vessels against the underlying skull.

Hæmorrhage from the mouth may usually be stopped by the use of ice and astringent (alum, tannin) or alcoholic (brandy, whisky, etc.) solutions; if not sufficient, a tampon should be firmly held against the bleeding point. In severe cases the common carotid artery (see description of this vessel), on the side corresponding to the injury, may be compressed, although this should only be used as a last resort.

The lips are supplied by arteries which divide at the angles of the mouth, and entirely surround this opening. When the lips have been injured, the hæmorrhage may be checked by pressing the sides of the wound between the thumbs and fingers.

Severe hæmorrhage following the extraction of a tooth can be controlled by replacing the tooth, or by the application of a tampon saturated with a strong solution of alum, or other astringent, to the cavity.

Epistaxis, or "nose-bleed," is the most frequent form of internal hæmorrhage, and may be controlled in the following manner: Elevation of the head and arms, removal of all constriction about the neck, cold applications to the

back of the neck, forehead, or bridge of the nose. Passing two fingers beneath the upper lip and directing pressure against the base of the nose or nostrils is very useful; snuffing up cold or salt or alum water, or, even better, syringing the nasal cavity with these remedies. If the mouth is kept open during this operation, the fluid will escape through the opposite nostril. The well-known practice of dropping a cold door-key down the back is not to be despised. A very valuable method of checking epistaxis is by the use of a rubber finger-cot or protector, which should be greased and carefully passed into the nasal cavity of the affected side; after the cot is in position it should be filled or partly filled with very small pieces of ice. In severe cases of epistaxis which resist the remedies already enumerated, the nasal cavity on the side corresponding to the hæmorrhage may be tamponed by using a strip of antiseptic gauze, lint, or soft muslin, about eighteen inches long and half an inch wide. One end of the tampon should be carefully introduced into the nostril and carried backward by the handle of a small pencil, pen-holder, or a small stick, having a blunt end; the remainder of the strip should be gently packed into the nostril until it is filled. The tampon should be left a number of hours, and never forcibly removed, but should be loosened by injection of water or oil.

In order to be able to properly control hæmorrhage by pressure, it will be necessary to know the position of certain arteries and their relation to contiguous structures, in order that these vessels may be readily found and compressed.

Common Carotid Artery.—This vessel supplies the head with arterial blood. Its course from below upward corresponds to a line drawn from the junction of the collar and breast bones (clavicle and sternum) upward to a point just behind the angle of the lower jaw, or between it and the mastoid process of the skull—a bony prominence just back of the ear; this line also indicates very closely the anterior or front border of the sterno-mastoid

muscle, which extends from the mastoid process to the sternal end of the clavicle already mentioned.

The application of digital pressure to the common carotid artery is indicated in severe hæmorrhage about the
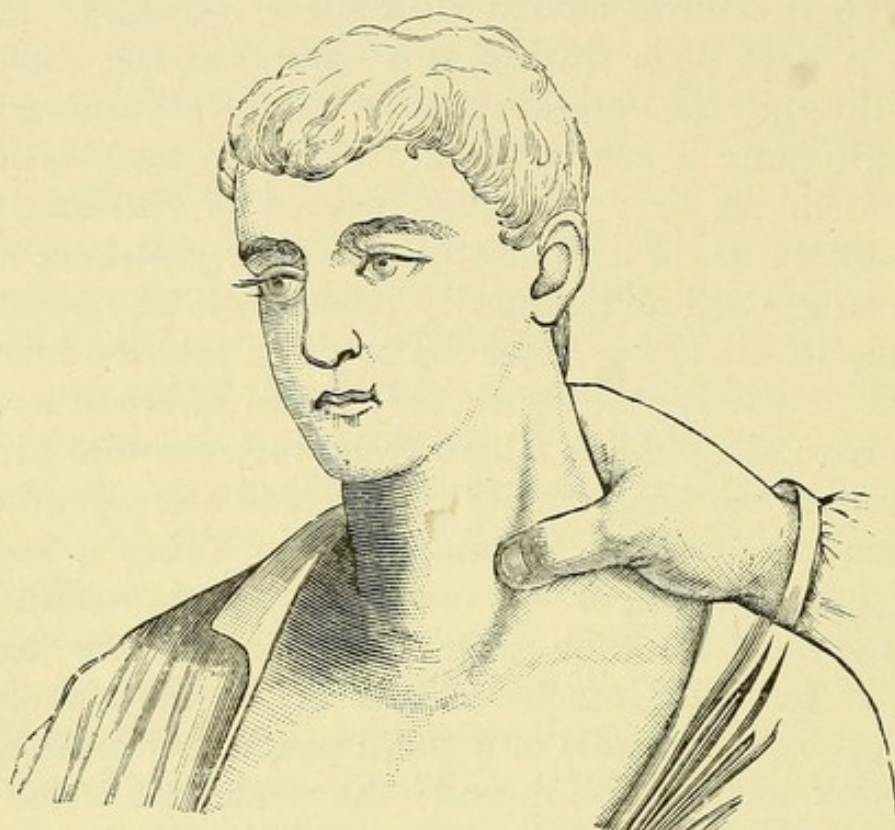
FIG. 66.—Digital compression of common carotid artery.

head and upper part of the neck (as in "cut throat"), which can not be controlled by other means. The pressure should be applied about midway in the neck at the anterior border of the sterno-mastoid muscle, and directed against the anterior portion of the spinal column in the neck (Fig. 66). The common carotid artery is accompanied by a large vein (internal jugular) and a very important nerve (pneumogastric) which may be injured if the part be roughly manipulated.

In wounds of the hand, forearm, and arm, associated with severe arterial hæmorrhage, pressure may be made upon the subclavian, axillary, brachial, or radial and ulnar arteries, according to the situation of the wound.

Subclavian Artery.—Pressure should be applied to

this vessel in hæmorrhage occurring at the upper part of the arm or in the axillary space ("arm-pit"). The outer
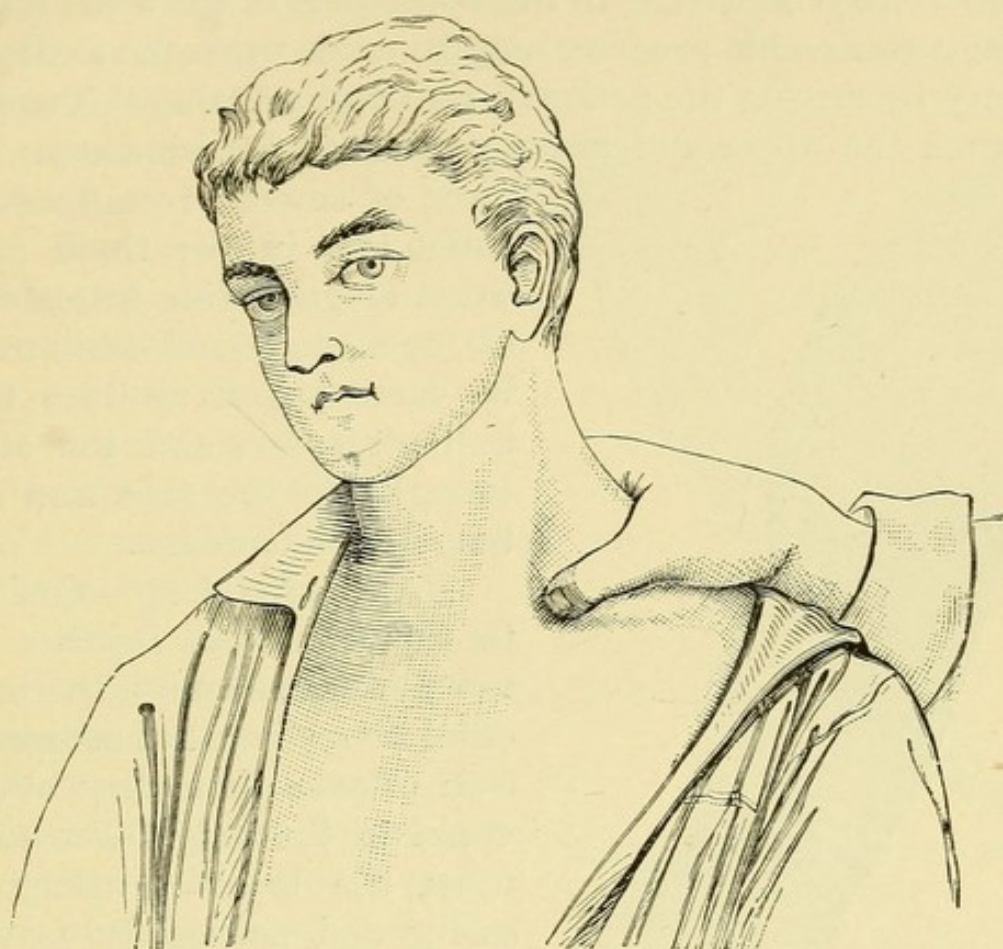
FIG. 67.—Digital compression of subclavian artery.

portion of the subclavian artery passes over the upper surface of the first rib. If the thumb is directed downward beind the clavicle, about two inches from the breast-bone, the artery may be reached and compressed against the first rib (Fig. 67). Pushing the shoulder of the patient downward facilitates this procedure. In some persons digital pressure fails to arrest the hæmorrhage, as the artery can not be reached by the finger; then the handle of a door-key or other suitable agent, covered with some soft material to prevent injury to the skin, may be substituted.

Axillary Artery.—This vessel is the continuation downward of the subclavian artery. It passes through the axillary space, and can not be easily compressed in this

situation; consequently, the subclavian is generally select-
ed as the artery to which pressure is to be applied in
hæmorrhage occurring in the upper part of the arm; how-
ever, considerable pressure may be made upon the axillary
artery by raising the patient's arm and pressing the vessel
against the upper and inner portion of the humerus. A
piece of smooth round wood, about two inches thick (the exact length being immaterial), or a good-sized book, may be carried well up into the axillary space, and the arm brought to the side and retained by a bandage.

Brachial Artery.—Owing to the numerous injuries of the upper extremity, the brachial artery requires compression oftener than any other vessel in the body. Pressure upon the brachial artery is easily and accurately made. Its course is along the inner side of the biceps muscle, which is found in the front of the arm and stands out very prominently, particularly in muscular subjects (Fig. 68). Pressure should be ap-

FIG. 68.—Line showing the course of the brachial artery.

plied at the inner border of the biceps and directed against
the humerus (Fig. 69). If the patient is to be removed, a
tourniquet should be made and adjusted in the manner
already described, or two round pieces of wood about the
diameter of a broomstick, and properly covered to prevent
injury to the skin, may be used to compress the brachial
artery. One piece should be placed transversely on the
inner side of the arm against the artery, while the other

occupies a corresponding position on the outer side of the arm; the ends of the sticks are then tied together with sufficient force to arrest the hæmorrhage.

Hæmorrhage in the forearm and hand may be controlled by placing a small pad at the bend of the elbow, and then flexing (bending) the forearm upon the arm and keeping it in this position.

The *radial* and *ulnar* arteries are branches of the brachial, and continue down the forearm to the hand; they are superficial at the wrist, the only point at which they can be

FIG. 69.—Digital compression of brachial artery.

compressed with any degree of success.

The *radial* artery or "pulse" may be found about three quarters of an inch from the outer border of the wrist (when the palm of the hand is turned upward), the *ulnar* being about one half inch from the inner border of the wrist. These vessels may be compressed in wounds of the hand, attended with hæmorrhage, although pressure upon the brachial is more often effective.

A very persistent form of hæmorrhage sometimes follows a wound of the palm of the hand. The bleeding should be checked by plugging the wound and then placing in the palm of the injured hand *over* the tampon a smooth and round piece of wood, potato, apple, lemon, billiard-ball, or whatever may be closely grasped. The hand should then be bandaged in this position. The hæmor-

rhage may be greatly diminished or even controlled by having the patient hold tightly one of the agents just mentioned, without the addition of the tampon.

Femoral Artery.—After the external iliac artery (in the abdominal cavity) passes into the leg, it is known as the femoral artery and supplies the lower extremity. It should be compressed in severe hæmorrhage from this portion of the body. The course of this artery is from the middle of the groin downward to the inner side of the knee (Fig. 70). The artery is superficial in the upper part of the thigh, from the groin downward about six or eight inches, and it is in this situation that the pressure must be applied (Figs. 71 and 72). It is compressed most effectively where it crosses the pelvic bone at the "groin."

Popliteal Artery.—This vessel is the continuation of the femoral artery, and is found in the popliteal space (behind the bend of the knee), and is only slightly affected by digital pressure, although a pad can be placed in the popliteal space and pressed upon the artery by flexing the leg upon the thigh and securing it in this position.

Hæmorrhage from the sole of the foot is sometimes controlled by compressing the *posterior tibial*, a branch of the popliteal artery, as it winds around the ankle between the internal malleolus (ankle) or lower end of the tibia, and the heel, rather closer to the former. Plugging is also valuable for this form of hæmorrhage.

Secondary hæmorrhage means the reappearance of

FIG. 70.—Line showing course of the femoral artery.

bleeding in the wounded part soon after it has been once arrested. It is generally capillary, and is caused by the re-action and increased force of the heart, the relaxation of the blood-vessels at the seat of injury, the immoderate use of stimulants, undue movement of the part, and also increased warmth to the surface that follows when the patient is placed in bed.

Elevation of the injured part and moderately increased pressure are often all that need be done, although, if the hæmorrhage continues, the dressings should be removed, the blood-clots cleaned out of the wound, and fresh dressings applied. Secondary hæmorrhage may also occur, when sloughing

Fig. 71.—Digital compression of the femoral artery.

is present, some days after the wound is received.

It should be well borne in mind that secondary hæmorrhage may be followed by collapse and death.

Clots are not to be removed from a wound unless the means of cleaning and dressing the wound are at hand; they act as a temporary compress and hæmostatic.

The *constitutional symptoms* of hæmorrhage following a great loss of blood are : Pallor of the face, lips, and surface of the body, the skin being often covered with a cold sweat ; the features are pinched. Restlessness and sighing, and disturbance of the functions of the brain, are

usually prominent—dimness of vision, ringing in the ears, delirium, etc., followed by unconsciousness or syncope (see Syncope). The severity of these symptoms depends upon the amount of hæmorrhage.

Fig. 72.—Arresting hæmorrhage from femoral artery by the use of an improvised tourniquet.

The *treatment*, besides checking the bleeding, consists in the careful internal use of stimulants, application of warmth to the body, and the general treatment of shock.

Hæmoptysis, or hæmorrhage from the lungs, is generally recognized by the expectoration of bright-red and frothy blood, also coughing, and pain and rattling in the chest. The usual cause is disease of the lung, although it may follow a wound of the chest.

Treatment.—Absolute rest in the recumbent position, the head and shoulders slightly elevated. The temperature of the room should be cool and the air pure. Small pieces of ice taken in the mouth from time to time, or a small amount of salt (half a teaspoonful), fluid extract of ergot (half a teaspoonful in water every two or three hours), spirits of turpentine (fifteen to twenty drops in cold milk every two hours), aromatic sulphuric acid, "elixir of vit-
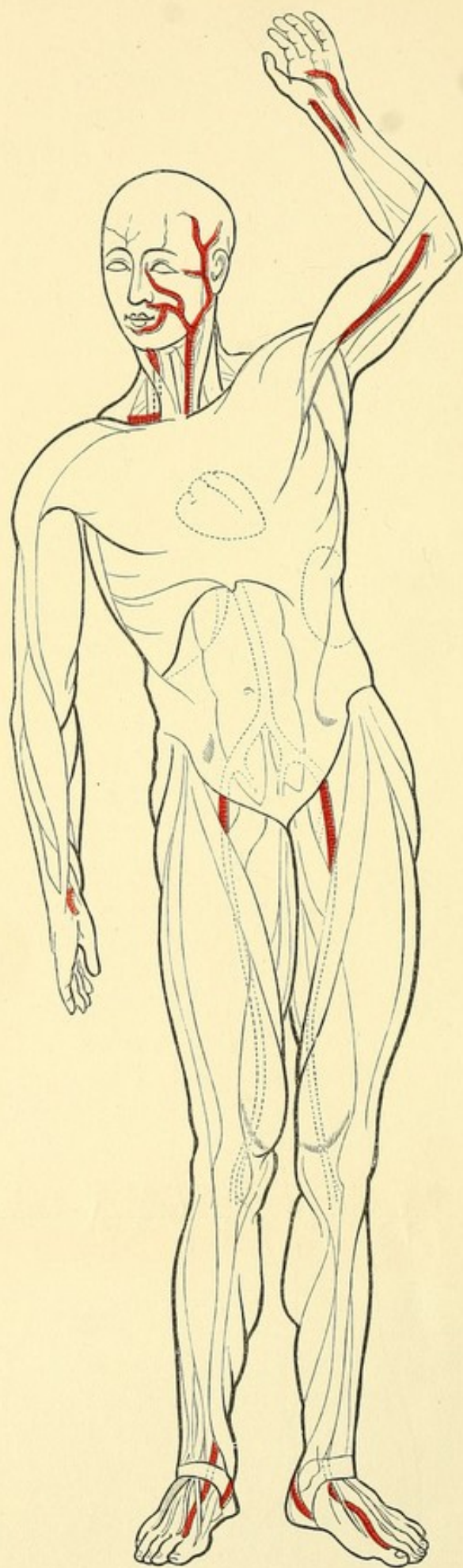
Fig. 73.—Diagram showing the position of the important arteries.

riol" (twenty to thirty drops in water occasionally), are often used, although absolute quiet and position are the most valuable agents. Hæmoptysis is rarely followed by a fatal termination, unless it results from a wound of the lung.

Hœmatemesis, or hæmorrhage into the stomach and vomiting of blood, is generally the result of some chronic disease of the stomach, although it may follow a blow or stab of the abdomen. The symptoms are those of profuse hæmorrhage (see CONSTITUTIONAL SYMPTOMS OF HÆMORRHAGE), also a sense of fullness about the stomach, commonly followed by the vomiting of dark or black blood, which is heavy, not frothy, as in hæmoptysis. The vomited matter is mixed with food, provided the hæmorrhage occurs soon after a meal. It should be remembered that the source of hæmorrhage in hæmatemesis may be from the mouth, nose, or throat, the blood having been swallowed, consequently these parts should be examined.

The usual treatment is rest in the recumbent position, administration of small pieces of ice, and the application of ice wrapped in a towel or in an ice-bag; snow, cold water, etc., over the stomach; hot applications are sometimes employed. No attempt should be made to administer medicine or stimulants by the mouth. In severe cases of hæmoptysis and hæmatemesis the general treatment of shock is called for, particularly the application of warmth to the extremities. Stimulants should be used with caution, as they are apt to encourage the hæmorrhage.

CHAPTER XII.

FRACTURES.

A FRACTURE is a breaking or solution of continuity in a bone.

Fractures are generally classified as simple, compound, comminuted, multiple, and complicated.

In a simple fracture the bone is broken into two fragments, but does not communicate with the outer world, the skin being uninjured.

In a compound fracture the bone is exposed to, or communicates with, the air by a wound of the soft structures.

In a comminuted fracture the bone is broken or crushed into a number of pieces at the same point, *and communicating with each other.*

In a multiple fracture the bone is broken into a number of pieces, but at different parts of the bone, and not communicating with each other.

In a complicated fracture there is, in addition to the breaking of a bone, an injury to some important adjacent structure resulting from the fracture, as blood-vessels, nerves, joints.

A fracture is either complete or incomplete. A complete fracture is the usual variety, and involves the entire separation or loss of continuity of a bone. An incomplete fracture frequently occurs in children, owing to the elasticity of bone in early life, and has received the name of "green-stick" fracture.

The direction in which the bone is fractured is indicated by the terms transverse, oblique, and longitudinal.

An impacted fracture occurs when the broken ends of a bone are driven into each other, and remain thus fixed.

The sign and symptoms of a fracture are deformity, abnormal or increased mobility, bony crepitus, pain, and loss of function.

The deformity is caused by the displacement of the broken ends of the bone, as the result of the violence causing the injury, also the vigorous muscular contraction at the affected part, and attempted movement on the part of the patient, which cause a shortening and change in the direction of the limb, and considerable deformity at the seat of injury. The deformity, as a rule, is not particularly apparent in impacted fractures.

Abnormal mobility is the result of the solution of continuity or break in the bone, producing a " false point of motion," which is detected by the surgeon while manipulating the part.

Crepitus, or grating, is caused by the rubbing together of the broken ends of the bone, and, when detected, is a positive sign of fracture; it is absent in impacted fracture, and also where muscular or other tissues have fallen between the ends of the broken bone ; consequently, *an absence of crepitus does not mean an absence of fracture.*

Pain is caused by the contact of the fragments of bone with the adjacent structures, also the strong muscular contraction that occurs at the seat of injury. More or less heat, redness, swelling, and discoloration of the part may be present.

Loss of function is the inability on the part of the patient to make use of the affected limb.

The repair, union, or "knitting" of the bone is begun by Nature soon after the occurrence of a fracture, and is accomplished by a substance formed at the seat of injury, known as callus, which is thrown around and between the ends of the broken bone. Although soft at first, the callus gradually hardens, and at the end of varying periods, depending on the bone injured, but not usually exceeding

six weeks, the fragments are firmly united. The minute structure of callus becomes in time (about one year) similar to that of bone.

Sometimes the formation of callus is imperfect or insufficient, and the broken bone does not become united. This condition constitutes an ununited fracture.

The union of bone in a simple fracture is likened to healing by first intention in wounds, while the repair in a compound fracture resembles healing by granulation. The popular belief that the pain is increased at the seat of fracture during the " knitting " or healing process is without any foundation.

TREATMENT. — The object of a surgeon in treating a fracture is simply to assist Nature. He first carefully reduces the fracture, or "sets" the bone; that is, he endeavors, as far as possible, to bring the broken extremities in apposition or directly against each other, and by retaining them in position for a certain length of time by splints or some other form of support, the permanent union is effected by the callus, and the function of the part generally restored.

Although it is best that a fracture should be reduced and the proper dressing applied as quickly as possible after the accident, it should be remembered that the union of the fragments does not begin for some time after the injury, and that a fracture may remain several days before being reduced, and be still followed by excellent results ; and also that a frequent cause of compound fracture is the outcome of unskillful manipulation. Consequently, when one not a surgeon is called upon to attend a person where a fracture is suspected, his duty consists in protecting and making immovable the injured part, and conveying the subject to a hospital, or wherever he can receive the necessary and proper treatment. However, should this be impossible, as the result of the accident having occurred where the professional services can not be procured for an indefinite period, an effort may then be

made to reduce the fracture, but the manipulations are to be made only with the greatest care.

As a rule, an injured person should not be removed from the position in which he is found until an examination has been made as to the character of the injury. A violation of this rule is a frequent cause of a compound fracture.

A brief account of the manner in which the injury was received should be obtained from the patient or a by-stander. An examination should then be made. If the injury is about the ankle or wrist, it can easily be exposed; however, if the affected part is nearer to the body, the clothing should be *cut* away, and not removed in the ordinary manner, which would be likely to disturb the fragments and increase the suffering. The different garments need not be indiscriminately cut, but, if possible, ripped at the seams.

If a fracture has occurred, an examination will probably show one or more of the ordinary symptoms and signs already described. If the necessary surgical attendance can be secured within a number of hours, the splints should be applied without an attempt being made to reduce the fracture ; otherwise, an effort in this direction is justifiable.

