application of the pure or diluted sticks of lunar caustic to that of solutions of not more than the one-fifth of one per cent. strength. To determine absorption the stronger applications are necessary, to control catarrhs the weaker; but in all cases care should be taken not to overdo the matter, and, by too strong or too frequent application, actually to interfere through excess of irritation with healing or with resolution. In the case of catarrhs, moreover, the remedy should not be used at all until the second stage of the process is reached, as betokened by the establishment of the catarrhal secretion and abatement of the initial pain or sensitiveness. Then, too, the strength of the application should be adjusted to the different degrees of sensibility of the different mucous membranes; for while the comparatively insensitive membranes, such as those of the fauces or vagina, may take a five-per-cent. solution, or even stronger, hardly more than the one-tenth of this strength can be applied without undue irritation to the nasal passages or to the male urethra. When a very brief action is wanted, the application of silver may be followed immediately by one of a solution of common salt, which salt immediately precipitates all excess of nitrate as the insoluble, and therefore inert, compound, silver chloride.

Silver Cyanide: AgCN. This salt is official in the United States Pharmacopœia as *Argenti Cyanidum*, Silver Cyanide. This salt is an insoluble white powder, not used in medicine, and official only for the making, by the pharmacist, of diluted hydrocyanic acid.

Besides the foregoing, a number of unofficial preparations of silver deserve brief notice.

Silver Vitelline, Argyrol.—This remarkable compound has recently been prepared and proposed for medical use by Barnes and Hille, of Philadelphia (*Medical Record*, May 24th, 1902). A salt solution of vitelline, a derived proteid obtained from gliadin, is precipitated by silver nitrate. Such precipitate — silver vitelline — properly dried, appears as a dark-brown powder. The substance contains thirty per cent. of silver, about half the amount contained in silver nitrate, and is remarkable for being extremely soluble in water, while at the same time it does not precipitate albumin or sodium chloride, and is wholly unirritating. Its solution also penetrates albuminoid tissues very readily and thoroughly. Silver vitelline thus possesses all the desiderata for an ideal silver preparation, and has been used with great success as a local application in inflammations of the mucous membrane of the eye, ear, nose, vagina, urethra, and bladder. It is employed in aqueous solution ranging in strength from one-tenth of one per cent. to twenty-five per cent. and upward, according to the character and sensitiveness of the part. Even a ten-per-cent. solution applied as an injection in acute gonorrhœa produced no irritation (Christian).

Colloidal Silver (Soluble Silver, Collargol).—This is a bluish-green substance obtained by precipitating with silver nitrate a mixed solution of ferrous sulphate and sodium citrate. Collargol contains 97.2 per cent. of silver, dissolves in 25 parts of water forming a dark reddish-brown solution, and is easily decomposed. Its aqueous solution, on standing, deposits a small sediment of insoluble silver.

Collargol, introduced into the general circulation, has been declared by Credé and others to exercise a remarkable curative power over the conditions of general septic infection, whether by action on the micro-organisms themselves or on their toxins is not clear. At the same time the remedy is non-poisonous and, being rapidly eliminated after absorption, does not produce argyria. The only untoward effect observed has been a slight chill and rise of temperature, but even this is not seen if (using by intravenous injection) care is taken that the solution be free from sediment.

Collargol may be administered by inunction or by intravenous injection. For the latter method a carefully prepared, freshly made solution in distilled water is to be used, of a strength of one-half to one per cent. If a sediment forms, the supernatant liquor must be decanted. Of such a solution from half a fluidrachm to five fluidrachms may be injected directly into some superficial vein once or twice daily, or every two or three days. The more common method of administration, however, is by inunction. For this purpose a fifteen-per-cent. ointment is used, of which the quantity of from thirty to forty-five grains is rubbed thoroughly into the skin of the inner side of the arms or thighs, or of the back, from one to three times daily. Collargol ointment decomposes readily and should not be exposed to the air. An ointment should not be used that shows white crystals on the surface, or that fails to color the skin black on inunction. An ointment having the official sanction of Professor Credé is on the market under the title "Unguentum Credé." This ointment contains fifteen per cent. of collargol in a mixture of lard, wax, and benzoic ether.