The reduction of a fracture consists in bringing the ends of the broken bone together, and is accomplished by extension and counter-extension. The term extension, when applied to the treatment of a fracture, indicates a procedure whereby the broken limb below the seat of fracture is pulled *from* the body. In counter-extension, the upper fragment, or the portion of the broken bone nearest the body, is held securely in position, or is carried in an opposite direction from the lower fragment. This manner of reducing a fracture is performed by the surgeon with the hands or an instrument devised for the purpose. The hands are generally used.

The extension and counter-extension should be made in a straight line; that is, in the long axis of the broken bone.

After the seat of injury has been examined, and the presence of a fracture ascertained or suspected, the clothing previously turned aside can now be replaced and wrapped around the part, thus affording considerable protection to it.   The splint should then be adjusted, and the patient removed to a place where he can receive the proper surgical treatment.

The slings necessary to support an injured arm have already been described (see TRIANGULAR and CRAVAT BANDAGES).   In addition to these, the skirt of the coat may be utilized for this purpose (Fig. 74); also other devices, such as pinning the sleeve to the waist, etc.

If the fracture is compound, no effort should be made to apply splints until the wound has been covered as quickly as possible with an antiseptic material or some form of clean dressing. When a blood-clot fills the wound, it should under no circumstances be disturbed until the patient is in the hands of the surgeon. The protection afforded by the compress or blood-clot just alluded to, prevents the entrance of poisonous germs into the system. If a point of the broken bone is pushed through the skin, it should not be interfered with, but dressed antiseptically.

FIG. 74.—Skirt of coat used as a sling.

SPLINTS.—Splints can be made of any material which is capable of rendering the part practically immovable without injuring the soft structures to which they are ap-

plied. They should be long enough to extend some distance above and below the injury, and generally including the nearest joint, and at times two or three joints, as in fracture of the thigh. Their diameter should exceed that of the limb to which they are applied, although this is not absolutely necessary, as a cane or a sword makes a very fair support. Two splints are generally used, one for the inner and one for the outer side of the limb. Splints should always be padded on the side next to the skin with some soft material, so as to prevent undue pressure and injury. After a splint has been fitted to the limb, it should be retained by the necessary bandages; the latter, however, should not surround the limb at the point of fracture, nor should they be drawn sufficiently tight to increase the suffering of the patient. This should be particularly observed in *unreduced* fractures.

Although thin wooden boards are regarded as the most desirable material for splints (at least for temporary use), being light, and easily formed to suit special cases, other substances may be employed with good results. Among those which can be secured in emergencies are shingles, laths, fence-boards, cigar-boxes, barrel-staves, bark and branches of trees, the latter being bound together with cord or green twigs. Binders' board, cut into the proper shape, makes an excellent splint. Book-covers may be used; also sole-leather, newspapers tightly and thickly folded, hay or straw bound in the same manner as the branches of trees; canes, umbrellas, broomsticks, coat- or shirt-sleeves or boot-legs stuffed with hay, grass, leaves, etc., can be utilized. A pillow, or an article of clothing properly folded, makes a very valuable temporary splint and pad combined, and is particularly useful in fracture of the leg (Fig. 79).

In military service, in addition to the above articles, guns, swords, scabbards, bayonets, leather from a saddle, etc., can be made available.

PADDING.—For padding, cotton or any soft substance,

as an article of clothing, oakum, furniture-stuffing, straw, hay, moss, grass, leaves, etc., may be used.

Bandages for the purpose of retaining the splint may be formed of handkerchiefs, neck-ties, suspenders, strips of clothing, straps, green twigs, rope, cord, wire, etc. Care should be taken that when using such substances which are small, as wire and cord, that the skin be well protected, so that it shall not be injured or cut.

Special fractures will now be considered.

FRACTURES OF THE CRANIAL BONES are usually followed by symptoms of concussion and compression of the brain. A fracture occurring at the base of the skull is usually caused by a blow about the forehead or opposite the point of fracture, or by a fall from a height, the person striking on the head or upon the feet or buttocks, and has, in addition, special symptoms which point directly to this form of injury, viz., an escape of blood from the nose and ear, and beneath the thin membranes covering the eye ; or, what is still more positive, an escape of a colorless fluid from the ear.

Treatment.—The patient should be placed on his back in a cool, dark room, and kept perfectly quiet. Cold, in some form, should be applied to the head, to prevent excessive reaction. For the same reason, the internal use of stimulants is to be avoided.

FRACTURE OF THE INFERIOR MAXILLARY BONE (lower jaw) is caused by kicks, blows, or falls. The body of the bone (the portion into which the teeth are inserted) is the usual seat of fracture, which is generally compound, having a communication with the cavity of the mouth. The deformity is shown by the irregular line of the teeth on the affected side. Crepitus, swelling, dribbling of saliva, and bleeding from the mouth, are also generally present.

Treatment.—The teeth should be brought together, thus allowing the superior maxillary bone (upper jaw) to act as a splint. A four-tailed bandage (Fig. 43) should then be applied to retain the parts in this position.

FRACTURE OF THE SPINAL COLUMN should be suspected when, following an injury to the back, there appears more or less paralysis *below* the point of injury (paraplegia), as the result of pressure upon the spinal cord. The ordinary symptoms of fracture are not usually present, *nor should they be sought for*, as efforts made to elicit crepitus, etc., might increase the injury to the spinal cord. Paraplegia may also be caused by a dislocation of the vertebræ.

Treatment.—The patient should be allowed to assume the position (lying down) which is most agreeable to him, provided he does not lie *face downward*. An ice-bag, or some form of cold, may be applied to the seat of injury, and perfect rest enjoined. If necessary, the patient can be moved on a stretcher which is so prepared that undue movement of the spine is prevented (see TRANSPORTATION). The after-treatment, consisting of efforts made to adjust the fragments of bone and to prevent subsequent inflammation and injury to the spinal cord, and relieving the paralyzed bladder of urine, should be attended to *only* by a surgeon.

FRACTURES OF THE RIBS are caused by direct or indirect violence, as the result of a fall or a blow, or being subjected to severe pressure, as in a crowd, or by muscular contraction. Muscular action during a paroxysm of coughing or sneezing, has been known to produce a broken rib. The seat of fracture is usually between the third and eighth ribs, and about on a line downward from the axillary space. The floating ribs—eleventh and twelfth—are rarely broken, owing to their single attachment (vertebral column), which allows sufficient freedom whereby to escape injury.

Fractured ribs are usually difficult to recognize, in a large number of cases the injury being mistaken for contusions.

Embarrassed and shallow breathing, associated with a sharp and lancinating or "stabbing" pain at the injured part, or a "stitch in the side," is almost always complained of. Crepitus may sometimes be detected by placing the

hand or the ear against the injured side, and then having the patient take a long breath or cough. It is uncommon to find any external evidence of fracture, and great care should be observed in examining so as not to inflict a greater injury by the manipulation.

A broken rib may be followed by serious consequences, as an injury to the lung, which would be demonstrated by shock, spitting of blood, and, in some cases, a crackling sensation when the hand is carried over the skin at the seat of pain, due to the presence of air under the skin (emphysema).

Treatment.—The treatment consists in limiting the action of the affected side or sides as much as possible. This indication is met by the application of bandages or adhesive plaster. A triangular bandage, folded in the form of a cravat, and bound snugly around the chest, would answer for a temporary dressing; a flannel or muslin bandage, about three inches wide, and made to encircle the chest a number of times, would be still better. At the present time, however, the most effective means of treating a fractured rib is by the use of adhesive plaster, applied in the following manner : Strips of plaster, one and a half or two inches wide and about fourteen to twenty inches long, (for the adult) or sufficient to extend somewhat more than half-way around the chest, are made ready. The strips are heated and then applied firmly around the chest (from above downward), following, as nearly as possible, the course of the rib, each strip overlapping the lower third of the preceding one. The space covered by the strips should be about eight inches in width. If, for example, the fracture is on the right side, the adhesive plaster should be first applied at about three inches to the *left* of the spinal column, and the other end should be carried around the *right* side of the chest to about the same distance to the *left* of the breast-bone, thus restraining the action of the injured side without materially affecting the opposite one. In the use of bandages or the strips of plaster, as already described, it is very important that they (particularly the

plaster strips) should be applied *at the end of expiration*, as at this time the chest is diminished in size and the broken fragments are brought closer together.

The above treatment may also be used in severe contusions of the chest.

FRACTURE OF THE CLAVICLE.—The collar-bone is more frequently broken than any other bone in the body, and is usually the result of indirect violence, as falling upon the shoulder. The recoil of a gun may cause direct fracture. It will be remembered that the collar-bones hold the shoulders *upward*, *backward*, and *outward;* consequently, the deformity following this injury would be dropping of the shoulder *downward*, *forward*, and *inward*, with some change in the outline at the site of the fracture.

Treatment.—The patient may be laid down, with a pillow between the shoulders, or, if he is to be removed, the following temporary support may be used : A soft pad is placed well up in the axilla or arm-pit, the forearm being laid against the chest and the shoulder raised by pressing the elbow upward, and held in this manner by an assistant, or by the patient himself, until supported by the bandages to be now described. A triangular or Esmarch bandage, folded in the form of a cravat, or a long strip of cloth, should be placed under the elbow, and one end carried upward, across the chest, and the other across the

FIG. 75.—Temporary dressing for fracture of clavicle.

back, and the two ends fastened over the opposite shoulder ; a similar bandage is then placed against the outside

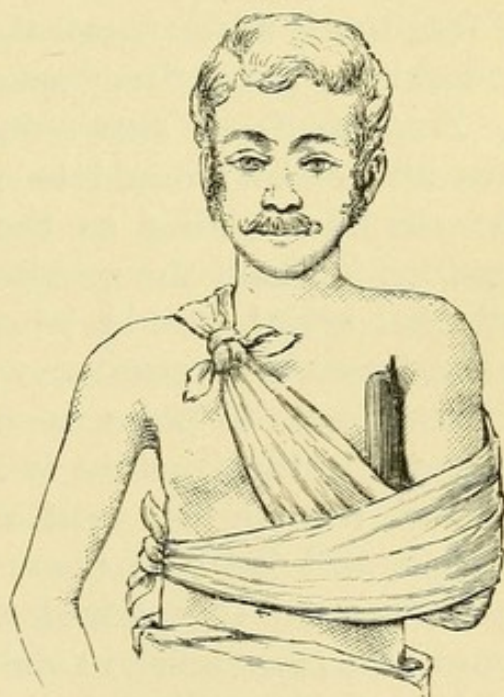of the arm, on the injured side ; the ends of the second bandage are carried across the chest and fastened at the opposite side. The dressing fulfills, to a great extent, the indications for treatment, viz., carrying the shoulder upward, backward and outward (Fig. 75).

FRACTURE OF THE SCAPULA or shoulder-blade is of rare occurrence, and the result of direct violence, as a heavy wagon-wheel passing over the part.

The signs and symptoms are usually obscure, the bone being so thickly covered with muscular tissue that it does not exhibit much deformity.

Treatment.—In a suspected fracture, the arm of the corresponding side should be placed in a sling and kept quiet by the side of the chest.

FRACTURE OF THE HUMERUS or arm-bone may be the result of direct or indirect violence or of muscular contraction. The signs and symptoms are usually well marked, and there is considerable shortening. If the seat of fracture is at the surgical neck, a bony prominence may be found in the axillary space or arm-pit.

Treatment.—When reduction is to be made, the forearm and elbow should be pulled downward (extension), the shoulder acting as the counter-extension. If the fracture is about the middle of the bone, an internal and external splint should be applied. Great care must be taken least the internal one should be carried into the arm-pit and made to press upon important blood-vessels and nerves. If the fracture is in the upper part of the bone, through the surgical neck, a soft pad may be placed in the arm-pit and held in place by a figure-of-8 bandage, or spica, around the shoulder. The hand and wrist only should be suspended in a sling, thus allowing the elbow to drop, thereby diminishing the tendency to shortening of the arm.

FRACTURE OF THE FOREARM generally occurs at the lower end of the radius, about two inches or less from the joint, and is known as Colles' or "silver-fork" fracture.

It receives the latter name from the peculiar appearance about the wrist, which has a fancied resemblance to a silver fork. Colles' fracture is almost as frequent as fracture of the clavicle, and is commonly impacted.

Treatment.—The arm should be placed at right angles, the thumb pointing toward the chin—midway between pronation and supination. An internal and an external splint should be applied, extending from the upper part of the forearm to the finger-tips. Care should be observed, in applying the internal splint, that it does not press upon the vessels at the bend of the elbow.

Reduction may be accomplished as follows: Should the fracture be on the right side, for instance, the attendant should grasp the right hand of the patient with the corresponding one of his own, and extension be carefully made; counter-extension being performed with the left hand, which grasps the forearm above the seat of fracture.

FRACTURE OF THE MIDDLE OF THE FOREARM may occur as the result of direct violence. One or both bones may be broken. When the latter occurs, the appearance is very characteristic. However, when either the radius or ulna is broken, the companion-bone acts as a splint, and the deformity and other signs are not so marked. In fracture of the *shaft* of the radius, which is uncommon, the usual symptoms of fracture are noted, and, in addition, the loss to a greater or less degree of pronation and supination, or turning the hand inward and outward. Fracture of the ulna sometimes follows an attempt to ward off a blow, and is not uncommon among pugilists.

Treatment.—Fracture at the middle of the forearm should be treated in the manner already described for Colles' fracture—internal and external splints applied while the arm is bent at an angle, with the thumb pointing to the chin, the injured limb then being supported by a sling.

FRACTURE OF THE METACARPAL BONES.—Indirect violence, as a fall upon the hand, or striking a blow with the

fist, is a common cause of fracture at this situation. A swelling on the back or dorsum of the hand usually follows, and the knuckle corresponding to the broken meta-carpal bone is sunken, and appears to be effaced.

Treatment.—A roller-bandage, wad of cotton, oakum, or other similar material, or a potato, lemon, etc., should be placed in the palm of the hand and retained there by a bandage.

FRACTURES OF THE PHALANGES are generally detected without much difficulty, the common signs of fracture being well marked.

Treatment.—After reduction has been accomplished, splints should be applied to the palmar and dorsal sides of the broken finger. A piece of a cigar-box may be used for this purpose, although a piece of tin or sheet-zinc, entirely covered with adhesive plaster, would be preferable ; or, after the fracture is reduced, the finger may be bound to a companion finger, or covered with a narrow roller-bandage, and stiffened (after being applied) with flour and white of an egg, which makes a very good temporary dressing.

FRACTURE OF THE FEMUR is one of the common fractures of the body. The great size of the bone—it being the largest in the skeleton—and the fact that more or less limping due to the shortening of the affected limb may follow this injury (particularly in the adult), makes the treatment a matter of great importance to the surgeon. The femur may be broken either at the neck, extremities, or shaft, the most frequent situation being about the middle of the bone. The fracture is more commonly caused by indirect violence, as falling, etc., and is oblique (in adults), which principally accounts for the shortening that follows.

The signs and symptoms are usually well marked. The foot and leg are turned outward, particularly if the shaft of the bone is broken. Fracture of the neck of the femur occurs in old people, and is due to the composition of bone at this period of life, which is more dense than at any other time, and also to the change in the angle of the neck of

the bone, and may in the aged follow a most trivial cause, as tripping, etc.

Treatment.—A long external splint, extending from about four inches below the axillary space or arm-pit to a short distance below the foot, is sufficient for a temporary dressing. If a gun is used as a splint, the stock should be placed beneath the arm-pit, and the barrel (turned downward) laid against the leg (Fig. 76). A fence-board, which is usually about six inches wide, makes an excellent splint. Before applying the splint, the thigh should be surrounded by a coat properly folded, or shawl, etc. A bandage should then be carried around the waist, two around the thigh (one above and one below the seat of fracture), one around the leg and foot each—the bandages being tied on the outside of the splint. If no better support can be devised, the affected limb may be bandaged to the one of the opposite side.

If a fracture of the femur can not be attended to by a surgeon within a short time, temporary extension and counter-extension can be made. The patient, for example, can be laid upon a bed, the foot of which is raised six or eight inches, thus carrying the body of the patient away from the seat of fracture (counter-extension). A large wad of cotton, or a fold of flannel or other soft material, should be wrapped around the ankle
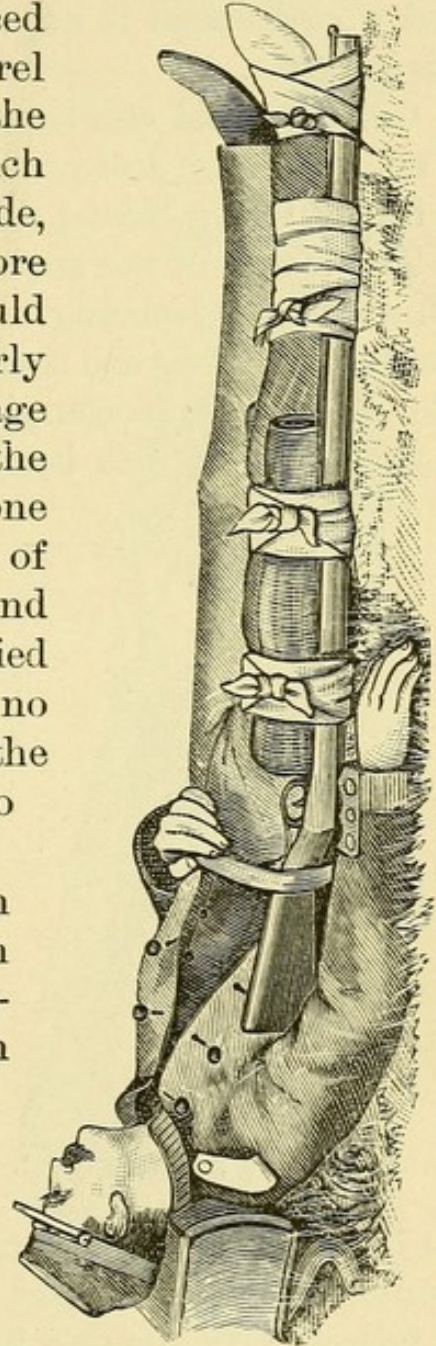
FIG. 76.—Gun used as a temporary splint for fracture of the femur.

and instep to prevent the bandage about to be described from injuring the part. The next step consists in arranging some means by which temporary extension can be made. This indication is very effectively met by the use of Gerdy's "extension-knot," which not only holds the foot in a firm grasp, but prevents the undue constriction that would ensue if an ordinary knot were employed for this purpose.

Gerdy's knot can be made out of a strip of muslin five or six feet long and about six inches wide. This should be folded into a cravat (two inches in width).

The center of the cravat is placed upon the ankle-joint behind, the ends being brought forward and crossed over the instep. They are then continued downward under the sole of the foot, recrossed and carried upward on the sides to the malle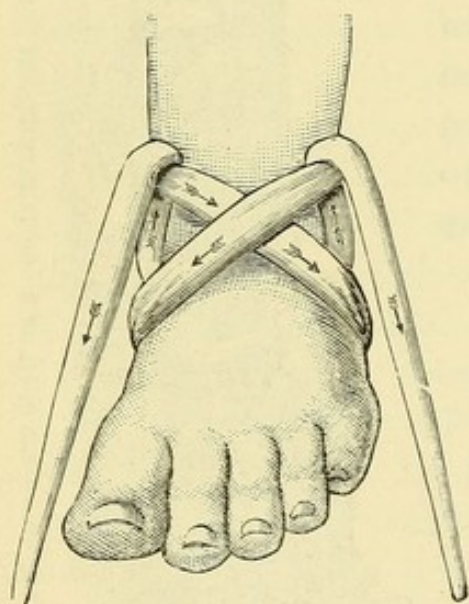oli (the bony prominences at the inner and outer sides of the ankle-joint), and then *under* the first turn around the ankle and downward, and tied below the foot in the form of a loop, in order that the weight shortly to be described may be attached (Fig. 77). A pail, bag, or some other receptacle should now be procured and in it placed stones or sand, or weight in some form, amounting to from ten to fifteen pounds, and so arranged that it can be readily attached, at the proper time, to the loop connected with the patient's foot. Extension and counter-extension should now be made by the attendants, as follows : While one holds the body in position, another grasps the leg and foot on the affected side, and makes steady extension ; a third attendant should place his hands over the seat of fracture to support and protect it.

FIG. 77.—Gerdy's extension-knot.

When the proper length has been regained, or nearly so, and while the limb is held in this position, the weight already prepared should be carefully and slowly attached. The weight should hang suspended over the foot-board of the bed, if the latter is low enough (on a level with the affected extremity), or over a board placed upright. *After* extension and counter-extension are made, and the weight is attached, the splints should be applied—*not before*. If the attached weight causes pain, it should be diminished.

FRACTURE OF THE LEG.—Fractures of this portion of the body usually affect both bones, although either the tibia or fibula may alone be fractured, the fibula probably oftener than the tibia. The fibula is generally broken near its lower extremity, and is known as Pott's fracture. In fracture of both bones, which commonly occurs about the middle, the signs are generally well marked, more so than when either the tibia or fibula only is bro-
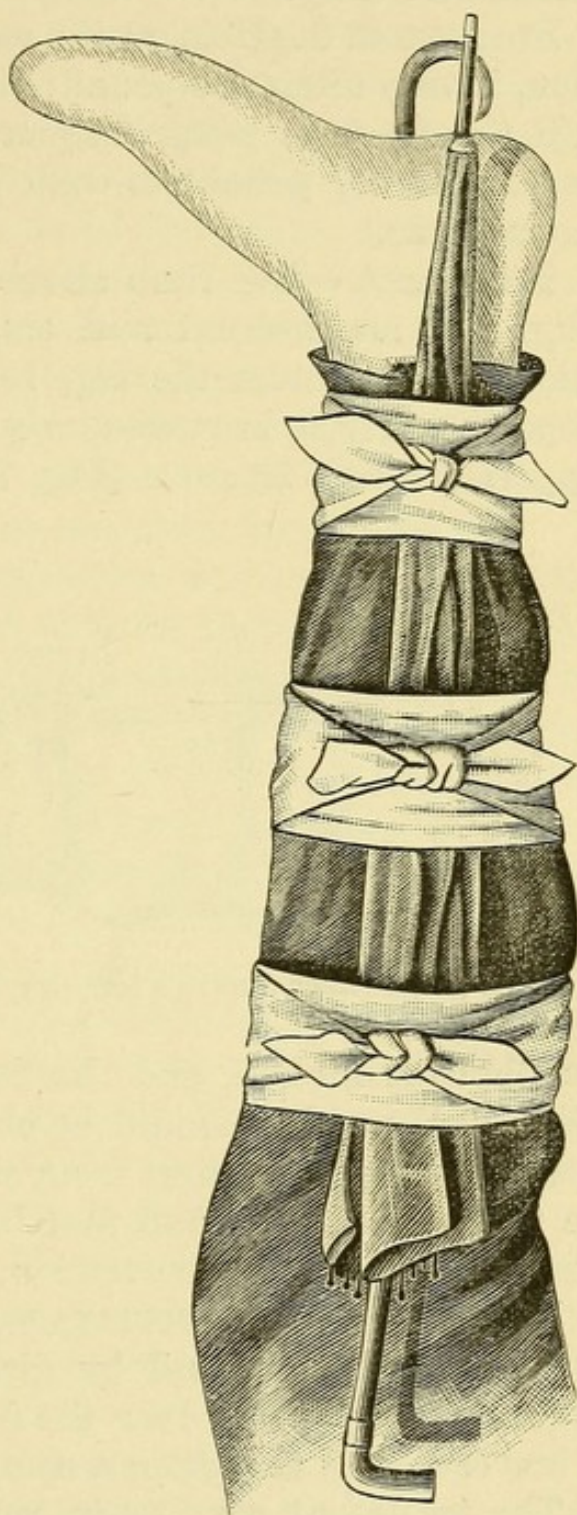
FIG. 78.—Umbrella used as temporary splint in fracture of the leg.

ken. Pott's fracture is usually attended with some eversion or turning outward of the foot, producing a characteristic deformity.

Fracture of the tibia, as the result of its superficial situation, is very often compound; the wound communicating with the fracture being frequently caused by efforts on the part of the patient to walk immediately after breaking the bone.

Treatment.—The limb should be handled very carefully, and an internal and external splint applied. A pillow placed under the leg, folded over the sides, and properly retained, is particularly adapted as a temporary support for this fracture (Fig. 79). If the lower end of
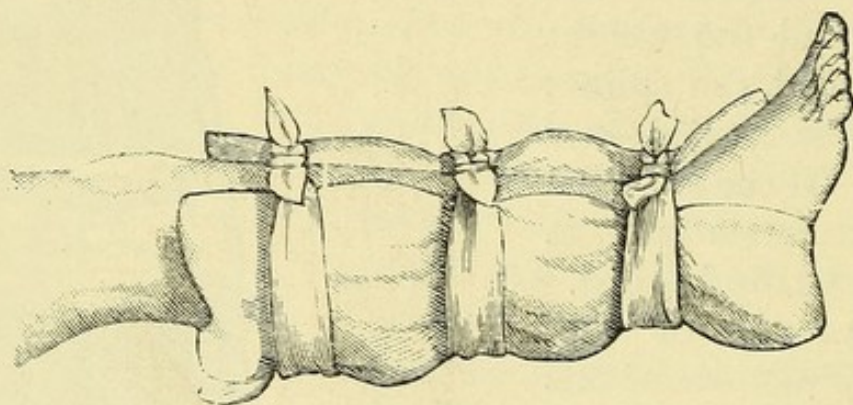

Fig. 79.—A pillow used as a temporary splint in fracture of the leg.

the fibula is broken, and the foot is turned outward, a splint, well padded, should be placed along the *inner* surface of the leg, extending from above the knee to beyond the foot, and the leg and foot bound to it, thereby overcoming the tendency to eversion.

Fractures of the metatarsal bones and phalanges of the toes are caused by direct violence, as a heavy wagon-wheel passing over the foot, which produces more or less crushing, and often a compound fracture.

The treatment consists in binding the affected toe to the one next to it, or by supporting the fragments with compresses or light splints. When the foot is seriously injured by crushing, amputation is often inevitable.

DISLOCATIONS.

A DISLOCATION or luxation is a forcible displacement of one articular (joint) surface of a bone from another, and may be the result of direct or indirect violence, or of muscular contraction. More or less rupture of the ligaments always takes place. The chief signs of a dislocation are deformity and loss of function of the joint. The mobility of the part is greatly diminished, while in fractures there is increased mobility. In dislocation the deformity is at the joint, while in fracture it is usually about the shaft. Crepitus is absent in a recent dislocation, and generally present in fracture. These points should be remembered, as dislocations are sometimes mistaken for fractures.

The reduction of a dislocation requires considerable technical skill, and should only be performed by a surgeon. Exceptions to this rule, however, may be made in dislocation of the *shoulder*, *lower jaw*, and *fingers*, provided the case can not be seen by the surgeon within a few hours.

DISLOCATIONS OF THE HUMERUS usually take place downward below the glenoid cavity (see SCAPULA). The indications for reduction are, to disengage the head of the humerus from its abnormal position by extension, counter-extension, and fulcrumage. This may usually be accomplished in the following way : A firmly compressed ball of cotton or similar material should be placed in the axilla or arm-pit ; the attendant should then remove the shoe from his foot nearest the affected side of the patient (facing the latter), and press the heel upward against the ball already in the arm-pit ; he should also grasp the patient's hand and arm, and pull downward, thus making extension and counter-extension. In this manner the head of the humerus is disengaged, and, if the foot of the attendant can be turned outward and the arm of the patient brought toward the chest *during extension and counter-extension*, the bone will generally slip back into

its proper position. After the reduction the arm should be bandaged to the chest, to prevent redislocation. It should not be forgotten that the axillary space contains many important blood-vessels and nerves, and too forcible manipulation may be followed by very serious consequences.

DISLOCATION OF THE LOWER JAW (inferior maxillary bone) is comparatively rare. It may be the result of a blow, but usually follows the act of gaping, laughing, or vomiting. The deformity is striking : the jaw is protruded and remains open, the patient being unable to bring the teeth together. The articular surfaces of the bone in this injury being carried *forward*, and somewhat upward, the reduction should be accomplished by depressing the articular portion (condyles) of the lower jaw, and forcing them backward. This may be performed in the following manner: The patient should be placed in a chair, with the operator standing before him, having his thumbs wrapped in a handkerchief, or some similar material, to guard against injury during the sudden closure of the patient's jaws at the moment the dislocation is reduced. The attendant then places a thumb upon each posterior molar tooth of the inferior maxillary bone of the dislocated jaw, and presses firmly downward, and with his fingers he tilts the chin upward. While the bone is being carried downward in this manner, a backward pressure with the thumbs should then be added which helps to carry the articular surfaces to their proper position. The jaw should then be held in place by a four-tailed bandage (Fig. 43).

DISLOCATION OF THE PHALANGES may be reduced by bending the dislocated bone further back, at the same time making extension and counter-extension, then suddenly flexing the joint. The subsequent adjustment of a dorsal and palmar splint is necessary.

SPRAINS.

A SPRAIN is a wrenching or twisting of a joint, associated with considerable stretching, and even tearing, of the

tendons and ligaments of the affected part. Sprains usually occur at the ankle or wrist. Pronounced swelling and pain rapidly ensue, and are characteristic of the injury; though it is often difficult to differentiate between a sprain, dislocation, or fracture. The proper relation of the ends of the bone composing the joint, and the absence of the principal signs of dislocation or fracture, indicate that a sprain exists. A sprain is always troublesome, and may be followed by serious results, a common sequel being anchylosis, or stiffness of the joint.

TREATMENT.—When the patient is seen soon after the injury, the part should be elevated, and a cold application made, preferably the rubber bag (manufactured for this purpose), or a pig's bladder partly filled with cracked ice. Should neither of these be obtainable, the cracked ice may be placed in a handkerchief or towel, and, if possible, the dressing enveloped with oiled silk or rubber cloth. If ice can not be procured, cloths wrung out in cold water should be substituted. A roller-bandage, carefully applied from the extremity upward, is also valuable in preventing the continuation of the swelling. The ice or cold-water applications can be applied *over* the bandage; it must, however, be borne in mind that a bandage that has been wet will shrink, and may make dangerous pressure, or even cause strangulation of the part. After the acute symptoms have subsided and the heat and swelling have diminished, the cold applications should be discontinued and gentle friction substituted; or the joint may be rubbed with a stimulating lotion, as soap-liniment, alcohol, or salt water. Massage is also a valuable remedy. Exercise of the affected joint should be commenced after the acute symptoms have subsided, and continued until the function of the part is re-established. This portion of the treatment is very essential, and, if not adhered to, permanent stiffness of the joint will follow.

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CHAPTER XIII.

BURNS, SCALDS, AND FROST-BITE.

BURNS AND SCALDS.

BURNS are caused by the action upon the tissues of some form of dry heat, or by a chemical agent. For practical purposes burns are divided into three degrees : (1) Simple redness of the skin; (2) vesication or the formation of blisters ; (3) more or less destruction or charring of the skin and deeper structures. Burns of the first and second degrees are usually unattended by serious consequences, but when they involve one half or more of the surface of the body a fatal result usually follows. Burns of the third degree are dangerous according to their situation, extent of injury, and complication. Burns of the thoracic and abdominal walls are often attended with great danger. Death following burns is the result either of shock (during the first twenty-four hours), internal inflammation, ulceration and hæmorrhage, blood-poisoning, tetanus, or exhaustion.

The temperature of the body falls immediately after a severe burn ; this is temporary, however, and is soon followed by more or less fever.

In burns of the third degree, which heal by granulation, the contraction of the scar and subsequent deformity of the part are particularly marked.

TREATMENT.—The treatment of burns is divided into local and constitutional. The *local* treatment depends upon the degree to which it belongs.

In BURNS OF THE FIRST DEGREE, remedies which are

soothing and protective against atmospheric air and cold should be applied. Among those which generally can be procured at once are bicarbonate of soda (common baking-soda, *not washing-soda*), starch, flour, chalk, magnesia, or charcoal. One of these may be thickly dusted over the burned surface. Vaseline, cosmoline, lanoline (made from wool-grease), olive, linseed, or castor oil; also lard and butter, provided they are not salted nor rancid; white lead paint, or lime-water, whitewash, or even ink, mucilage, or molasses may be employed, although inferior to some others.

The agents enjoying the highest reputation in the different hospitals, at the present time, are those containing carbolic acid (about five per cent), as carbolated cosmoline, vaseline, oil, lanoline, etc. The carbolized applications are not only protective and antiseptic, but the carbolic acid which they contain produces anæsthesia of the affected surface; that is, it diminishes the sensibility of the skin. "Carron-oil," composed of equal parts of linseed or olive oil and lime-water, is regarded as a very valuable remedy. The cosmoline, vaseline, carron-oil, etc., should be spread on a piece of lint, soft linen, or muslin, and laid on the burn. The part should then be enveloped in cotton batting, or two or three folds of flannel, or some other soft material which will properly protect the part ; the dressing should then be retained by a bandage. During the examination of severe burns of any degree, and also while the application of dressings is being made, great caution should be observed that the part is not unduly exposed to the air ; death has followed the careless exposure of a burn of this character. Such danger can be avoided by examining or dressing one part of the burn at a time.

In BURNS OF THE SECOND DEGREE the blisters require special treatment. If attached to the burn, the clothing should never be forcibly removed, but carefully cut off with scissors as close to the burn as possible. The small pieces adhering to the skin may be washed away with warm water, or softened with oil, and detached later. If

the blisters are large, they should be pricked at their lowest part, and the contents allowed to escape, or should be absorbed with clean blotting-paper. The oily substances recommended for burns of the first degree should then be applied in the manner already described. The dressings should not be disturbed oftener than every two days unless they become moist or offensive.

In BURNS OF THE THIRD DEGREE, where there is destruction of the tissues and more or less sloughing, antiseptic applications (carbolized vaseline, oil, etc.) are particularly indicated; offensive discharges should not be allowed to accumulate, but must be removed by warm antiseptic solutions, and fresh dressings applied. The removal of the slough or dead tissue may be hastened by the use of antiseptic poultices. (See POULTICES.)

In burns caused by acids (generally sulphuric, nitric, and muriatic), water should not be applied, for, when combined with an acid, an elevation of temperature of the mixed fluids immediately follows. The proper remedy would be the application of an alkaline powder, bicarbonate of soda, magnesia, chalk, or lime; the latter may be scraped from the walls. These agents neutralize the acid, and should be left on the surface but a few moments and then washed off.

If an acid is splashed into the eye, lime-water or a solution of soda or magnesia should be applied at once, also a few drops (three or four) of a four-per-cent solution of cocaine; the latter relieves the excessive pain. Burns of the mouth and throat from the same cause (acids) are also to be treated by the free use of the alkalies already mentioned. (See POISONS.)

Burns produced by caustic alkalies (caustic soda, potash, lime, ammonia, also quicklime and lye) should be treated by the application of acid solutions, as diluted vinegar, lemon-juice, hard cider, etc. Nitric, muriatic, sulphuric, and acetic acid may be used, but only when *abundantly diluted* and with great circumspection.

After the acid or alkali causing the burn has been neu-

tralized, the oily substances already referred to should be applied as in ordinary burns.

CATCHING FIRE.—Some of the severest forms of burns follow the catching fire of some portion of the wearing-apparel. A person in this condition should at once be enveloped in a blanket, coat, mat, piece of carpet, or whatever may be at hand to extinguish the flames, or she (the victim is usually a woman) should be rolled over and over on the floor to smother the flames. Water must be freely used and the clothing carefully examined to ascertain if the fire has been entirely extinguished. The burned surfaces should then receive the proper attention, according to their degree and intensity.

Constitutional Treatment of Burns.—Shock, which is always present in severe burns, requires the administration of stimulants. Pain is more constant and intense in burns than in any other form of injury, and requires sedatives, which will be administered by the medical attendant. Later on, the appearances of inflammation and other complications are to be carefully watched for.

SCALDS are injuries produced by the application of moist heat, as boiling water, steam, etc. Children commonly suffer from these injuries as the result of pulling over kettles containing hot coffee, tea, or water. Scalds should be treated as burns of the first and second degrees.

FROST-BITE.

Prolonged exposure of the body to a very low temperature results in a general or local loss of vitality. While the air is still, or snow is falling, it is favorable to the one exposed. Snow is a bad conductor of heat, and offers considerable protection; but when the wind is blowing, the warm air close to the surface of the body is rapidly removed, and the destructive effect of the cold is considerably increased. An exposure of one or two hours, inadequately clad, to intense cold is generally followed by a fatal result. Those who are thus unfortunately situated are soon overcome by

an irresistible sense of drowsiness and desire to sleep; to yield to the inclination is usually fatal. This disposition to stupor is due to the great diminution in the blood-supply to the surface, and consequent congestion of internal organs. In this condition the brain is unable to properly perform its function and the drowsiness follows.

In those who are frozen, the limbs become stiff and the skin white; the latter is preceded by a blue or purplish tint, which may still be apparent at the tips of the nose, toes, and fingers. This change in color denotes that the circulation and nourishment of the surface of the body are profoundly interfered with, and is commonly followed by excessive reaction and inflammation or gangrene.

TREATMENT.— A person who is frozen should never be taken to a warm room, or have warmth applied to the body. An abrupt change in temperature would be almost necessarily fatal. The temperature must be gradually raised. Consequently, the patient should be carried to a cool apartment, the clothing removed, and the body rubbed with snow or cold water. After a short time, particularly if consciousness returns and the limbs lose their rigidity, the use of a piece of flannel, or, still better, the hand, can be substituted for the cold application. The continuous rubbing may now be discontinued, and occasional friction resorted to. These measures must be pursued very gently, as rough manipulation might destroy the skin. It may be necessary to resort to artificial respiration in extreme cases.

Stimulants carefully administered are indicated if the patient can swallow; until this is possible, they should be given by the rectum, or ammonia or smelling-salts by inhalation ; nourishment in the form of beef-tea or milk may be given as soon as the patient can take it. The surface of the body should be carefully protected, but not subjected to heat, as some time must elapse before the circulation of the affected part regains its equilibrium. If portions of the surface subsequently become dark bluish or mottled, gangrene has commenced.

CHAPTER XIV.

UNCONSCIOUSNESS, SHOCK, AND SYNCOPE.

UNCONSCIOUSNESS.

UNCONSCIOUSNESS is associated with a number of different affections, and in order to intelligently treat this condition it is necessary that one should be familiar with the different causes producing it ; among which are apoplexy, opium-poisoning, syncope, concussion and compression of the brain, and epilepsy. This is very important, as the remedies suitable for one would be unfit for another : for instance, the unconsciousness due to syncope demands stimulants, which, if administered in apoplexy, might cause or hasten a fatal result. Ignorance of this subject has often been responsible for the humiliating and serious mistake of regarding a case of apoplexy as intoxication.

As the result of complications, it sometimes happens that the cause of the unconsciousness may not for the moment be apparent; however, a careful examination for signs indicating the different affections giving rise to this condition will generally clear up existing doubts. During this period of uncertainty the patient should be placed in the recumbent position, with the head slightly elevated or depressed, according to the appearance of the face, whether congested or pale. The clothing about the neck and body should be loosened, and fresh air freely supplied. Stimulants should be used with caution, and only when positively indicated. Artificial respiration may be resorted to in extreme cases.

SHOCK—COLLAPSE.

Shock is a condition in which there is a more or less diminished energy of the heart and circulation, and is the result of a severe impression made upon the nervous system, produced by either a physical injury, or a mental emotion. The majority of cases met with are the result of extensive burns or other grave injuries, particularly those produced by gunshot wounds and railway accidents, which are generally associated with great laceration and crushing of the tissues, and mental excitement. Severe cases of shock may be produced by fright alone. Shock may be of a very mild character, as the result of a trifling injury or fright, the symptoms being hardly noticeable, of short duration, and demanding no treatment; or, it may assume a form which is rapidly fatal.

The symptoms of shock depend upon the severity of the cause ; in some, where the injury is slight, they may be hardly apparent, or, only a pale face and a weak and rapid pulse, a slight nausea, and a general sense of prostration may be evinced. The form that fully illustrates a case of severe shock would be that following a serious railway injury, and can hardly be mistaken. There is no other condition which so closely resembles death. The extreme pallor and coldness of the skin are startling ; the surface of the body is covered with moisture ; large beads of sweat cover the forehead ; the pulse at the wrist may be lost, or if perceptible, is weak, rapid, and irregular; the features are shriveled, particularly about the nose, which appears pinched; the eyes are lusterless, sunken deeply in the sockets, and turned upward, the pupils being generally dilated; the fingers and nails are of a bluish color. The patient is conscious, but dazed and flighty, can not realize his condition, and apparently only appreciates loud and repeated questions; articulation is difficult, although there is no paralysis present. The sensibility to pain may be so blunted that an operation can be performed without the cogni-

zance of the patient. As a result of the depression of the circulation, the heat of the body is diminished, the temperature in some cases being below the normal register. The respirations are sighing in character and irregular, and the patient is restless. These symptoms may continue for a few minutes or a number of hours, and usually end in death.

In cases which end favorably, there appear, usually within an hour or so, symptoms denoting an increase in the strength of the heart and circulation ; this change is known as reaction, and generally indicates, so far as the shock is concerned, a happy termination. When reaction occurs, the color and warmth gradually return to the skin, the eyes are brighter and the mind clearer; the pulse becomes stronger, and the symptoms indicate an approach to the normal condition. Vomiting is regarded as a favorable symptom, and generally denotes reaction.

Reaction, however, does not always insure the safety of the patient, as it may be interrupted suddenly by failure of the heart and death ; or, in injuries about the head, the reaction may be so intense as to go beyond the normal activity of the circulation, and produce serious cerebral diseases, such as congestion or inflammation of the brain; for this reason the patient should be carefully watched, and excessive reaction obviated by position, quiet, cold applications to the head, and warmth to the extremities.

Cases of shock from severe injuries, associated with complete unconsciousness, almost always prove fatal.

TREATMENT.—It will only be necessary to refer to the condition indicated by shock to clearly understand the means necessary to bring about reaction; consequently, whatever can safely be used to stimulate the heart and circulation constitutes the proper treatment. As an illustration, we will suppose that a man has been injured by a railway accident and is found in a condition of shock. Whoever is to attend to the case should at once loosen

the clothing, and make a rapid examination to ascertain whether severe hæmorrhage exists (which fortunately is not common in shock, owing to the feebleness of the circulation), or whether some other symptom may be present demanding immediate attention, which being promptly alleviated, the patient should be carefully conveyed to a place near by, more suitable for the subsequent treatment. While being removed the head should be as low as or somewhat lower than the body, or the extremities may be slightly elevated, so as to favor the flow of blood toward the brain. If possible, four persons should be selected to carry the patient, one for each extremity and the contiguous portions of the body. If one or more of the bones of an extremity have been broken, a temporary splint ought to be applied to prevent any movement of the fragments of bone at the seat of fracture during transportation, and should be attended to as rapidly as possible, and before the man is lifted from the ground. Arriving at the place selected, the clothing of the patient should be removed carefully, or cut away, if necessary, rather than have too much delay. He should then be placed in a warm bed, his head being still kept low.

The treatment now consists in applying warmth to the surface of the body, and internal stimulation. The first indication can be met by surrounding the patient with bottles containing hot water, placing them about the arms and legs, inside the thighs, and under the arm-pits and about the body, but not about the head, as the heat might favor a subsequent congestion when reaction occurs; hot bricks, stones, plates, etc., will also answer the purpose, dry heat being the essential element. It must be remembered that the sensibility of the patient is blunted, and that the bottles or bricks may be so hot as to burn the skin and not inflict any pain. A hot plate, enveloped in a towel, may be placed over the region of the heart, and, when unusual vomiting occurs, mustard plasters applied over the stomach. Friction is a method of some value in exciting

the circulation, and should be resorted to when heat can not be supplied as indicated above. The second indication —the use of internal stimulation—is of course governed by the condition of the patient. If able to swallow, he should be given about two teaspoonfuls of whisky or brandy, with a small amount of hot water, or, still better, hot milk; this may be repeated every ten or fifteen minutes, until four or five doses have been taken, or reaction becomes apparent. When the latter occurs, the stimulant should be diminished or discontinued. There are cases where a greater amount of liquor may be required, but it should be given with caution, as too much may produce undue vomiting and favor excessive reaction. If a number of large doses of a stimulant have been given with no effect, it is evident that the stomach is unable to absorb the fluid, and its further administration by the mouth would be useless. A large number of persons suffering from shock are unable to swallow, as the result of extreme prostration ; this should be carefully ascertained before giving anything by the mouth, otherwise strangulation might ensue, by the fluid entering the larynx. In such cases a tablespoonful or more of liquor in half a cupful of warm milk or water can be introduced into the rectum (lower bowel) by a syringe, and may be repeated about every fifteen or twenty minutes.

The value of the liquors depends upon the percentage of alcohol they contain, which in brandy and whisky is about forty to fifty per cent, and consequently more than in wines, which contain but from fifteen to thirty-five per cent. One half the amount of diluted alcohol would therefore be a substitute for the liquors. Beer and ale, containing only two or three per cent of alcohol, would be worse than useless, simply filling up the stomach, with no satisfactory results. A small amount of spirits of ammonia or ether, or about four or five drops of nitrite of amyl, on the hand or a handkerchief, and placed near the patient's nose, has a decided stimulant effect. Warm turpentine rubbed up

and down the spine can be used with benefit, if it does not interfere with the treatment already begun.

The usual and most effective method of introducing stimulants into the system, now employed by physicians, is by the hypodermic method, which consists of injecting under the skin, with the hypodermic syringe, stimulants— brandy, whisky, or ammonia-water ; the amount so injected being generally from twenty drops to a teaspoonful of the undiluted stimulant, and is repeated as often as is indicated by the condition of the patient.

Artificial respiration may be resorted to in desperate cases, but it is of doubtful value. When reaction has taken place, the stimulants are gradually diminished, and some form of nutriment may, if required, be administered; it must be given in small doses, and of such a character as to be readily absorbed. Warm beef-tea or milk, or an occasional sip of kumyss, will be sufficient for the time being.

SYNCOPE—FAINTING.

Syncope is a condition of suspended animation associated with a great diminution of blood in the brain and unconsciousness, and caused by sudden enfeeblement of the heart's action.