Silver Sulphocarbolate, $C_6H_4(OH)SO_3Ag$. This compound occurs as a white crystalline powder soluble in water. It contains twenty-eight per cent. of silver. If exposed to light and air it decomposes spontaneously. It has been proposed as a substitute for silver nitrate because non-corrosive.

Silver Citrate: Itrol, $Ag_3C_6H_5O_7$. This compound is a fine, dry powder, without taste or smell, very slightly soluble in water. Its solution is immediately decomposed by organic matter. Like silver vitelline, it is non-irritant and penetrating, and has been proposed as a surgical disinfectant and for injection in gonorrhœa and cystitis. The strength of solution ranges from 1 to 4,000 to 1 to 8,000.

Silver Lactate: Actol, $AgC_3H_5O_3$. This compound is a white powder, without taste or smell, and soluble in from fifteen to twenty parts of water. It is a powerful germicide, and penetrates tissues, although decomposed by contact with the same. It is used as a surgical antiseptic, and strong, even saturated solutions may be applied to infected parts. Ordinary strengths are 1 to 1,000 or 2,000 parts of water.

Silver Quinaseptolate or *Oxy-chinolin-sulphonate: Argentol,* $C_9H_5N.OHSO_3Ag$. This compound is a yellow powder, slightly soluble only in water. In contact with septic substances it decomposes into oxyquinolin and metallic silver. It is used in surgery as a dusting powder, or applied in ointment (1 or 2 parts to 100 of ointment) or in solution, 1 to 3 parts to 1,000 of water.

Argentamin.—This name is given to a solution of silver phosphate (10 parts) in a ten-per-cent. aqueous solution of the organic base ethylendiamin. It is a clear fluid, strongly alkaline, and is devised to give a non-poisonous and unirritating antiseptic solution which shall not precipitate albumin. It is diluted one thousandfold for use.

Argonin.—This name is given to a body obtained by precipitating with alcohol a mixed solution of silver nitrate and a sodium compound of casein. Argonin is a white powder, neutral in reaction; insoluble in cold water, but readily soluble in warm or albuminous water. Solutions must be kept away from exposure to light. It has been used in gonorrhœa in solutions of from 1 to 7 parts in 1,000 of water.

Largin.—This name is given to an albumin compound of silver occurring as a gray powder soluble in 9 parts of water. Largin is powerfully germicidal while non-irritating, and is not precipitated by albumin or sodium chloride. It has been used in gonorrhœa in solutions ranging in strength from one-fourth to one and a half per cent.

Protargol.—This name is given to a silver albumose containing eight per cent. of silver. It is a yellow powder, freely soluble in water; unaffected by heat, albumin, or sodium chloride in weak solution, and wholly unirritating. It may be used with great freedom as a local application, being employed in solutions varying in strength from five to twenty-five per cent.

Edward Curtis.

SILVER, POISONING BY.—See *Argyria*.

SIROLIN is a ten-per-cent. syrup of thiocol. (See *Thiocol.*)
W. A. B.

SITKA HOT SPRINGS.—Location on Baronoff Island, Alaska, sixteen miles south of Sitka. They are reached from Sitka by boats only. Four houses have been built at this place, three with bath-rooms attached. In 1860 a hospital for rheumatism and skin and blood diseases was opened by the Russian-American Company. The baths were found to be very beneficial in syphilitic affections. The Indians have resorted to the springs for many years. They are about thirty feet above the sea-level, and distant from salt water about fifty yards. The springs are four in number, but the rate of water flow is unknown. The temperature of the water is 120° F., and it is said to contain sulphur, iron, manganese, and chlorine. The weather in this region is generally clear during the summer months, with a temperature ranging from 60° to 80° F. The spring and fall seasons are rainy, and the winters cold and cloudy, the temperature varying from zero or a little below to 40° F. The spring season is considered preferable for visiting the springs. Other hot springs are located on Chickagoff Island, about eighty miles from Sitka, but as yet no name has been given to them. Little is known concerning them, except that they have some reputation among the Indians in the same diseases as those mentioned above. Within half a mile of Sitka, on a road called Davis Avenue, there is an iron spring flowing from a rock. It has not been analyzed, but it was formerly esteemed by the Russians for its tonic properties.