Syncope may be the result of disease of the heart, hæmorrhage, pain, excessive emotion, as grief, fear, and joy; tight lacing, certain drugs, indigestion, hunger, exhaustion, and the hot and vitiated air of public assemblies, are also exciting causes of this condition. Before the stage of unconsciousness, the person affected experiences a weak and sinking feeling, associated with dizziness, dimness of vision, roaring in the ears. The face and extremities become pale, cold, and clammy.

The stage of unconsciousness may last a few seconds or a number of hours; however, it usually extends over a period of but a few minutes, during which time the pulse is either very weak or lost, and the respirations are shallow and sometimes apparently cease.

Fainting is of common occurrence and not usually fatal.

Treatment.—The treatment is very simple, and consists in stimulating the heart and circulation, and increasing the amount of blood in the brain. The patient should be laid down, with the head somewhat lower than the body, to favor the flow of blood toward the brain. Fresh air is one of the essential elements in the treatment of fainting. All tight clothing, as collars, corsets, skirts, or trousers, should be at once loosened, and stimulation in some form begun. Smelling-salts, ammonia, and other stimulants may be poured on a handkerchief or the palm of the hand and given by inhalation, care being taken that none is dropped into the eyes, and that the remedy is not held too close to the nose or mouth, otherwise violent irritation of the air-passages may follow. The head and face may be bathed with an alcoholic solution, as camphor, bay-rum, cologne, or whisky, or friction can be applied to the limbs and over the heart. No attempt should be made to administer stimulants by the mouth unless the patient is able to swallow.

The means just described are usually sufficient to bring about reaction. In some cases, however, it will be necessary to resort to more active measures, such as the introduction of stimulants into the rectum or lower bowel, in the manner described in shock, or the inhalation of nitrite of amyl —about five drops on the palm of the hand or on a handkerchief—held to the nose of the patient, the application of mustard over the heart, or it may be necessary to employ artificial respiration.

A person after recovery from an attack of syncope should be kept quiet until the action of the heart and circulation is properly strengthened.

Syncope and shock are similar, and may be the result of the same cause; however, in syncope the patient is *unconscious*, while in shock he is more or less conscious. Shock usually follows a severe injury, whereas fainting

may follow a very trivial cause. Syncope differs from apoplexy in the following manner : In syncope the face is pale, the pulse weak, and the respiration shallow, and the affection is generally of short duration; while in apoplexy the face is usually congested, the pulse about normal, and the breathing is noisy and labored or snoring (stertorous), and paralysis exists on one side of the body.

CHAPTER XV.

*CONCUSSION AND COMPRESSION OF THE BRAIN—APOPLEXY
—INTOXICATION—EPILEPSY—HYSTERIA—HEAT-STROKE.*

CONCUSSION OF THE BRAIN—STUNNING.

Concussion of the brain is a term applied to a shaking up or jarring of this organ. More or less contusion of the cerebral tissue probably occurs in severe cases. This form of injury is the result of a fall or a blow upon the head, or the shock may be transmitted upward through the spinal column, as in jumping from a height, etc. The injured person may only be stunned or dizzy for a moment, with no loss of consciousness; the face is usually pale, and more or less weakness and trembling of the limbs are present. These transient symptoms are generally followed by a rapid restoration to the normal condition; although in mild cases serious cerebral disturbance may subsequently occur—usually within a week.

In severe cases the patient is in the condition of shock, which has already been described. There is one point connected with the shock following concussion of the brain which must be emphasized, viz., that the reaction is usually excessive, being more pronounced than in shock following injuries of other parts of the body, and often terminates in inflammation of the brain.

Treatment.—In mild cases the treatment consists in keeping the patient quiet, with a cooling application to the head. The more serious cases of concussion of the brain which assume the form of shock should receive the treatment appropriate to the latter affection, particular atten-

tion being paid to the extreme reaction that may occur. For this reason, internal stimulants should not be given. Warmth to the extremities, and cold applied to the head, are also indicated.

Rest and quietude must be insisted upon in all cases of concussion of the brain.

COMPRESSION OF THE BRAIN.

Compression of the brain commonly follows fracture of the skull, a portion of the broken bone being driven into the cerebral tissue and causing pressure. The lodgment of a bullet, or cerebral hæmorrhage, may also produce this condition. It is often difficult to differentiate between concussion and compression of the brain. They may also exist together. The principal distinction between them, when not associated, is as follows : In compression the patient is usually unconscious, and the pupils are dilated, but not in a uniform manner. The breathing is similar to that in apoplexy (stertorous), and more or less paralysis is present.

Treatment.—Aside from keeping the patient quiet and applying cold in some form to the head, and preventing the administration of stimulants, very little can be done by an unprofessional person, and the case should be placed in the hands of a surgeon as early as possible. If a wound is present, it should be protected by an antiseptic compress.

APOPLEXY—STROKE OF PARALYSIS.

Apoplexy is a sudden loss of consciousness associated with paralysis, and generally due to the failure of a certain portion of the brain to perform its function, as the result of pressure following the escape of blood (hæmorrhage) from a diseased cerebral vessel. Embolism, which is very similar to apoplexy in its manifestations, is caused by the plugging up of a large artery within the skull, which is followed by a loss of vitality and function of a portion of the brain.

The paralysis is confined to one half of the body (hemi-

plegia). For example, if the hæmorrhage is on the left side of the brain, the muscles of the right arm, leg, and the corresponding side of the face are rendered powerless. The paralysis may sometimes affect the opposite side of the face. The paralysis occurring on the opposite side of the body from the seat of pressure is due to the crossing of the nerves already referred to (see NERVES).

The form of apoplexy caused by cerebral hæmorrhage affects persons advanced in years. A person may suffer from a number of attacks in quick succession, or at long intervals, or the first may prove fatal. The common belief that one dies during the third attack is unfounded.

An apoplectic attack is abrupt, and not generally preceded by any sign or symptom which indicates its approach. The subject usually falls to the ground as though struck down, although in some cases the attack is less sudden, and preceded by a sharp outcry.

If unconsciousness does not occur immediately, it follows in a very short time—within a few minutes. In this condition the patient can not be aroused, which is an important point in distinguishing this from some other affections. The face becomes reddened or congested, and the pupils are usually dilated—not uniformly, however ; one may be dilated and the other in the normal condition or contracted. The respirations are slow, labored, and snoring (stertorous breathing), the cheeks being puffed out during expiration. The pulse, although generally slow, does not differ very much from that of health. Convulsions and vomiting may occur.

Apoplexy is often mistaken for intoxication—a very disagreeable and unfortunate error. It may also be mistaken for opium-poisoning and epilepsy.

It should be remembered that in intoxication, hemiplegia does not exist, and that the alcoholic odor of the breath is always present (this *may* sometimes be present in apoplexy); also that vomiting is common, and the subject can be more or less aroused by pinching, douching with cold water, etc.

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In opium-poisoning there is an absence of hemiplegia, the respirations are very slow, sometimes being reduced to four or five during the minute. The face is pale and the pupils are uniformly contracted.

The absence of hemiplegia, the convulsive movements, and foaming at the mouth, and the comparative short duration of the attack, are usually sufficient to distinguish epilepsy from apoplexy.

If improvement does not follow an attack of apoplexy within ten or twelve hours, the case usually terminates fatally.

Treatment.—The object of treatment is to arrest the further escape of blood within the skull; consequently the head should be slightly elevated, and cracked ice or some other form of cold applied. The clothing about the neck and waist should be loosened. Internal stimulants, which tend to increase the hæmorrhage, must not be used. If possible, warmth should be applied to the extremities. The further treatment must be indicated by the medical attendant.

INTOXICATION.

Intoxication is a condition of such common occurrence that a lengthened description would be unnecessary. The important element in the consideration of this subject is to impress upon the reader the necessity of particularly distinguishing this condition from apoplexy, and has already been referred to in the article on the latter subject (see APOPLEXY). If any doubt exists, the patient should be laid upon his back, with the head slightly elevated, and all constriction about the neck and waist removed, and perfect quietude and rest maintained until the arrival of the medical attendant.

Treatment.— The treatment of intoxication consists usually of rest and quiet, Nature being generally able to effect the desired result. If vomiting does not take place, mustard may be given to produce emesis (vomiting). In some cases it may be necessary to apply warmth to the

extremities and over the heart, also ammonia or nitrite of amyl by inhalation, and rectal stimulation (coffee, etc.).

EPILEPSY—EPILEPTIC FITS—FALLING-SICKNESS.

Epilepsy is an affection of the brain which at variable intervals gives rise to an attack characterized by convulsive movements and unconsciousness.

Subjects of this disease are usually warned of the approach of a paroxysm by certain sensations which immediately precede the convulsion ; the premonitions, however, are generally of very short duration. The attacks usually occur singly, although one may follow another in rapid succession.

The person affected utters a sharp, piercing cry, and falls to the ground in an unconscious and helpless condition, and is thus frequently seriously injured about the face. This is followed immediately by more or less rigidity, and a few moments later the convulsive movements commence. The eyes are usually opened and turned upward, the pupils being dilated. The face becomes livid and congested, the jaws are brought together with considerable force, and the tongue is very commonly badly wounded by the teeth. There is considerable foaming or frothing at the mouth.

The paroxysm lasts but a few minutes, when consciousness gradually returns, the patient being in a stupid and drowsy condition for a short time afterward.

Malingerers and hysterical subjects who endeavor to simulate epilepsy do not bite their tongues, and always select a convenient place in which to fall.

Treatment.—The treatment of an epileptic attack consists in laying the patient on his back, loosening the clothing, particularly about the neck, and preventing injury to the tongue by placing between the teeth a cork, piece of wood, or handkerchief-knot. The stupor that follows the convulsion requires no treatment, unless the patient is quite weak, when stimulants may be cautiously given.

HYSTERIA—HYSTERICS—HYSTERICAL ATTACK.

Hysteria is a functional affection of the mind and nervous system, occurring in paroxysms, usually affecting females, and characterized by temporary loss of will-power and considerable emotional display on the part of the one affected, who laughs and sobs immoderately, without any regard to the surroundings.

Hysteria sometimes assumes a form which may be mistaken for syncope, apoplexy, or epilepsy, according to the manifestations of the patient.

Hysterical subjects should not be treated as malingerers ; the perverted condition of the nervous system leads them to believe that the illness assumed is real. One unaccustomed to observing cases of hysteria may be easily misled, therefore the following distinctive characteristics should be remembered.

A case of hysteria may be distinguished from syncope in the following manner : In hysteria the extremities and face are warm instead of cold, and the pulse is normal; and when an effort is made to open the eyelids, it is met with considerable opposition, which does not occur in unconsciousness. In the hysteria that simulates epilepsy the tongue is not injured, and, if the patient falls, a suitable place is selected for this purpose, in order to avoid injury. There is no frothing at the mouth in hysteria, unless produced by soap or other agents held in the mouth.

Although hysteria may be associated with temporary paralysis and mistaken for apoplexy, it will be noticed that the facial muscles are not involved, and that the paralysis does not always affect one side of the body (hemiplegia), and there is no stertorous breathing and flapping of the cheeks, which are so prominent in apoplexy.

Treatment.—The best treatment for a case of hysteria is to let the patient alone. To sympathize with one in this

condition simply prolongs the attack and can do no good. Firmness on the part of the attendant, with an intimation that the condition is fully understood, is generally all that is necessary. When considerable demonstration is made, it is a common practice to douche the patient with cold water. If this method is used, it should be confined to the face ; pouring a large quantity of cold water indiscriminately over a weak and delicate woman is not always followed by the most desirable results.

HEAT-STROKE—SUNSTROKE—INSOLATION—SUN-FEVER—HEAT-APOPLEXY.

The term *heat-stroke* is now used to denote the serious manifestations which sometimes follow exposure to intense heat. This condition may be due to the direct rays of the sun, or to a high temperature caused by solar or artificial heat. Those who are employed in hot and close apartments, where the air is impure, as in mines and in the fire-rooms of steamers, are particularly liable to be affected by heat-stroke from artificial heat.

It is a fact worthy of notice that those who generally suffer from this malady are either addicted to the use of stimulants or are in a weak or debilitated condition.

Locality has considerable influence in causing sunstroke, the vitiated air of the city in its hot summer months being particularly favorable to it. The high degree of temperature which can ordinarily be borne by the body is mainly dependent upon the proper action of the skin; the large amount of perspiration being rapidly evaporated, cools the surface and indirectly the blood. Evaporation takes place more rapidly when the air is dry; consequently, heat-stroke is more frequent when the air is moist. The heavy woolen shirts worn by workmen in hot weather are cooler than those made of cotton, because the former increase the activity of the sweat-glands, and indirectly diminish the temperature of the body.

Heat-stroke is not always developed abruptly, nor does

it generally occur at the beginning of a heated term, but usually after the hot weather has been persistent for two or three days. There are certain symptoms which indicate the approach of this affection and should be recognized as a warning, viz.: an irritable and depressed condition ; headache, congestion of the eyes, and flushing of the face, and also a dryness of the skin and sometimes nausea. Unless the person affected seeks relief, the symptoms just enumerated are followed by those which are more serious, as delirium, convulsions, and unconsciousness. The temperature of the body sometimes rises to a great height, 108°–110° (normal temperature being $98\frac{4}{10}$°). The pupils are generally contracted. The pulse at first is strong and rapid, but subsequently becomes weak. Death may occur suddenly in consequence of the action of the high temperature upon the nerve-centers, or, at a later period, as the result of exhaustion. Quite a large percentage of those who recover from the immediate effect of sunstroke subsequently suffer from some temporary or permanent affection of the nervous system.

Those who have been overcome by the heat are peculiarly susceptible to this element for some time afterward.

Heat exhaustion is a mild type of the condition just described and is very common. The symptoms are usually dizziness or faintness, and often some nausea and weakness. These conditions, however, generally respond to simple treatment.

TREATMENT OF HEAT-STROKE.—There are two important indications for treatment—reduction of temperature and the use of stimulants. The use of cold is regarded as the best method of meeting the first indication, and the manner of its application depends upon the facilities at hand. The patient should first be removed to a cooler spot if possible, or at least where shade can be secured, or, if a person succumbs in a place where the ventilation is defective (in addition to the heat), he should be carried to the fresh air. The treatment should be begun at once.

Efforts are often made first to remove the patient to his home, which involves the loss of considerable valuable time and may still further exhaust him. The clothing about the neck and body must be either loosened or removed. Cold is particularly indicated in cases where there is great heat of the body, and delirium and convulsive movements are present. This means of reducing the temperature may be applied in the shape of cracked ice about the head and spine, or the use of cold water, by means of a sponge or by pouring it from a sprinkling-pot, or the patient's head may be held under a pump; however, the best plan is to remove the clothing and sponge the head and body with cold water at frequent intervals. If the heat of the body is very great, it may be necessary to wrap the patient in sheets wet with cold water. The sheets are to be kept wet by frequently pouring water over them while on the body, until consciousness returns or there is an evidence of marked diminution of temperature. After the cold has been discontinued, should serious symptoms, such as unconsciousness or the previous high temperature recur, the cold application should again be employed.

If there is, besides the great heat, evidence of serious depression, stimulants must be used while the cold is being applied.

There are some cases of heat-stroke where stimulants alone are indicated, as when the signs of a high fever are absent and great depression is present. In these cases, in addition to the use of internal stimulation, the application of mustard over the heart and to the calves of the legs is indicated.

The treatment of heat exhaustion consists in rest, bathing the face with an alcoholic solution, or the internal use of a stimulant.

CHAPTER XVI.

ASPHYXIA AND DROWNING.

ASPHYXIA--SUFFOCATION.

Asphyxia is a condition of unconsciousness due to a great diminution of oxygen in the blood, resulting either from an obstruction to the passage of air to the lungs, or to the presence of poisonous gases which render the air unfit for respiration. Among the numerous causes of suffocation are drowning, hanging, and obstruction in the respiratory tract, either by the lodgment of foreign bodies, or by certain maladies affecting this part, as croup. Asphyxia also follows the inhalation of the fumes of charcoal or coke, and the carbonic-acid gas contained in empty wells, caves, beer-vats, and mines ; in the latter situation it is known as "choke-damp." Coal-gas from stoves, and illuminating and sewer gases, are frequent causes of suffocation. The appearance of a person suffering from asphyxia is well marked. The face is of a dusky or purplish hue (showing deficient oxygenation of the blood), and swollen. The respirations are extremely labored, and associated with convulsive movements and delirium. If relief is not promptly at hand, these symptoms are rapidly followed by unconsciousness and death.

TREATMENT.—The treatment consists in removing the cause, in order that the lungs may be supplied with the proper amount of pure air, and restoring the different functions to their normal condition by stimulants and artificial respiration. (See DROWNING.)

PRECAUTIONS.—In rescuing a person from an empty

well, care should be taken that the mouth and nose of the person making the descent are protected by holding against them a cloth saturated with water, or vinegar and water. A rope should also be tied around the waist of the rescuer, by which he can be brought rapidly to the open air. Matches should not be ignited while in the well, nor should any artificial light be carried down; for, while carbonic acid gas, which constitutes the bulk of poisonous gases in these receptacles, is not a supporter of combustion, other gases may be present which are ignitible, and a serious explosion would probably follow. Sewer-gases are often inflammable, and illuminating gases always so. A light should never be taken into a cellar or any apartment where gas has escaped, until the room has been thoroughly ventilated by open windows and doors.

It is often necessary to enter empty wells and cess-pools in order to examine or clean them. The carbonic acid which they contain, and which is heavier than air and consequently settles to the bottom, should be stirred up and removed previous to making any descent for examination. This may be done by free ventilation, and by pouring into the well large quantities of water or lime-water, or by lowering and quickly withdrawing an opened umbrella, or throwing down lighted papers and straw. Should the latter means be used, care should be taken not to remain near the opening, as gases may be present which are inflammable. Discharging a gun into the receptacle may also be employed for this purpose.

DROWNING.

The asphyxia or suffocation that follows submersion is due to the fact that air is prevented from reaching the lungs. More or less water is found in the air-passages, but not in such quantities as is generally supposed. In some cases very little if any water reaches these organs, on account of the rapid closure of the epiglottis. Water, however, enters the stomach, and considerable is found mixed

with mucus in the throat. Death is usually the result of suffocation, as is made obvious, after the removal of the body from the water, by the bloated and discolored appearance of the face. However, in some cases death may be due to sudden heart-failure before the person sinks. When such is the case the face of the drowned would be pale and flabby, and very little water and mucus would be found in the respiratory tract. There is a better chance of resuscitating one who sinks as the result of syncope than when suffocated, as the demand for oxygen in the former is less than when asphyxiated by submersion.

Persons who are submerged for four or five minutes or more are not usually restored to life; although numerous cases are recorded where resuscitation was effected after an interval of twenty minutes. In such cases it is supposed that syncope occurred, or, on account of the existing excitement, an error was made in calculating the actual time of submersion. The action of the heart usually continues some little time after respiration ceases.

TREATMENT.—The treatment consists first in re-establishing respiration, then stimulating the action of the heart and circulation by the use of stimulants and warmth, friction, etc. When a person has been under water but a few moments, simple means may restore respiration, and should be first tried.

The water, sand, and mucus should first be quickly removed from the mouth and nose, and the attendant should then carry his finger to the back or base of the patient's tongue, which must be pulled forward, thus enabling the water and mucus in the throat and respiratory tract to escape, and also to favor the entrance of air into the lungs; while this is being done the patient should be turned on his side (left, if possible), face downward, to favor the escape of water from the stomach and air passages. He should then again be turned on his back, while the hands of the attendant are placed on the belly or abdomen and pressure directed upward and inward toward

the diaphragm. This movement tends to stimulate respiration and should be repeated two or three times at intervals of two or three seconds. The mouth in the mean time should be kept open by a cork or piece of wood, or a knot tied in a handkerchief, etc., in order that the passage of air to the lungs should not be interfered with. Smelling-salts, ammonia, or two or three drops of nitrite of amyl, may be administered by inhalation, or the nose may be tickled with a feather or straw. When breathing commences and consciousness returns, the patient should be carefully divested of all wet clothing (if necessary, the clothing should be cut in order to avoid delay), well rubbed, and wrapped in warm covering, and stimulants given in the manner already described. (SHOCK.)

If the simple measures just enumerated are productive of no good result after a short trial, artificial respiration should be at once resorted to.

Three methods of artificial respiration are accepted as being particularly efficient, viz., *Sylvester's, Howard's*, and *Hall's*. The first (Sylvester's) is generally regarded as being the best. The methods of Sylvester and Howard may be performed by one person, which is an important consideration.

Before artificial respiration is begun, the patient should be stripped to the waist, and the clothing around the latter part should be loosened so that the necessary manipulations of the chest may not be interfered with.

SYLVESTER'S METHOD.—The water and mucus are supposed to have been removed from the interior of the body by the means above described. The patient is to be placed on his back, with a roll made of a coat or a shawl under the shoulders; the tongue should then be drawn forward and retained by a handkerchief which is placed across the extended organ and carried under the chin, then crossed and tied at the back of the neck. An elastic band or small rubber tube or a suspender may be substituted for the same purpose. If no other means can be made avail-

able, a hat- or scarf-pin may be thrust vertically through
the end of the tongue without injury to this organ. The
attendant should kneel at the head and grasp the elbows
of the patient and draw them upward until the hands are
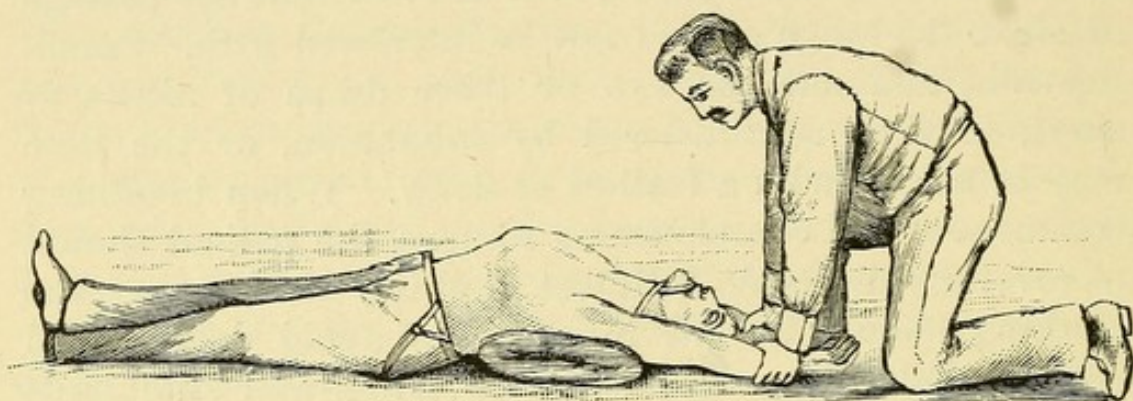
FIG. 80.—Sylvester's method.   First movement (inspiration).

carried above the head and kept in this position until one,
two, three, can be slowly counted (Fig. 80). This move-
ment elevates the ribs, expands the chest, and creates a
vacuum in the lungs into which the air rushes, or, in other
words, the movement produces *inspiration*. The elbows
are then slowly carried downward, placed by the side, and
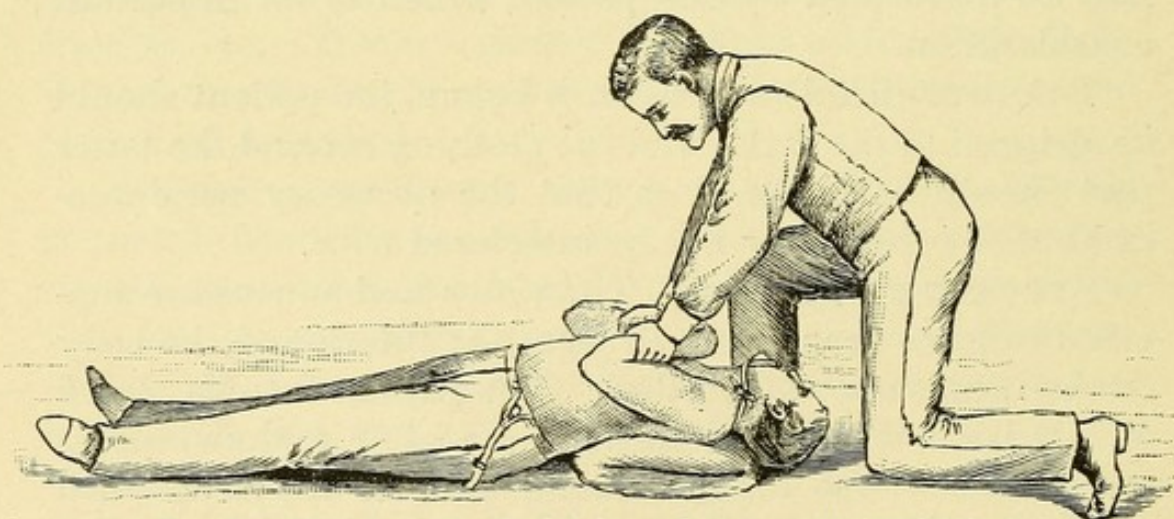
FIG. 81.—Sylvester's method.   Second movement (expiration).

pressed inward against the chest, thereby diminishing the
size of the latter and producing *expiration* (Fig. 81). These
movements should be repeated about fifteen times during

each minute for at least two hours, provided no signs of animation present themselves.

HOWARD'S METHOD is divided into two parts. *Part first* consists in removing the water, etc., from the respiratory tract and stomach, and is as follows:

The patient should be placed face downward, with a pillow or roll of clothing under the pit of the stomach, the head resting on the forearm, which keeps the mouth from the ground and renders traction on the tongue unnecessary. The attendant, standing over the drowned person, should then place his left hand on the lower and back part of the left side of the chest, while the right hand is laid on the
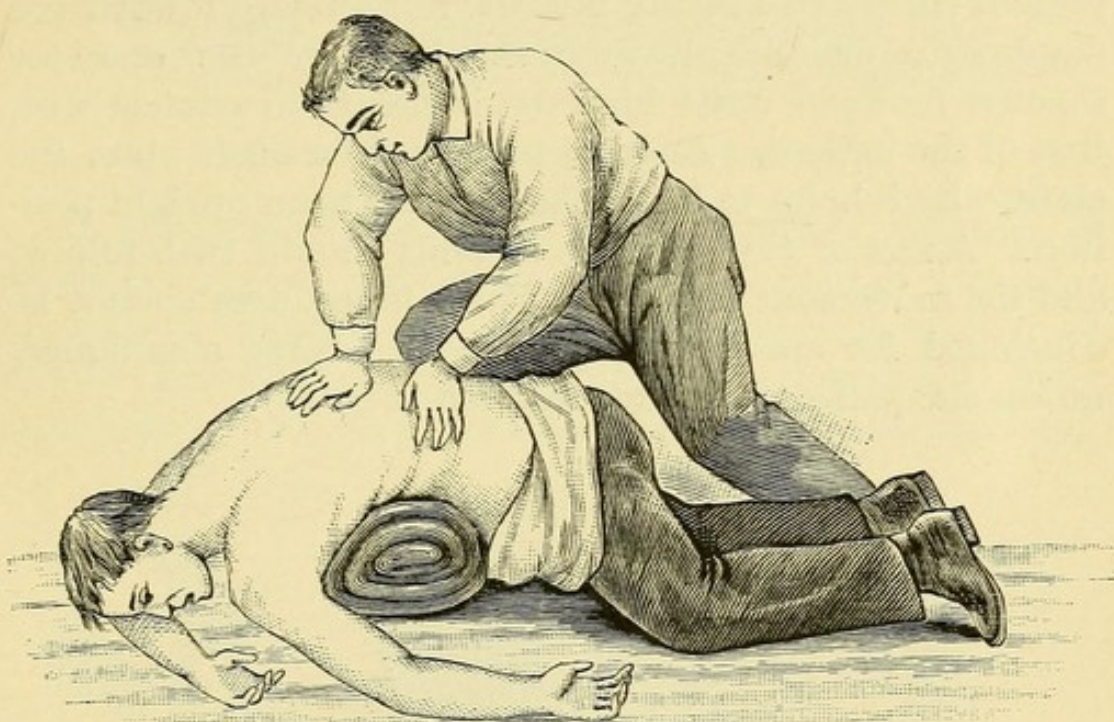
FIG. 82.—Howard's method. Part first.

spinal column about on a line or a little above the left hand; firm pressure is then made by the operator throwing the weight of his body forward on his hands; this is to be continued while one, two, three, are counted (slowly), and ended with a push which helps to raise the operator to an upright position and forcibly expel the fluid. These movements should be repeated two or three times if fluid continues to flow from the mouth (Fig. 82).

Part Second : *Artificial Respiration.*—The patient should now be turned on his back, face directly upward, with the roll placed under the shoulders; it should be made thick enough to allow the head and neck to be fully thrown back. The hands of the patient should be carried above his head and tied with a handkerchief, suspenders, etc. The attendant should then kneel astride the patient's hips and place the palm of his open hands upon the lower part of the patient's chest with the thumbs at the lower border of the breast-bone, the fingers being applied to the spaces between the ribs, the little finger being laid along the lower border of the ribs, in front. The hands are then pressed slowly and firmly upward and inward toward the diaphragm or midriff, with the body of the operator thrown forward until his face is nearly in contact with that of the patient. A sharp push is then made upon the chest, which helps to bring the operator to an upright position. A rest of two or three seconds should then follow, and the movement repeated. These procedures should be continued for about two hours before being abandoned, unless the patient is sooner restored (Fig. 83).

FIG. 83.—Howard's method. Part second.

HALL'S METHOD.—The drowned person should be placed face downward, the head resting on his forearm with a roll or pillow placed under the chest; he should

then be turned on his side, an assistant supporting the head and keeping the mouth open; after an interval of two or three seconds, the patient should again be placed face downward and allowed to remain in this position the same length of time. This operation should be repeated fifteen or sixteen times each minute, and continued (unless the patient recovers) for at least two hours (Figs. 84, 85).
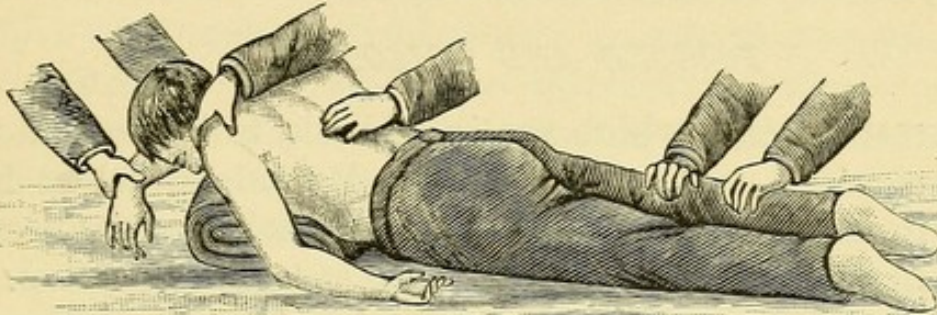
FIG. 84.—Hall's method.   First position.

If, after using one of the above methods, evidence of recovery appears, such as an occasional gasp or muscular movement, the efforts to produce artificial respiration must not be discontinued, but kept up until respiration is fully established.   All wet clothing should then be removed,
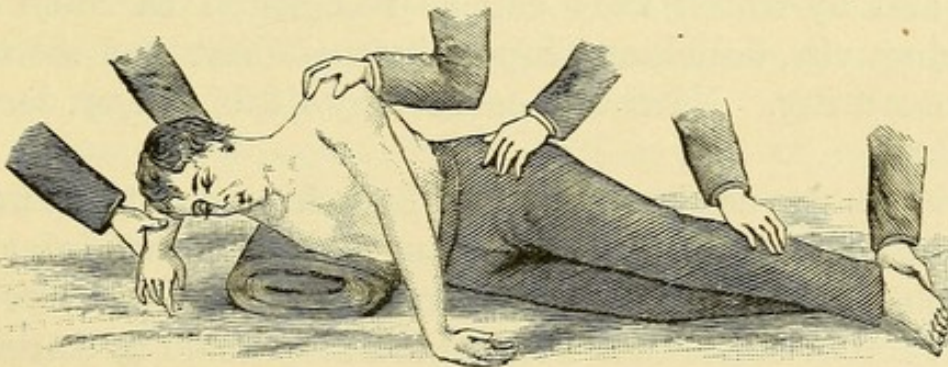
FIG. 85.—Hall's method.   Second position.

the patient rubbed dry, and if possible placed in bed where warmth and stimulants can be properly administered.   A small amount of nourishment, in the form of warm milk or beef-tea, should be given, and the patient kept quiet for two or three days.

CHAPTER XVII.

POISONS AND POISONING.

CERTAIN agents which are invaluable in the treatment of the sick and injured become deadly poisons when improperly used. This may be the result either of accidents, errors in administration, or attempts at self-destruction.

Poisons may be divided into *narcotics* and *irritants.* Some of the irritants are exceedingly destructive to the tissues with which they come in contact, and are known as *corrosive* poisons.

Narcotics are employed in the practice of medicine to produce a soothing effect or sleep. When these drugs are taken in poisonous doses, they are followed by symptoms which in a general way are common to all of this class, and by which they can be recognized in cases of poisoning, viz., delirium, stupor, insensibility, and stertorous breathing. Narcotics cause very little, if any, local irritation.

Irritants are used medicinally both for a constitutional and local effect. Their poisonous action is particularly noticeable by the local irritation they produce. Great destruction of the tissues with which they come in contact follows the use of the corrosives. This is markedly apparent about the lips, mouth, and throat. Intense abdominal pain, associated with vomiting and purging, and also shock, are more or less constant.

TREATMENT OF POISONING.—The treatment of poisoning is both local and constitutional.

The local treatment consists in preventing the further

absorption and irritating effect of the poison by removing it from the stomach by the use of emetics and the stomach-pump. Remedies are also used which in a measure render the operation of the poison harmless (antidotes).

The constitutional treatment is directed toward antagonizing the action of the poison, and stimulating the patient.

Agents which directly counteract the local and constitutional effect of a poison are known as antidotes: for example, when an acid is taken in a poisonous dose, an alkali, such as soda, is given as the antidote; or, when opium is the poison introduced, belladonna is administered as the physiological antidote. These examples demonstrate local and constitutional antidotes.

LOCAL TREATMENT.—EMETICS.—Under this heading, may be included the introduction of the forefinger or a feather into the throat, and by passing either backward as far as possible can be employed to induce vomiting (emesis). This means may also be used to stimulate the action of emetics which have been given internally.

Mustard.—One tablespoonful added to half a pint of tepid water. Mustard is a stimulant emetic, and very valuable in narcotic poisoning.

Chloride of Sodium (common salt).—Two tablespoonfuls added to half a pint of tepid water. Not very certain as an emetic, but generally on hand.

Alum.—Tablespoonful in half a pint of tepid water. Rather a feeble emetic.

Sulphate of Zinc (white vitriol).—Twenty to thirty grains in half a glass of water. Very efficient and safe. One of the best emetics.

Ipecac.—Thirty grains of the powder or two tablespoonfuls of the wine or sirup of ipecac; the latter preparation is apt to be found in the house.

Carbonate of Ammonia.—Thirty grains in half a glass of water.

Sulphate of Copper (blue vitriol, blue-stone).—Five to ten grains in half a glass of water.

The dose recommended of each of the above emetics is for adults, the amount should be proportionately small for children.

STOMACH-PUMP.—If a stomach-pump can be procured *at once*, and if it is in a condition for *immediate* use, it is a valuable means for removing poison from the stomach; should a stomach-pump not be available, and its use be particularly indicated, a small rubber tube about six feet long may be substituted. One end of the tube, after being oiled, is passed into the stomach. This procedure requires considerable care, as the tube may be introduced into the air-passage by mistake, instead of into the œsophagus; for this reason the tongue should be depressed and the end of the tube carried backward as far as possible and then downward. After this has been accomplished, the end projecting from the mouth is raised and a funnel attached, through which tepid water (about two or three pints) should be poured into the stomach. The upper end of the tube (still raised) should be pinched between the thumb and finger, and in this condition lowered below the level of the stomach. When the thumb and finger are removed, the water held in the tube acts as a siphon, and the contents of the stomach are withdrawn, provided the poisoning does not occur soon after a meal. This operation may be repeated a number of times, until the poison has been removed. It is always best, particularly in cases of suicide, to place a cork, or, still better, a spool of thread, as a gag between the teeth, to prevent the tube from being bitten in two.

The use of a stomach-pump is *not* indicated when the poisoning is due to *corrosives*, as the mucous membrane is greatly swollen, and the introduction of the tube is productive of great pain and danger of laceration of the soft tissues. The ordinary fountain syringe, which is found in almost every house, is an excellent instrument for washing out the stomach. The rubber or metal end being cut off, the tube can be introduced. The at-

tached fountain makes the use of a funnel unnecessary.

CONSTITUTIONAL TREATMENT.—The constitutional antidotes will be referred to with the special poisons. Stimulants are indicated to overcome the depressing action of the different poisons, particularly the narcotics, and may be administered by the mouth (if the patient can swallow), provided the poisoning is not due to *corrosives*, or by the rectum (lower bowel), or by inhalation. The stimulants administered are those ordinarily used, and in addition strong coffee ; the latter is of great value in narcotic poisoning, and it may be given in the same manner as other stimulants, either by the mouth or rectum. When stimulants are given by the rectum, the amount should be considerably larger than when given by the mouth, and they should be diluted with sufficient warm water or milk to make a cupful. Ammonia, and nitrite of amyl can be given by inhalation ; they should always be administered by dropping a sufficent amount on a handkerchief or the palm of the hand. The bottle should never be held to the nose, as the contents might be spilled into the mouth or nasal cavity. Stimulants should be given by inhalation with great caution, where corrosive poisons have been taken, as they are liable to irritate still more the inflamed membrane. Nitrite of amyl, which is given by inhalation, is a powerful heart stimulant, but should be used with care and in small amounts—three to five drops. This remedy is now obtained in small glass capsules, which contain about five drops, and are broken when the nitrite of amyl is needed.

The following list of narcotics and irritants comprises those which are commonly the cause of poisoning.

NARCOTICS.

ACONITE.—(Monk's-hood, wolf's-bane.) The tincture has the appearance of sherry wine, for which it has been mistaken. Aconite is commonly found in fever-mixtures,

neuralgia "cures," liniments and ointments, and is exceedingly poisonous.

Symptoms.—Great prostration ; tingling of the lips, mouth and throat, and extremities — the latter become numb ; slow and weak pulse ; shallow respiration ; the mind is generally clear; convulsions may sometimes occur.

Treatment.—Emetics ; free use of stimulants ; warmth to extremities ; twenty drops of tincture of belladonna, repeated (once) in half an hour ; mustard over heart and calves of legs ; artificial respiration.

ALCOHOL.—Acute poisoning is very uncommon. A large amount is sometimes taken for a wager, or by one unaccustomed to its use.

Symptoms.—(See INTOXICATION.)

Treatment. — Keep the patient aroused by pinching, slapping with wet towel, or hot and cold douches to head and spine ; coffee in large amount by stomach or rectum ; inhalation of ammonia, and artificial respiration.

BELLADONNA. — (Deadly night-shade.) Contained in cough-mixtures, etc., liniments, ointments, and plasters. *Atropine*, the active principle of belladonna, is commonly found in eye medicaments. Poisoning sometimes follows the use of an external application containing either belladonna or atropine, it being absorbed through the unbroken skin.

Symptoms. — Headache ; intense dryness of mucous membrane of mouth, throat, and nasal cavity; inability to swallow ; eyes brilliant (belladonna is often used for this purpose) ; *pupils dilated ;* face usually flushed ; delirium and stupor, or convulsions.

Treatment. — (Belladonna and atropine.) Emetics ; thirty drops of laudanum, or one to two tablespoonfuls of paregoric, or one quarter of a grain of morphine, repeated (once) in half an hour ; stimulants ; warmth to extremities ; artificial respiration.

CAMPHOR.—Usually taken in the form of a tincture (spirits), or the gum.

Symptoms.—Characteristic odor; surface of body cold and clammy; disturbances of vision; noise in ears; delirium and convulsions.

Treatment.—Emetics; stimulants; warmth to extremities; hot and cold douches.

HYDRATE OF CHLORAL. — (Chloral.) Odor similar to bananas or pears. Chloral is often an ingredient in sleeping potions and liniments.

Symptoms.—Face congested; weak pulse; labored respirations, stertorous breathing; stupor and unconsciousness, sometimes convulsions.

Treatment.—Free use of stimulants; warmth to extremities; mustard over heart and calves of legs; artificial respiration. An emetic may be given, if the patient is seen immediately after a poisonous dose has been taken.

CHLOROFORM.—When poisoning is caused by inhalation, the patient's tongue should be drawn forward and artificial respiration performed; hot and cold douches; also friction; plenty of fresh air; the patient's head should be low, or it may be allowed to drop down, the body being elevated by carrying the legs over the shoulder of the attendant.

When poisoning follows the internal use of chloroform, large doses of bicarbonate of soda in water should be given internally, in addition to other means of resuscitation.

DIGITALIS.—(Purple foxglove.) Generally given for heart maladies.

Symptoms.—Purging and vomiting; great pain in abdomen; face pale; pupils dilated; skin cold and clammy; pulse feeble and slow; great depression; gasping respiration; delirium, and convulsions.

Treatment.—Emetics (only in case one large dose of digitalis has been swallowed); about twenty grains of tannin in solution, or white-oak bark, or strong tea, repeated; mustard, especially over the heart, and the calves of the legs, and stimulants internally. The patient should

be kept in the recumbent position for some time after the serious symptoms have ceased.

FUNGI.—Poisonous mushrooms.

Symptoms. — Colic ; vomiting and purging ; dilated pupils ; extreme muscular weakness ; mental excitement. Symptoms usually occur within an hour.

Treatment.—Emetics ; castor-oil ; stimulants ; heat. "It is always dangerous to warm up a dish containing mushrooms." (Murrel.)

The treatment of mushroom-poisoning is applicable to poisoning by eating mussels.

HYDROCYANIC ACID.—(Prussic acid.) The dilute acid is the form in which this poison is generally used, and is a colorless fluid. Prussic acid is one of the deadliest poisons known. The poisonous symptoms begin almost immediately.

Symptoms.—Great and sudden prostration ; surface cold and clammy ; pupils dilated ; eyes fixed ; blueness of face, locked jaws ; gasping respiration and covulsions.

Treatment.—Dilatory treatment is of no avail in poisoning by this agent ; whatever is to be done must be done at once ; no time should be lost in trying to give emetics, or use the stomach-pump ; stimulants should be given freely ; flapping with wet towel ; hot and cold douches ; artificial respiration. In poisoning by this drug, stimulants should be given by hypodermic injection, even by a non-professional person ; a teaspoonful of brandy or whisky, or ammonia-water (not spirits), introduced into the calf of the leg, and repeated in five minutes ; inhalations of nitrite of amyl.

The symptoms of poisoning which may occur after cyanide of potassium, peach-pits, and bitter almonds have been taken internally are dependent upon the presence of prussic acid, and should be treated accordingly.

OPIUM.—The preparations generally used are morphine (the active principle of opium), tincture of opium (laudanum), *camphorated* tincture of opium (paregoric), Mc-

Munn's elixir, codeine, and narceine. Opium is an active ingredient in many preparations, particularly sedative and cough mixtures, soothing syrups for children, and numerous patent medicines.

Symptoms.—Usually begin with more or less mental excitement, followed by great depression, headache, sensation of weight in the limbs, an irresistible desire to sleep, which soon deepens into a stupor; *the pupils are contracted* and the respirations are *greatly diminished in number*, sometimes to four or five a minute, and the skin is cold and clammy and the face pale. Convulsions sometimes occur.

Treatment.—Emetics; cold douche to head, face, and spine; flapping with wet towel; coffee by rectum or mouth. Wines and liquors *must not be given.* Twenty drops of the tincture of belladonna repeated (once) in fifteen minutes. Artificial respiration for at least two or three hours. The patient should be carefully watched for some time after the dangerous symptoms have subsided.

IRRITANTS.

ARSENIC.—This agent is used medicinally, generally in the form of Fowler's solution and arsenious acid; it is also contained in rat-pastes, fly and vermin killers, and is employed to a large extent in the arts, for coloring flowers, wall-paper, stuffing birds, etc. Realgar is a red, and Orpiment, or King's yellow, is a yellow preparation of arsenic. Arsenite of copper (Paris green, or Scheele's green) is commonly taken by suicides.

Symptoms.—Intense burning pain in pit of stomach; faintness and depression; vomiting and purging; vomited matter streaked with blood. Abdomen tender and painful; skin cold and clammy. If Paris green has been taken, the green color is generally apparent about the mouth, hands, or clothing.

Treatment.—Emetics; large draughts of hot, greasy water, or salt and water; dialyzed or tincture of iron; a

large amount of magnesia may be given ; or lime which may be scraped from the walls or ceiling or from a fence ; castor-oil ; sweet-oil, or equal parts of sweet-oil and lime-water, or lime-water alone ; raw eggs ; milk ; stimulants (well diluted if given by the mouth) ; twenty to thirty drops of laudanum, or one quarter of a grain of morphine, to allay the pain.

CANTHARIDES.—(Spanish fly.)

Symptoms.—Burning sensation in mouth and throat ; violent pain and soreness in abdomen ; vomiting and purging, vomited matter containing streaks of blood ; great irritation of urinary organs and passage of bloody urine ; delirium and convulsions.

Treatment.—Emetics, if necessary, raw eggs, sweet-oil, milk, laudanum (twenty drops), or morphine (one quarter of a grain), may be given. Stimulants (by rectum), if necessary ; heat ; poultices over abdomen.

COPPER, SULPHATE OF (blue vitriol, blue-stone), or subacetate of copper (verdigris), is sometimes the cause of poisoning, although copper-poisoning is more frequently due to substances which have been cooked in copper vessels, which is an unsafe method of preparing food.

Symptoms.—Vomiting and purging ; griping pain in abdomen ; metallic taste in mouth ; great thirst and weakness ; labored respirations and rapid pulse ; dimness of vision ; and sometimes convulsions.

Treatment.—Copious draughts of warm water ; emetic (if necessary) ; raw eggs ; milk ; stimulants ; morphine (one quarter of a grain) ; laudanum (twenty to thirty drops).

CROTON-OIL.—Has been mistaken for castor-oil.

Symptoms.—Vomiting ; purging ; violent pain in abdomen ; great depression ; skin cold and clammy.

Treatment.—Emetics ; raw eggs ; stimulants ; spirits of camphor, ten drops in water every five minutes until five or six doses have been taken ; morphine (one quarter of a grain) ; laudanum (twenty drops) ; paregoric (tablespoonful).

IODINE.—As generally used is in the form of the tincture—a dark reddish fluid.

Symptoms.—Great local irritation and pain; the mucous membrane of the mouth is discolored yellow; vomiting and purging, the vomited matter having a *bluish* color, as the result of the admixture of the iodine and starchy matter of the food (iodide of starch). *Blue* color also noticed when vomited matters come in contact with starched articles of clothing.

Treatment.—Free use of starch, then emetics, raw eggs, chalk, magnesia, and stimulants.

STRYCHNINE.—(The active principle of nux-vomica).

Symptoms.—An irritable condition of the muscular system, and twitchings and discomfort, soon followed, usually within less than an hour, by severe convulsions, which occur at intervals of two minutes to half an hour. The contractions of the powerful muscles of the back cause the body to assume the form of a bow, the patient resting on the head and heels (opisthotonos); great pain is present as the result of the intense muscular contraction. The mind is usually clear. The respiratory muscles are prominently involved in this affection, and death by asphyxia, as the result of rigidity of these muscles, may follow, or death may occur later, as the result of exhaustion.

Strychnine-poisoning can only be mistaken for tetanus (locked-jaw). The distinction is to be made as follows: In strychnine-poisoning the attack is sudden; there is generally evidence of poison having been taken, and no injury has been received. In tetanus, the development of the disease is more gradual; no poison has been taken, but some form of injury is present. In strychnine-poisoning the muscles of the jaw are only slightly affected, if at all, but the upper extremities are always involved; while in tetanus, the rigidity of the muscles of the jaws (locked-jaw) is the first and prominent symptom, and continues to the end, the upper extremities are only affected in the severe cases, and then only slightly. In strychnine-poisoning, the dura-

tion of the attack covers but a few hours, while in tetanus a number of days may be involved.

Treatment.—The stomach-pump can only be used if the patient is seen immediately after the poison is taken, as the convulsive movements prevent the introduction of the tube; a mixture of tannin or animal charcoal, and followed by an emetic; then by large doses of bromide of sodium or potassium (sixty grains in solution), repeated every hour until three or four doses have been taken, together with nitrite of amyl; artificial respiration.

PHOSPHORUS.—Poisoning frequently occurs as the result of sucking or swallowing the heads of matches.

Symptoms.—Vomiting and purging; vomited matter has a garlicky odor, and is luminous in the dark. Intense pain in abdomen.

Treatment.—Emetics; free use of magnesia; French turpentine, given in an alcoholic or alkaline solution, half teaspoonful every half-hour, until a number of doses have been taken (five or six): three grains of sulphate of copper every five minutes until free vomiting occurs; white of egg.

TARTAR EMETIC.—Antimony, or Stibium.

Symptoms.—Vomiting and purging; vomited matter contains streaks of blood; skin cold and clammy; collapse.

Treatment.—Warm water; mixtures of tannin; white-oak bark; also strong tea; stimulants, and warmth.

ZINC.—The sulphate or chloride is generally used. The chloride is far more dangerous and corrosive.

Symptoms.—Pain and vomiting, with great depression, and, if the chloride has been taken, the mucous membrane of the mouth is inflamed.

Treatment.—Large quantities of bicarbonate of soda (baking-powder) or carbonate of potash in solution; milk; eggs; mixtures of tannin or strong tea, or oak-bark; morphine (one quarter of a grain); laudanum (twenty to thirty drops).

CORROSIVES.

ACIDS.—Sulphuric (oil of vitriol); muriatic (spirit of salt); nitric (aquafortis); acetic; carbolic, and oxalic acids.

Symptoms.—Mucous membrane of lips, mouth, and throat greatly inflamed and swollen, with more or less destruction of the tissue, and symptoms of shock. When taken in a concentrated form, muriatic and sulphuric acids discolor the lips and mouth *black*, while nitric acid stains these tissues *yellow;* when oxalic and carbolic acids have been taken, the membrane has a *whitish* appearance.

Treatment.—For sulphuric, muriatic, nitric, and acetic acids; immediate use of alkalies, as mixtures of soda, potash, magnesia, chalk, white crayons, lime, soap-suds, or tooth-powder (chalk); raw eggs, milk, oil. Rectal stimulation for shock.

OXALIC ACID.—Is sometimes mistaken for Epsom salts. Is used for cleaning kitchen boilers, and sometimes introduced accidentally into food.

Symptoms.—Same as other corrosive poisons.

Treatment.—Magnesia or lime in some form should be administered—the latter may be scraped from the wall or ceiling—white crayons; tooth-powders, etc. Soda, potash, and ammonia should *not* be used. Castor-oil or sweet-oil should be administered by the mouth, and rectal stimulation resorted to. Poisoning by salts of lemon and sorrel, which are derivatives of oxalic acid, should be treated as above.

CARBOLIC ACID, CREASOTE (Phenol).

Symptoms.—Same as other *corrosives*, and also distinguished by their characteristic odor.

Treatment. — Alkalies, particularly sulphate of magnesia (Epsom salts) or sulphate of soda (Glauber's salts) given in large doses; raw eggs; castor-oil, and sweet-oil. Emetic if necessary.

CORROSIVE SUBLIMATE.—(Bichloride of mercury.) Used largely as an antiseptic, and to preserve specimens, etc.

Symptoms.—Similar to those of arsenical poisoning. Vomiting and purging ; intense pain in abdomen ; membrane of mouth and tongue white and shriveled ; metallic taste in mouth.

Treatment.—Emetics, if vomiting is not present. White of egg in large amount ; milk or mucilage in abundance ; flour and water or arrowroot or barley-water ; chlorate of potash.   Stimulants by rectum.

ALKALIES.—Caustic potash and soda ; pearlash ; strong solution of ammonia.

Symptoms.—Similar to poisoning by corrosive acids. Intense swelling and inflammation of lips and mouth.

Treatment.—The treatment consists in the administration of *acids*—vinegar, lemon or orange juice, hard cider; also acetic, nitric, muriatic, and sulphuric acids *largely* diluted ; raw eggs ; olive-oil ; milk ; arrowroot, and barley-water. Stimulants by the rectum. Morphine (one quarter of a grain) or laudanum (twenty to thirty drops) may be given.

CHAPTER XVIII.

THE CONVULSIONS OF CHILDREN.

CONVULSIONS affecting children are of common occurrence, but do not carry with them the gravity which is associated with a like affection in adults. The convulsions are often the result of trivial causes, as indigestion, teething, worms, swallowing foreign bodies. They may sometimes, however, usher in serious affections, as scarlatina (scarlet fever). At the time of the convulsion the thumbs are carried across the palm of the hand; the eyes are set and turned upward; then suddenly the patient becomes rigid, with some contraction of the facial muscles; the face and lips become dusky, as the result of considerable interference with respiration. This rigidity lasts but a few moments, and is generally followed by a stupor, which often terminates in a natural sleep and recovery.

TREATMENT.—The head should be enveloped in a cloth wet with cold water, and the child at once placed in a hot bath (about 100°). A tablespoonful of mustard may be added to the water, the efficiency of the bath being thereby increased. The child should remain in the bath about two or three minutes, and should be again immersed if the convulsion is repeated.

TETANUS—LOCKED-JAW.

Tetanus is a disease characterized by spasmodic rigidity of the voluntary muscles, and is generally the result of a wound of the foot or hand, made by a blunt or jagged implement, as a rusty nail. Tetanus may also follow burns. Cases of the disease are not frequent. An interval of from

five to fifteen days generally follows the reception of the injury before the symptoms become apparent.

The first well-marked symptoms of the disease are pain and stiffness about the neck and jaws, which is commonly mistaken for rheumatism. This increases in severity, and the muscles of mastication become involved and the patient is unable to open his mouth (trismus). The name by which the disease is commonly known (locked-jaw) is due to this fact. The rigidity about the neck soon extends to other portions of the body. The strong muscles of the back being so forcibly contracted, the body is bent in the shape of a bow and rests on the head and heels (opisthotonos). The upper extremities are but slightly affected in mild cases. The contraction of the facial muscles elevates the corners of the mouth, and produce a characteristic appearance known as risus sardonicus, or canine laugh. This affection is usually followed by a fatal result.

Tetanus is to be distinguished from strychnine-poisoning. (See STRYCHNINE-POISONING.)

TREATMENT.—Medicine is of very little use in tetanus, even when given in enormous doses. Operative measures are often undertaken by the surgeon. The patient's strength should be kept up as well as possible by nourishment, such as milk, beef-tea, and kumyss, which may be carefully poured into the mouth between the teeth and cheeks; in this way it reaches the stomach. Excitement of all kinds should be avoided, and the administration of medicine left to the surgeon.

FOREIGN BODIES IN THE EYE, EAR, NOSE, LARYNX, AND PHARYNX.

EYE.—Foreign bodies in the eye usually consist of cinders, sand, dust, and minute scales of iron. The latter have become a frequent source of annoyance since the elevated railroads have been in operation.

Treatment.—The foreign bodies just described are usually lodged about the center and under surface of the

upper lid, and are generally washed out of the eye by the increased flow of tears which follows their introduction. If the foreign body still remains lodged, the upper lid should be gently pulled away from the eye with the thumb and finger, and carried downward and pressed against the lower lid, to which the particle is usually transferred. Should this not be successful, the upper lid may be turned upward and folded on itself over a pencil, when the foreign body can generally be seen and removed by lightly touching it with a small fold of a clean handkerchief or other similar substance. The operation of eversion, or turning the lid upward, usually requires considerable practice before it can be done dexterously. The lower edge of the upper lid should be carried away from the eye and somewhat upward by seizing the lid with the thumb and forefinger of the left hand—the operator standing behind the patient —while with the tip of the index-finger of the other hand, or the shaft of a lead-pencil, the center of the lid is pressed downward, and the inner surface is exposed. The particles of iron already referred to, and also some other foreign bodies, have sharp cutting edges, and often penetrate the eyeball, usually over the pupil, and can not be dislodged by the ordinary process. All unskillful manipulation, and also the common practice of rubbing the eye, press the substance still deeper into the structures. This condition should *always* be attended to by a surgeon. The pain and reddened condition of the eye may be relieved by applications of warm water, tea, or rose-water.

EAR.—Greater danger, probably, results from the unskillful, unnecessary, and rough manipulation, in cases where foreign bodies have been introduced into the ear, than from the presence of the article itself. A foreign body, even of large size, which does not cause immediate pain and distress, may remain in the ear for some time without causing any serious result. It can, at least, remain until removed in a proper manner. Only the simplest and gentlest measures should be employed by a non-

medical person. Among the foreign bodies which are found in the ear are insects, bugs, peas, beans, pebbles, cherry-pits, and shoe-buttons. Children commonly introduce the latter articles into their own ears or the ears of other children.

Treatment.—Bugs and insects are readily removed by carefully syringing the affected ear with warm water ; or, if a syringe can not be procured, then water can be poured into the ear. This procedure either drowns the insect or drives it out, and is so uniformly successful and simple that it is regarded as the best treatment for this purpose. Another method, which is commonly employed, consists in applying a piece of cotton saturated with salt water or vinegar to the ear, and when the cotton is removed, after an interval of a few minutes, the insect is usually found attached to it. Gentle syringing should also be employed to remove other foreign bodies from the ear; *exception should, however, be made when the body is liable to be increased in size by the use of water, as peas and beans.* Tooth-picks, button-hooks, and other similar instruments, should *never* be used; for when they are employed, the foreign body is almost always pushed further into the canal, and its subsequent extraction by the surgeon made more difficult, and the drum of the ear is very liable to be perforated, or other grave accident ensue.

NOSE.—Foreign bodies are often inserted into the nose by children and insane persons, or as the result of accident. The article introduced may be small and not particularly irritating, and may remain in the nasal cavity for a long time before its presence is known.

Treatment. — Tickling the opposite nostril with a feather until sneezing is induced, is very often all that is necessary, particularly if the foreign body has recently been inserted; if not successful, the nasal douche of warm water should be employed through the unaffected nostril, unless the foreign body is likely to be increased in size by contact with water. The reservoir which holds the water should be raised above the head, in order that a continuous

stream may be secured. If the mouth is kept open, the water will better escape from the affected nostril. If the simple means just described are not followed by the desired result, the case should be seen by a surgeon.

LARYNX.—Foreign bodies may enter the larynx during a fit of laughing, or when a sudden act of inspiration is made; this occasionally occurs while eating. A piece of meat is often a cause of strangulation. The obstruction to the entrance of air into the lungs is immediately followed by a violent paroxysm of coughing, which usually expels the foreign body; if not dislodged, evidences of suffocation immediately follow. The face becomes congested and the eyes protrude; the inspirations are gasping in character, and the patient makes frantic efforts for relief. The substance causing the obstruction is usually in such a position that some air reaches the lungs.

Treatment.—The *nearest* surgeon should *at once* be sent for, and always informed as to the character of the case, in order that he may bring with him the instruments necessary for an operation, which usually consists of an external opening into the windpipe. In the mean time the subject should be slapped violently on the upper portion of the back between the shoulder-blades, particularly at the moment of coughing. If this is not successful, invert the body—that is, hold the patient by his feet with the head down—and again slap the back. This should at once be discontinued if it increases the distress. If the accident occurs during a meal, the finger should be passed into the throat, with a possibility of dislodging the piece of meat or whatever may cause the mischief.

If the patient becomes unconscious from the consequent asphyxia, artificial respiration should be employed until the surgeon arrives. Fresh air is an important element in the treatment.

PHARYNX.—The local distress caused by foreign bodies in the pharynx—which usually consist of articles of food, coins, fish-bones, pins, needles, false teeth—depends upon

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their size, which, if large, produce more or less pressure over or upon the air-passage, together with symptoms similar to those of foreign bodies in the larynx; or, if sharp-pointed, the article may cause great pain and irritation.

Treatment.—Foreign bodies in the pharynx are often removed by acts of vomiting or coughing; if not so expelled, an examination of the throat should be made, and, if possible, the substance removed ; if this can not be done, and the foreign body is not too large or sharp, it may be pushed downward into the stomach. A fish-bone, pin, or needle is almost always found sticking into the mucous membrane, and care should be observed, while trying to remove it, that it is not forced still further into the tissues.

Children often swallow coins, buttons, etc., and sometimes substances of very large bulk. When this occurs, emetics and cathartics should *not* be given. Emetics are objectionable, because it is safer to have the foreign body pass downward through the alimentary tract. Instances have occurred where coins, etc., have been brought up by the use of emetics and have entered the air-passages before they could be expelled from the mouth. Cathartics should not be used, for the reason that they irritate the intestinal tract without doing any good. The child should receive the usual food, with the addition of wheat or rye flour in the form of a gruel; this material adheres to the foreign body, and prevents it from irritating the canal on its way down. After a foreign body, such as is usually swallowed, reaches the stomach, it is rarely followed by a serious result.

The passages from the bowel should always be carefully examined for the substance, which usually makes its appearance within three days. The medical attendant must be at once informed if the child becomes restless or feverish, or is affected with pain.

BED–SORES.

A bed-sore is a localized form of gangrene, appearing usually about the buttocks, and also along the spine,

shoulders, and elbows, caused by long-continued pressure on these prominences in invalids who are confined to the bed, and who are often in an emaciated, enfeebled, or paralyzed condition.

Bed-sores are generally preventable, and means should be employed to obviate them, as they do not readily respond to treatment after once being formed.

In order to prevent the formation of bed-sores, strict cleanliness should be observed ; the bed must be soft and smoothly made ; pressure upon the exposed part, as the buttocks, must be avoided. An air-cushion placed *beneath* the sheet is a valuable means of preventing pressure ; or, if consistent, the patient should at certain intervals be made to change his position in bed, or, best of all, placed on a water-bed. Feather-beds should always be avoided. The skin over the exposed part can be hardened by the application of alcoholic solutions. When formed, the treatment of a bed-sore consists in removing the dead tissue by a charcoal or carbolized flaxseed poultice, and then stimulating and healing the resulting ulcer by the use of balsam of Peru, oxide of zinc, carbolic-acid ointment, etc.

Bed-sores often contribute very materially toward a fatal result.

FOOT-SORENESS.

The following very valuable remarks, in regard to foot-soreness, are made by Prof. Parkes (Parkes' "Manual of Hygiene") :

"Foot-soreness is generally a great trouble, and frequently arises from faulty boots, undue pressure, chafing, riding of the toes from narrow soles, etc. Rubbing the feet with tallow or oil, or fat of any kind, before marching, is a common remedy. A good plan is to dip the feet in very hot water before starting, for a minute or two; wipe them quite dry, then rub them with soap (soft soap is the best) till there is a lather ; then put on the stockings. At the end of the day, if the feet are sore, they should be wiped with a wet cloth, and rubbed with tallow and spirits

mixed in the palm of the hand (Galton). Pedestrians frequently use hot salt and water at night, and add a little alum. Sometimes the soreness is owing simply to bad stockings ; this is easily remedied. Stockings should be frequently washed, then greased. Some of the German troops use no stockings, but rags folded smooth over the feet. This is a very good plan.

"Very often the soreness is owing to neglected corns, bunions, or in-growing nails. If blisters form on the feet, the man should be directed not to open them during the march, but at the end of that time to draw a needle and thread through the blister ; the fluid then oozes out.

"All foot-sore men should be ordered to report themselves at once."

CHAFING.

Chafing is particularly common among soldiers, and is generally due either to the friction caused by badly fitting clothes or where surfaces of the skin rub together, as the inside of the thigh, or at the flexures or bendings of the different joints of the body.

Treatment.—The cause of irritation should be removed if possible, and the affected part washed with cold water, dried thoroughly, and then dusted with fuller's earth, bismuth, lycopodium, oxide of zinc, starch, oatmeal, or flour. Fuller's earth is superior to the others mentioned for this purpose ; flour and starch are apt to become sour, and increase the local irritation.

Unless the affection is promptly attended to, inflammation of the skin may follow, which requires rest together with active and prolonged treatment.

CHAPTER XIX.

TRANSPORTATION.

IT is an important part of the management of emergencies and accidents that means should be supplied to remove the patient as quickly and carefully as possible to a place where the proper treatment can be applied. Transportation may be effected by the use of a stretcher (litter), or by one or more persons carrying the one injured. The use of a litter is superior to the latter means, and should always be employed if practicable.

The following essential qualities for a stretcher are suggested by Longmore (Pilcher, "Transportation of the Wounded; Reference Handbook of Medical Science") :

" 1. A support for the patient, firm and comfortable, but capable of being readily cleansed.

" 2. Lightness, to facilitate carriage by bearers.

" 3. Strength, to resist shock from rough usage.

" 4. Simplicity of construction, combined with—

" 5. Capability of being folded up to economize space in stowage and to lessen liability to injury.

" 6. Such a connection of the component parts as to prevent risk of loss.

" 7. Provision for keeping the patient a certain distance above the ground when the litter is laid down.

" 8. Economy in cost."

The different forms of litters are as numerous as the varieties of splints, and are either manufactured or extemporized.

MANUFACTURED LITTERS.—The Halstead litter, which

is used in the U. S. Army, complies with the above essential points, and its construction is detailed by Captain Pilcher, Assistant Surgeon U. S. A., as follows : " The Halstead litter consists of two poles of seasoned white ash, eight feet long and one inch and a half square, the ends of which are rounded off for handles. These poles are connected by braces, one at either end, each consisting of two pieces of wrought-iron one inch wide and three eighths of an inch thick ; one piece is fifteen and the other twelve inches in length, hinged in the center of the litter ; the longer one overlapping the shorter three inches and a half, and when the litter is open shutting on a bolt or pin, forming a stiff shoulder for the hinge and preventing the stretcher from accidentally closing. The braces attached to the under side of the poles just external to the legs, so as to form a shoulder against which the legs impinge, are fastened to the side-poles with heavy screws, pieces of common hoop-iron being placed underneath them to prevent their wearing the wood. The legs, made of seasoned white ash like the poles, are fourteen inches and a half long, one inch thick, one inch and seven eighths wide at the top, and tapering to one inch and three eighths at the bottom ; they are fastened to the poles with screw-bolts having washers under the heads and rivets through the upper end of the legs to prevent their splitting. Over the top of this frame-work is tightly drawn a strip of canvas which is fastened on the outside of the poles with six-ounce tacks, forming a bed five feet and eleven inches in length. and twenty-three inches and a half in width, allowing the poles to project as handles for a distance of thirteen inches at one end and twelve inches at the other. The shoulder-straps weigh eight ounces, and are made of striped cotton webbing two inches and a half wide by fifty inches long, with a five-inch loop at one end and at the other end a leather strap twenty-two inches and a half long by one inch and one sixth wide, with a buckle to loop around the handles of the litter at any length desired. A hair-pillow covered
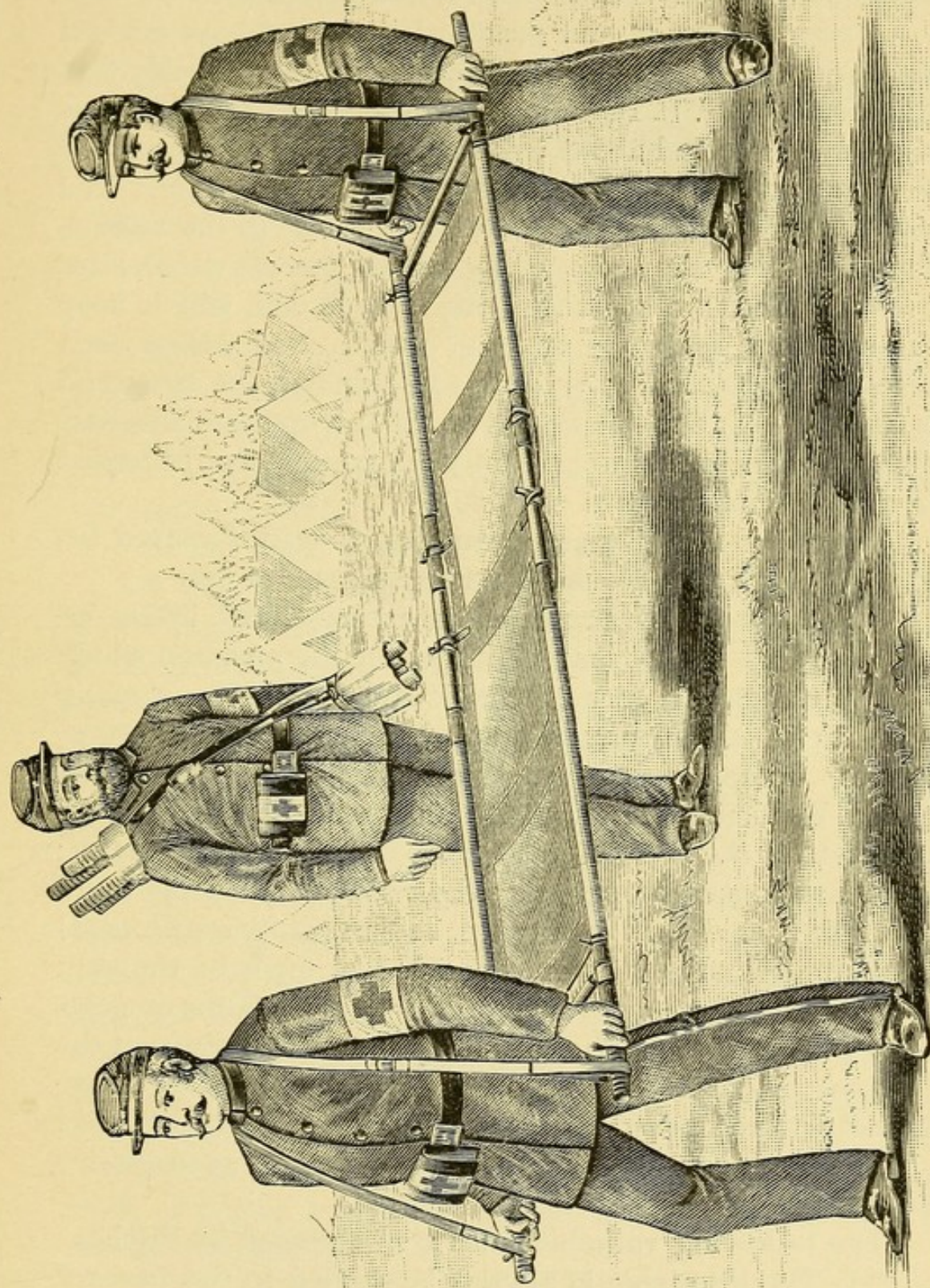
Fig. 86.—Marsh's stretcher.

with canvas also accompanies it.   The litter complete
weighs only twenty-three pounds and a quarter."

A very ingenious and practical litter has been devised
by Major E. T. T. Marsh, Surgeon of the Seventy-first
Regiment, N. G. S. N. Y.   It consists of two ash side-bars,
eight feet long and about two inches in diameter, attached
to a piece of canvas six feet long and two feet wide.   The
side-bars are hinged (but not disconnected) in the middle,
the joint being strengthened by a brass ferrule which slips
over it.   The two spreaders, one at each end, which keep
the side-bars apart, are made of wood.   One end of each
spreader is attached by a hinge to a side-bar, the other end
is capped with a metal crutch to fit the opposite side-bar.
The stretcher, which weighs only ten pounds, can be folded
in a very compact form (Fig. 86).

The above are given as examples of manufactured lit-
ters, although numerous others are in general use.

EXTEMPORIZED LITTERS.—The extemporized litters in-
clude any agent (not manufactured for the purpose) which
can be utilized to carry the sick and wounded.   Among
the articles which may be employed are window-shutters,
boards, doors, bed-frames, mattresses, benches, tables,
chairs, blankets—the last may be carried by two or more
persons, or the four corners may be tied to two poles ;
rugs, hammocks, carpets, may be used in the same man-
ner.   It is said that during an Indian campaign General
Jackson carried the wounded on litters made of the skin
of oxen strung between two guns or poles.   Guns or poles
may be passed through sacks (openings being made at the
bottom), or coats (Fig. 87), or trousers.   Poles may be re-
tained at the proper distance apart by rope or telegraph-wire.

At the present time four men are regarded as necessary
for the proper manipulation of a litter.

The following valuable rules are suggested by Pilcher :

" 1. The litter should always be carried in the bearers'
hands, the arms hanging by the sides, or at that level if
it is supported by straps, and never on their shoulders.

The necessity of having the patient in sight of the bearers in order that a demand for checking hæmorrhage or ex-
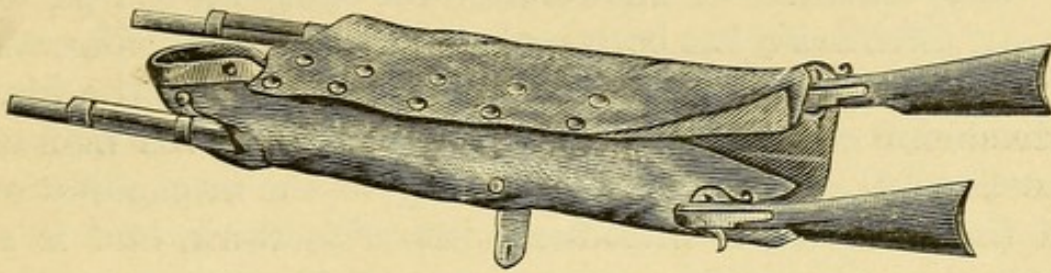
Fig. 87.—Extemporized stretcher.

tending other aid may be promptly appreciated, would make the latter position improper. The height also is liable to cause anxiety on the part of the patient, and in case of the fall of one of the bearers actual injury may occur to the patient.

"2. The litter should be held level.

"3. The litter should be borne with the patient's feet to the front, except in carrying a patient up an ascent, or in carrying a patient with a fracture of the lower extremity down a declivity, when the position should be reversed, in order to prevent pressure upon the injured part.

"4. The bearers' step should be firm, and not springy, with the knee slightly flexed, and the hips moved as little as possible, and should be about twenty inches in length. The step in which the front bearer starts off with the left foot and the rear bearer with the right foot is highly esteemed by many authorities, and is unquestionably the best practical method of preventing the unpleasant rolling motion produced by both bearers' stepping in time with the same foot. Bearers should be thoroughly drilled in avoiding all jolting movements or swinging or rocking of the litter.

"5. The litter should not be carried over a fence or wall, or across a ditch, or similar marked depression, if it can be avoided."

The manner in which the sick and wounded may be transported by one or more persons without the litter will

be referred to in the following extract from Dr. Smart's manual.

The "Manual of Instruction for Hospital Corps, U. S. A." (Heizman) has been recently modified and corrected by Major Charles Smart, Surgeon U. S. A. By the kind permission of this gentleman that portion of his manual (sections 49 to 82, inclusive) relating to the transportation of the wounded is introduced into this work, and is as follows :

"**49.** In BEARER DRILL the instructor designates by their numbers the squads which he wishes to operate with the hand-litters, ambulances, etc., and assigns the Hospital Stewards and Acting Hospital Stewards to the superintendence of drills that are not supervised by officers. No. 1 of each set is the ranking member, and gives the commands needful for the proper manœuvring of the squad.

"**50.** No. 1 of a squad designated to practice with a hand-litter procures the litter and prepares it for use, placing it lengthwise on the ground, its near end opposite and two yards in front of the center of the squad ; he then resumes his place on the right of the squad and commands : 1. *To your posts*, 2. MARCH. At the second command, Nos. 2 and 3 take position between the handles—No. 2 in front, passing by the right, No. 3 in rear ; No. 4 takes position on the left of the litter opposite its center and one yard from it ; and when No. 1 has seen that the other numbers have their proper posts, he takes his own on the right of the litter opposite its center and one yard from it, all facing to the front.

"**51.** Or: The folded litter being in position in front of the squad, at the command, *To your posts*, MARCH, the members take post, No. 2 on the right of the front handles, No. 3 on the left of the rear handles, and Nos. 1 and 4, respectively, on the right and left of the litter at its midlength, all facing to the front. Then, at the command, *Open*, LITTER, 1st, all face inward to the litter; 2d, Nos. 1 and 4 bend

on the knee, grasp litter with hands under poles and rise erect, holding litter horizontal; 3d, Nos. 2 and 3 unbuckle and fix straps, adjust legs and straighten traverse irons, etc. Then, at the command, *lower* LITTER, Nos. 1 and 4 lower litter to the ground; and all resume position as in last paragraph, after the command, *To your posts*, MARCH.

"**52.** No. 1 now commands: 1. *Prepare to lift litter*, 2. LIFT LITTER. The first command is executed by Nos. 2 and 3 adjusting the braces about their shoulders; the second, by the same numbers raising the litter in position to be carried, Nos. 1 and 4 standing fast. If, owing to a difference in height of the carriers, the litter is not horizontal, No. 1 directs a change in the length of the braces to correct the inequality.

"**53.** He then commands: 1. *Forward*, 2. MARCH—when, at the second command, the carriers break step, that is, step off with different feet, No. 2 with the right, No. 3 with the left foot, marching with the litter as nearly horizontal as possible, and taking short sliding steps to avoid jolting and to secure a smooth uniform movement of the litter; Nos. 1 and 4 march on their respective sides of the litter.

"**54.** The litter is carried to the point previously designated by the proper officer by means of the command: 1. *Litter, right* [or *left*]; or *Litter, half-right* [or *left*]; or *Incline to the right* [or *left*]; MARCH.

"**55.** To halt the litter and rest the squad, No. 1 commands: 1. *Litter*. 2. HALT. 3. *Lower litter*, 4. REST. At the third command the litter is slowly and steadily lowered to the ground and the carriers release themselves from the braces; and at the fourth command, the men stand at ease in the vicinity of their posts.

"**56.** To resume the attention the commands are: 1. *Squad*, 2. ATTENTION.

"**57.** The transfer of a patient to the litter requires practice and the united action of two, three, or all the bearers of a squad, according to the gravity of the wound or the helplessness of the patient. Every movement should

be made without haste and as gently as possible; and the wounded part should be carefully protected from all injurious contact.

" 58. Having reached the sick or wounded man, No. 1 halts and lowers the litter so as to place it in front of the head or feet of the patient in the direction in which he is lying. As soon as they are released from the braces, Nos. 2 and 3, passing by their right and left respectively, take position facing each other, on opposite sides of the patient, near his hip bones, and, if a limb be injured, No. 4 places himself by its side. Everything in readiness, No. 1 commands: 1. *Prepare to lift patient;* when Nos. 2 and 3 stoop down and get each one hand under the back of the patient near the shoulder-blades, and lock them by grasping firmly each other by the wrists; the other hands are passed under the upper part of the thighs and clasped; No. 4 attends only to the injured limb. No. 1 now commands: 2. LIFT PATIENT; when the bearers rise slowly, and when upright, as illustrated in Fig. 88, at the command, 3. *Forward,* 4. MARCH, they move by short steps until the head of the patient is over the pillow on which it is to rest. No. 1 then commands, 1. *Squad.* 2. HALT. 3. LOWER PATIENT; when the bearers slowly lower the patient to the litter. Or the commands for marching and halting may be omitted, the bearers standing fast while No. 1 slips the litter under the patient.

" 59. Nos. 1 and 4 now see that the patient is in a comfortable and secure position, the head properly supported and the wounded part so placed that it can be easily attended to on the march.

" 60. The movements of the loaded litter are executed in accordance with the commands of the hand-litter drill as stated above [52–56].

" 61. It will be observed that, in raising the patient to the litter by this method, the head and upper part of the body are considerably elevated. An individual who is intensely prostrated may not be subjected to this treatment
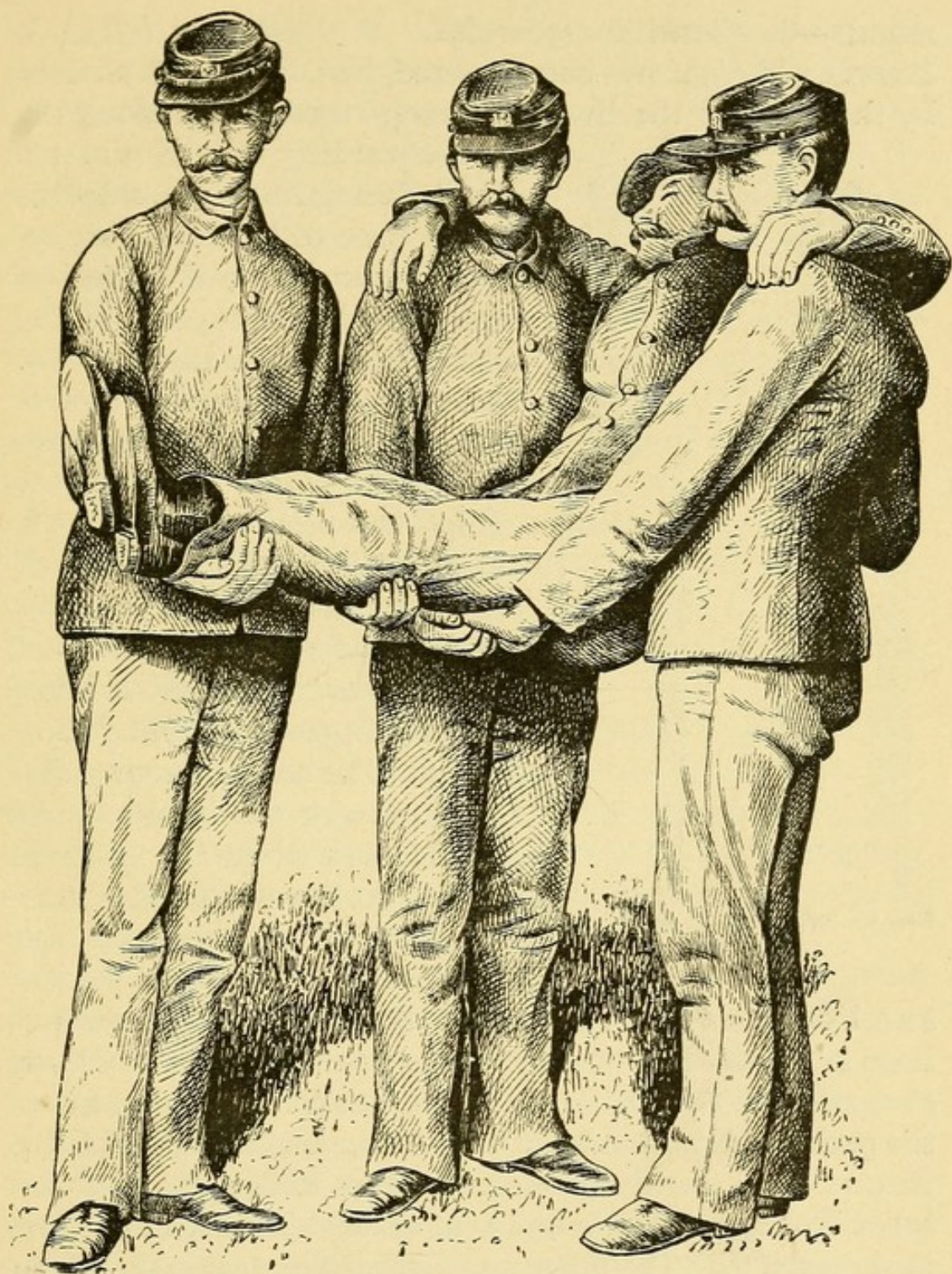
FIG. 88.—Nos. 2 and 3 supporting patient, and No. 4 taking care of injured limb.

without risk of syncope. In such cases, the following method is recommended:

"62. When the litter has been halted near the head or foot of the patient, and in line with the body, No. 1 com-

mands—1. *Stand to wounded.* 2. *Right* (or *left*). 3.
MARCH. If *right* has been ordered, Nos. 2, 1, and 3 proceed
by the right of the litter and range themselves along the
corresponding side of the pa-
tient, facing him—No. 2 by his
right knee or left shoulder, ac-
cording as the head or feet of
the wounded man point to the
litter, No. 1 at his hip, and No.
3 at his right shoulder or left
knee, while No. 4 takes posi-
tion opposite and facing No. 1.
If *left* has been ordered, Nos. 2,
4, and 3 proceed by the left of
the litter and range themselves
along the corresponding side of
the patient, while No. 1 takes
position opposite to and facing
No. 4. The accompanying dia-
gram shows the positions of
the bearers when the order is
right. At the command—LOAD

FIG. 89.—Standing to wounded by
the right.

—using the numbers for the
movement, *one*, the bearers
kneel on the right knee if on the right, and on the left
knee if on the left of the patient; *two*, No. 2 or 3, who is
stationed at the patient's knee, passes both arms about
the patient's legs, carefully supporting the fracture, if there
be one, Nos. 1 and 4 pass their arms under his hips and
loins, No. 2 or 3 passes one arm under his neck to the fur-
ther axilla, with the other supporting the nearer shoulder;
if possible the patient clasps his arms about the neck of
this bearer; *three*, all lift together slowly, supporting the
weight upon their knees, and as soon as the patient is
firmly supported, No. 1 or 4, whichever is on the free side,
withdraws his arm and passes by the shortest line to the
litter, which he takes up near the middle, one pole in each

hand, and returning to his position, places it under the patient and close against the bearers, being careful to see that its legs are properly arranged, and then assists, as before, in supporting the patient; *four*, all the bearers gently lower the patient upon the litter; *five*, the bearers rise and resume their position, 2 and 3 as carriers, and 1 and 4 on the right and left of the litter respectively.

" **63**. It will frequently occur that, being wounded in the leg or foot too severely to walk, the soldier can, nevertheless, with proper attendance, seat himself upon the prepared litter placed by his side, and then lie comfortably upon it.

" **64**. To change bearers on the march, No. 1 commands —1. *Litter*. 2. HALT. 3. LOWER LITTER; followed by 1. *Change posts*. 2. MARCH; when Nos. 1 and 2, and 3 and 4 exchange posts and duties, except that No. 1 retains command of the stretcher.

" **65**. The transfer from litter to litter or to bed is effected in the same way as from the ground to the litter [**58**, **62**], the bearers always observing, as far as practicable, that the litter or bed to which the patient is to be transferred shall be at the head of the patient, its length in the direction in which he is lying.

" **66**. As a general rule in hand-litter operations, the feet of the patient should point in the direction in which the litter is carried. But in going up-hill or up-stairs, the patient's head should be in front unless he has a broken leg or thigh, in which case the order is reversed to prevent the weight of the body from pressing down on the injured part; and on going down-hill the patient's head should be behind, except, for the reason given, in cases of fracture of the lower extremities. It is important that the bearers should keep the litter level, notwithstanding any unevenness of the ground. In making ascents, the stronger of the two bearers should be in the rear, as he has to bear a greater weight in raising his end of the litter to the proper level, and in making descents he should for the same rea-

son be in front. A breach should be made in a fence or wall for the passage of the stretcher, if there be no gate or other opening, rather than risk the passage of the injured man over it; but should it be necessary to surmount the obstacle, Nos. 1 and 2 place the front handles securely on top, while 3 and 4 elevate the rear handles; the two first-mentioned then cross the wall and advance the litter until its rear handles rest upon it, when 3 and 4 cross, resume the handles, and all lower the litter, after which the march is continued as before the obstacle was reached. In crossing a ditch or deep cut, the litter is laid on the ground with the front handles near the edge; Nos. 1 and 2 descend and advance the litter, keeping it level, until the rear handles rest upon the edge, when Nos. 3 and 4, who have assisted in this movement, descend and resume the support of their respective handles; the ascent on the other side is made by Nos. 1 and 2 resting their handles on the edge, ascending, and advancing the litter until its rear handles rest upon the edge, when 3 and 4 ascend, and the march is resumed. The position of a patient on the litter depends on the site and nature of his injury. The head should, as a rule, be kept low, particularly when the patient is faint; but difficulty of breathing in penetrations of the chest often requires that the head and shoulders be elevated. In wounds of the abdomen, the best position is on the injured side, or on the back, if the front of the abdomen is wounded, the legs in either case being drawn up, and a pillow or other suitable object placed behind or beneath the knees to keep them bent. In an injury of the upper extremity calling for litter transportation, the best position is on the back or on the uninjured side; while in injuries of the lower extremity the patient should be on his back, or inclining toward the wounded side.

"67. To change the direction of the litter in order to ascend an elevation when the patient's lower limbs are not fractured, or to descend an elevation when such a fracture is present, No. 1 commands—1. *Squad.* 2. HALT. 3.

Lower LITTER.   4. *About* FACE.   5. *Raise* LITTER.   6. *On
No.* 2 (or *No.* 3) *right* (or left) WHEEL.

" **68.** Tŏ *fold the litter*, when the patient has been dis-
posed of and the necessity for the open litter is at an end,
the squad being at their posts [**50**], No. 1 commands—*Fold*,
LITTER; when, 1st, No. 2 steps to the outside of his right
handle, No. 3 to the outside of his left handle, and *all* face
the litter; 2d. Nos. 1 and 4 advance to mid-length of the
litter, bend on the knee, grasp litter with hands under poles
and rise erect, holding the litter horizontal; 3d. Nos. 2 and
3 remove slings from handle and lay them across litter
near its ends, close handles, legs, and traverse-irons, fold
canvas lengthwise on top of poles, placing slings length-
wise on canvas buckles out, and securing all by straps at
ends. The litter is then lowered: At the command, *Lower*
LITTER, Nos. 1 and 4 lower the folded litter to the ground,
handles on the right of Nos. 2 and 3, and recover the erect
position. The command—*To your posts*, MARCH—brings
the squad to position as in **50** ; after which, at the com-
mand—*Front into line*, MARCH—1, 3, and 4 advance to the
line of No. 2, in their regular formation, 1, 2, 3, 4, from
right to left. The squad may then be rested, or marched
off in any direction without the litter or with it.

" **69.** It will be seen that this litter drill has a reference
only to the open litter in connection with the wounded or
sick man who is to be carried. When troops are on a
march, the folded litter may be carried *at will* by one man
on the right or left shoulder, by two men holding it by the
handles, or in any other way that will render its trans-
portation least burdensome. Litter-bearers are assumed
to have attained, by a preliminary drill or otherwise, that
familiarity with the management of the folded litter
which will enable them to handle it without incommod-
ing their neighbors in the ranks.

" **70.** In *drilling with ambulances*, the squad under the
direction of No. 1 will be brought to a halt, in line, facing
the rear of the ambulance and two yards behind it.

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This is its position at the command—1. *Ambulance;* 2. Posts.

"71. Should the officer desire to inspect the ambulance or to see that everything is in proper condition, he will do so at this stage of the drill ; and, when satisfied, notify the chief of the squad that the inspection is completed.

"72. On marches, the squad will be two yards in rear of its ambulance, or Nos. 1 and 2 on the right, and Nos. 3 and 4 on the left, or all on the right or left, according to the condition of the roads. When there is no immediate necessity for their services, all the bearers may be marched at the head of the ambulance column.

"73. To *prepare the ambulance:* The squad being in line, two yards in the rear of the ambulance, the command is given—1. *For one litter* [or *two litters* or *for seats*]. 2. PREPARE AMBULANCE—when all advance to the rear of the ambulance ; No. 1 enters the ambulance, and, assisted by the others, makes the needful arrangements, and, if a litter is required, places it unopened on the rollers, after which he resumes his place on the right of the line.

"74. At the command—1. *From ambulance;* 2. TAKE LITTER, No. 2 takes hold of the projecting handles, and, stepping backward, pulls the litter out; 1 and 4 face toward the litter and support it about its mid-length, palms upward, 3 lays hold of the unsupported end, and all move from the ambulance until the near end of the litter is two yards clear of the rear of the ambulance, when the litter is opened, lowered, and carried off in accordance with the principles of bearer drill.

"75. To *load the ambulance*, the litter is halted and lowered so that the head of the patient will be toward and close to the rear of the ambulance. No. 1 then commands—1. *Prepare to load*, when No. 3, who is in advance, steps to the outer side of the front handle opposite to and facing No. 1, who takes post on the outer side of the other front handle, No. 2 remaining between the rear handles, while No. 4 mounts the box to give assistance from that point ;

Nos. 2 and 3 remove slings, and drop them temporarily on the ground. At the command—2. *Raise litter*—the three bearers stoop, take hold of the handles, and slowly raise the litter to the level of the rollers on the floor of the ambulance, being careful to keep it in a horizontal position. At the command—3. Pass in—the front handles of the litter are gently placed on the rear rollers and passed in, No. 2 pushing and following the litter, halting and occupying the space between Nos. 1 and 3. During this operation, Nos. 1 and 3 attend to the folding of the legs of the litter, and No. 4 sees that the fastenings provided to secure the litter in the ambulance are properly adjusted ; Nos. 2 and 3 then resume their slings, and at the command— *Ambulance*, posts—the squad is reformed in line in rear of the ambulance.

"76. To *unload the ambulance*, the men of the squad being at their posts, two yards in rear of the ambulance, No. 1 commands : *Prepare to unload*, when Nos. 1 and 3 place themselves on the right and left of the litter to be withdrawn, facing each other ; No. 2 places himself in the interval between Nos. 1 and 3, facing the ambulance ; No. 4 mounts the box and loosens the fastenings of the litter. All being in readiness, No. 1 commands : 1. *Pass out ;* 2. LOWER LITTER. At the first command, No. 2 takes hold of the rear handles and draws out the litter ; Nos. 1 and 3 stand fast, adjusting the legs of the litter, and supporting the poles until the front handles are reached. Care should be taken that the litter is preserved in a horizontal position at the level of the rollers. At the second command, which may, if necessary, be preceded by the command *steady*, the litter is lowered to the ground.

"77. The patient having been carried to the point designated by the officer, the squad will return to the ambulance and unload the other litter, if required ; after which No. 1 forms his squad in line and awaits further orders.

"78. When company bearers are drilled with arms, first : In the litter drill, after the command : 1. *To your*

post ; 2. MARCH, and before the command *Prepare to lift litter*, No. 2 will hand his rifle to No. 1, and No. 3 to No.
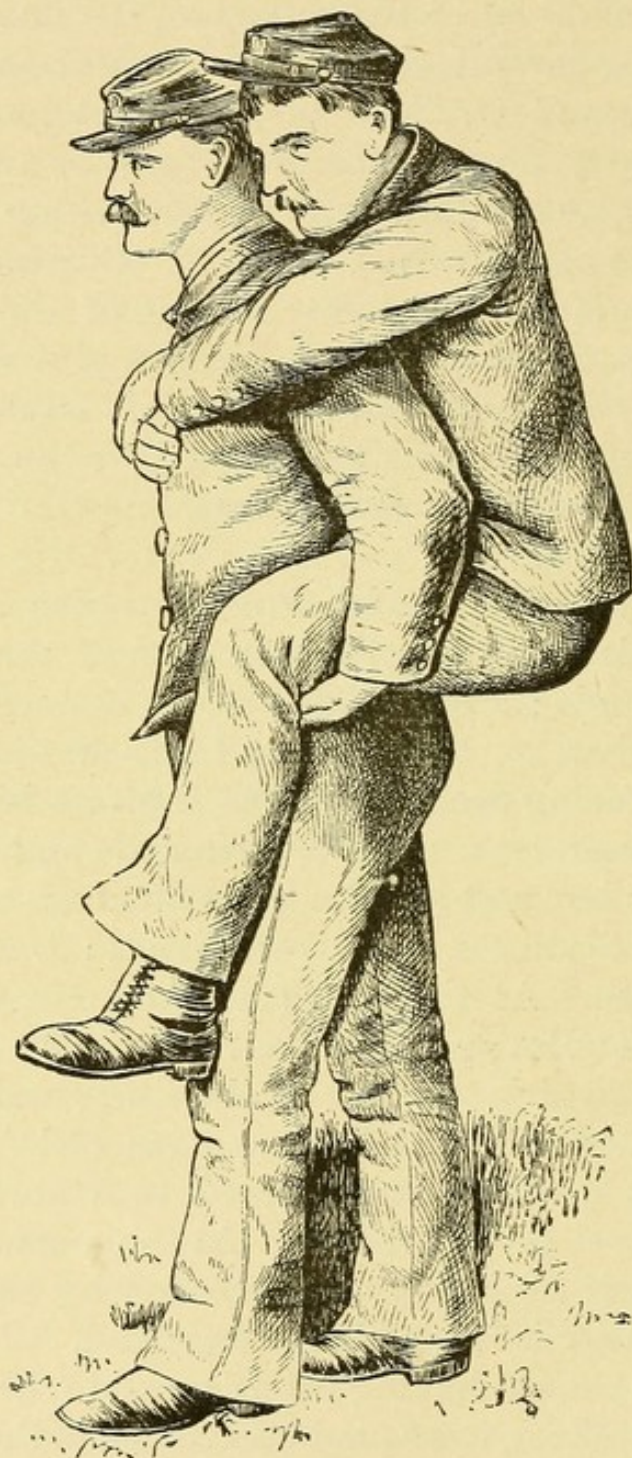
FIG. 90.

4 to carry.   Second : in the transfer of the patient to the litter, immediately before taking position about the patient,

Nos. 1 and 4 will lay the arms on the ground, in a safe place, where they can not be injured ; the drill will then proceed as without arms, until the bearers are in position to carry the wounded man on the litter, when the arms
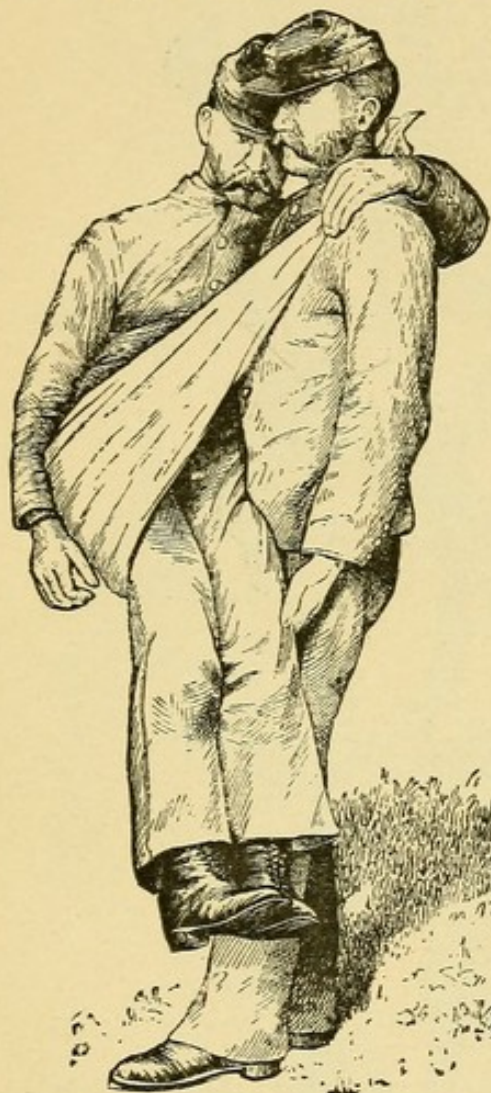
FIG. 91.—Heyfelder's method.   FIG. 92.—Harbers' method.

will be resumed by Nos. 1 and 4 as above. Third : In ambulance drill, a halt will be made before the halt in rear of the ambulance, the rifles will be stacked, and the drill performed as without arms.

"79. A mounted squad having been assigned to a specific drill will dismount and No. 4 will take charge of the horses.

"80. Other modes of carrying a disabled man may be practiced :
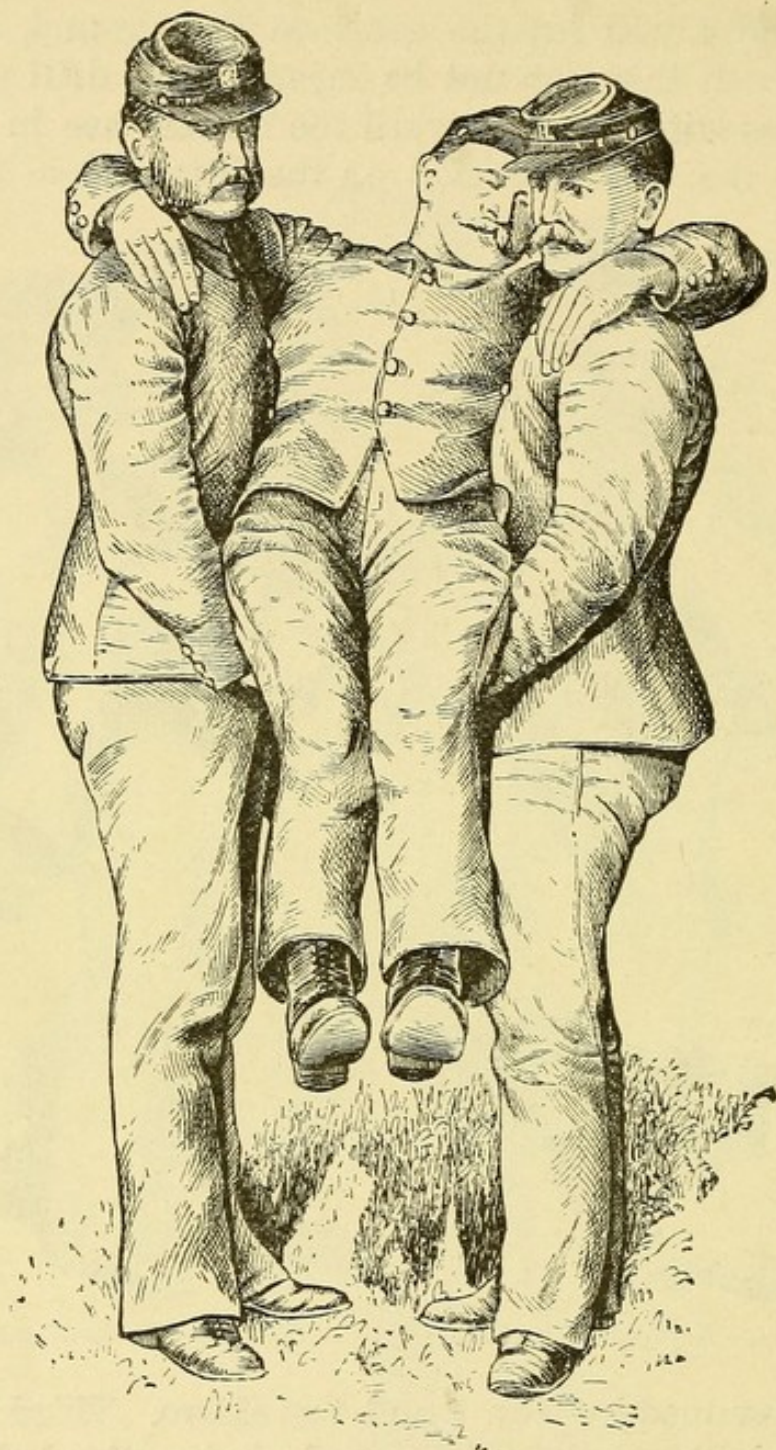
Fig. 93.—Patient seated on two hands.

"By one man, patient on bearer's back, as in Fig. 90.

"By one man, patient in camp-chair strapped on bearer's back.

"By one man, patient in bearer's arms, as in Heyfelder's method (Fig. 91), or by the strap arrangement of hospital steward Harbers (Fig. 92).

"**81.** By two men, patient sitting on two hands (Fig. 93).

"By two men, patient sitting on four hands (Fig. 94).

"By two men, patient sitting on an improvised seat of
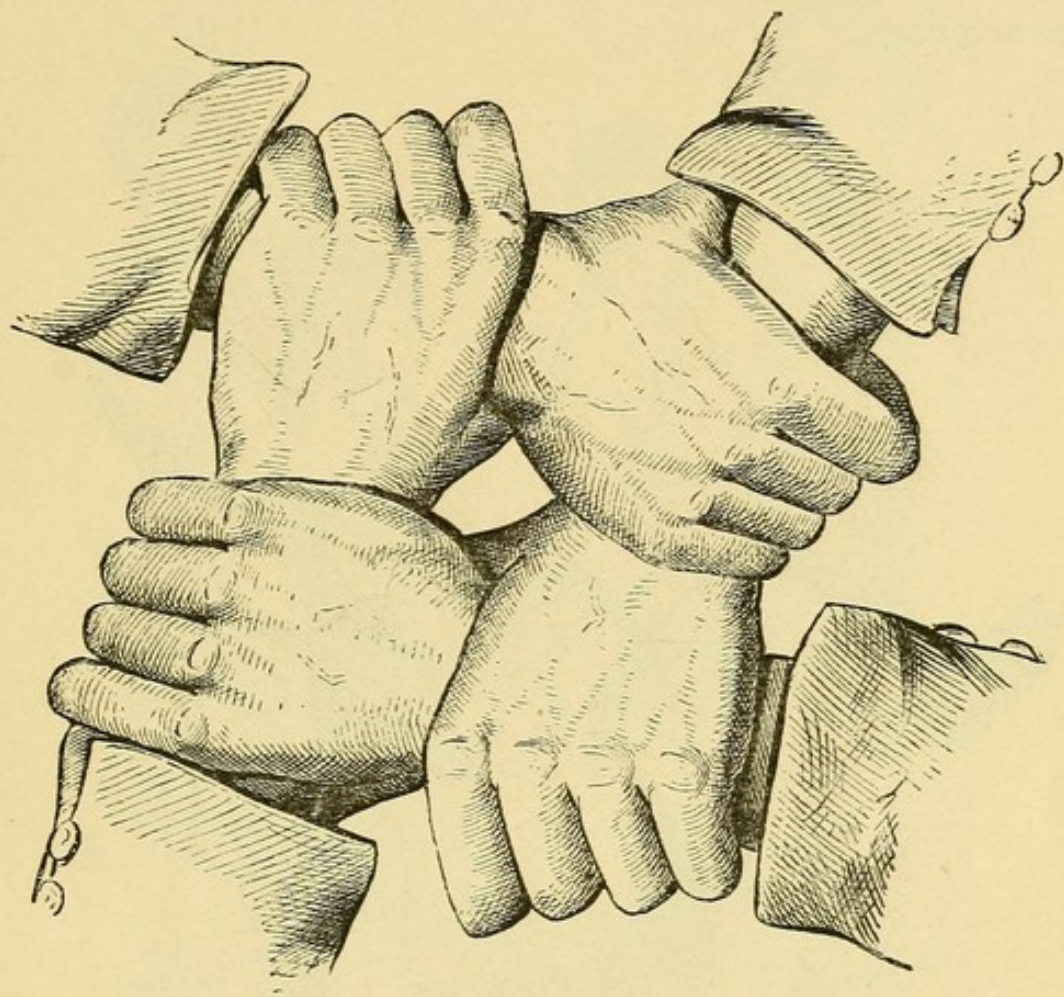
FIG. 94.—A four-hand seat.

leather, cloth, canvas, straw, or twisted rope, or on a board, saber, scabbard, or chair.

"By two men, patient held by the sides.

"By two men, patient supported by the extremities, as illustrated in Fig. 95.

"By two men, patient stretched on a screen, shutter, board, door, ladder, wheelbarrow, or hammock.

"By two men, patient supported on two rifles connected by crossed gun-slings, suspenders, overcoat, jacket, etc., as shown in Fig. 96. No. 1 must see that the rifles are not loaded.

"By two men, patient stretched on two long beams or four rifles tied together by blankets, tent-flies, surcingles, ropes, straw-matting, etc.

"82. By wheeled litters, which are, as a rule, of use only in hospitals.
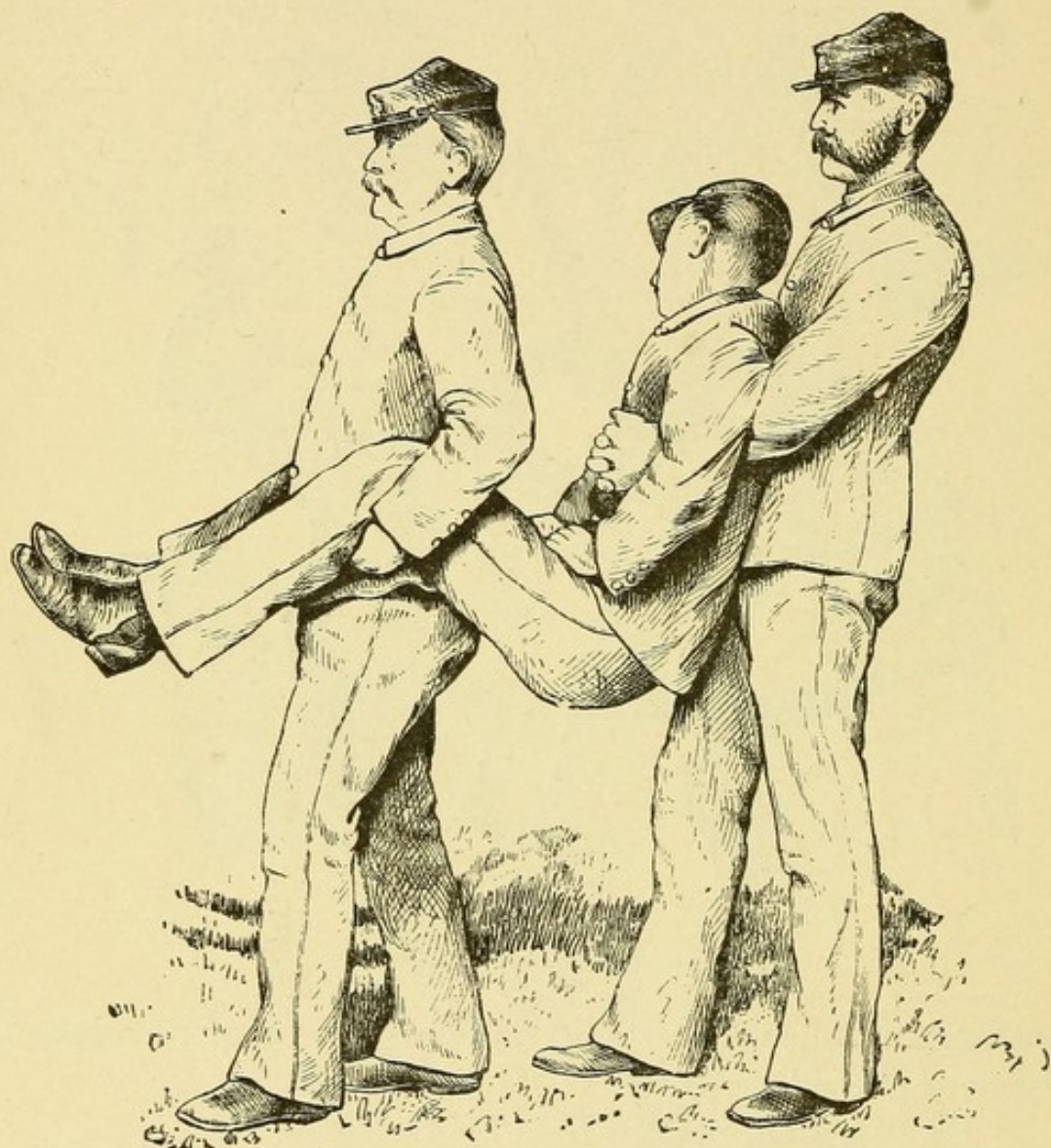
FIG. 95.—Patient supported by the extremities.

"By mule, horse, or bullock, on cacolets and litters differing from the regulation litter.

"By travois, improvised Indian, Greenleaf's, Munn's, etc.

"By wagons, quartermasters' supply-wagons, army spring wagons, spring carriages of any kind, caissons, coun-

try or farm wagons, carts, etc. If there is any choice, spring wagons should be preferred. Over the bodies of other wagons springs of rope may be corded, or of saplings se-
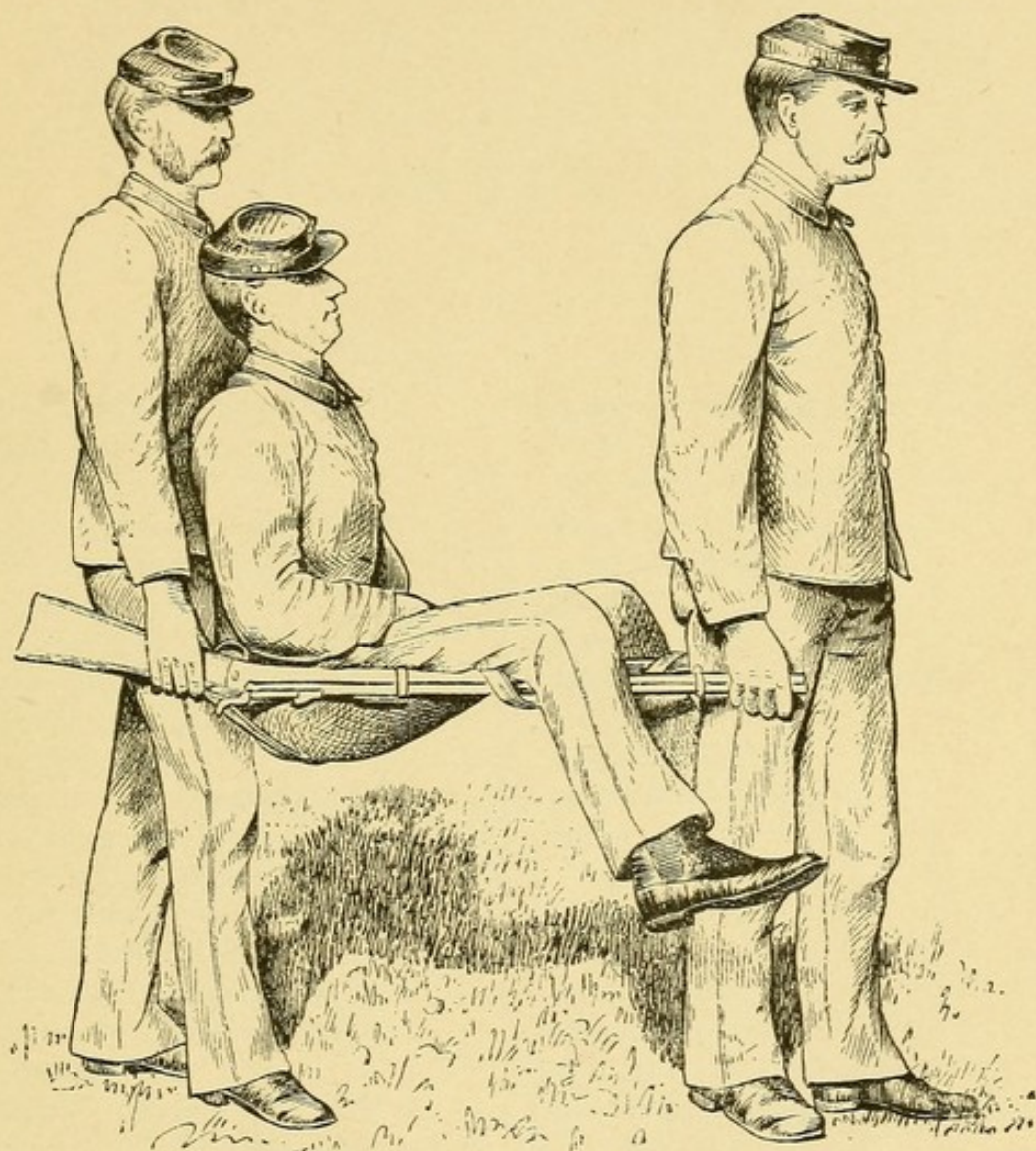
FIG. 96.—Improvised litter.

curely attached, on which the ordinary hand-litter may be fixed ; or bedding of straw or leaves may be laid on the floor, and the litters or patients placed directly on it."

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THE END.