James K. Crook.

SKAGG'S HOT SPRINGS.—Sonoma County, California.

Post-Office.—Skagg's Springs. Hotel and cottages.

Access.—From Tiburon Ferry, San Francisco, 7:40 A.M. and 3:30 P.M.; arrival at Geyserville, where connection is made with stage for springs at 11 A.M. and 7 P.M. Connections from Sacramento by Carquinez and Santa Rosa Railroad to Santa Rosa, thence viâ San Francisco and Northern Pacific Railroad to Geyserville.

Skagg's Hot Springs are pleasantly located in the Coast Range Mountains, in a picturesque spot, nine miles west of Geyserville and twenty miles east of the coast. The surrounding mountains are clothed with every variety of California verdure, and they abound with trout streams. Many varieties of game are also found, including bear, deer, grouse, and quail. We are informed that a new road from the springs to the coast has recently been constructed, making accessible the Gualalla River, a widely celebrated trout-fishing stream. The springs, four in number, yield fifteen gallons per minute, the water having a temperature of about 120° to 140° F., and a somewhat pungent, agreeably alkaline taste. Excellent bathing facilities have been provided. Analyses have been made by Prof. Eugene W. Hilgard and Dr. Winslow Anderson, which show no material difference in their results. That of Professor Hilgard is as follows:

One United States gallon contains (solids): Sodium chloride, gr. 5.90; sodium bicarbonate, gr. 161.27; sodium biborate, gr. 26.47; magnesium carbonate, gr. 11.11; calcium carbonate, gr. 2.20; silica, gr. 7.02; sodium iodide, potassium chloride, potassium sulphate, potassium iodide, magnesium sulphate, ferrous carbonate, barium carbonate, lithium carbonate, strontium carbonate, alumina, and organic matter, very small quantities. Total solids, 214.80 grains.

Free carbonic-acid gas, 124 cubic inches.

The waters here are very useful in rheumatism, neuralgia, sciatica, etc., as well as in affections involving the bladder and kidneys. They are highly recommended by medical men on the coast, and the proprietor has determined to keep the resort open all the year.

James K. Crook.

SKIN, ANATOMY OF.—See The Appendix.

SKIN, FUNCTIONS OF.—The functions of the skin may be conveniently classified as follows:

I. Protective; II. Excretory; III. Temperature-regulating; IV. Absorptive; V. Sensory.

I. Protective Functions of the Skin.—As an outer covering of the body, the skin protects the deeper parts (*a*) from evaporation, (*b*) from excessive wear and tear, and (*c*) from mechanical violence. The outer layer of the skin (epidermis) has a structure like horn, and forms a shell over the entire body. The deeper layers of the skin and the subjacent tissues and organs are constantly bathed with lymph, which must be renewed from the blood, and if it were not for the horny covering of the epidermis the lymph would evaporate from the surface more rapidly than it could be renewed, and the nerve endings and other delicate structures in the deeper layers would be thrown out of function. The secretion of the sebaceous glands (oil glands), by keeping the epidermis slightly permeated with oil, is of material aid in preventing this evaporation. It is very important that some water should be evaporated from the surface of the skin, but this is provided for through the sweat glands, whose function will be considered in Sections II. and III.

The epidermis of the skin is obviously a great protection against wear and tear, which the softer parts, underneath, would not stand. It varies in thickness in different parts of the body, being thickest in those parts which are most used in such a manner as to wear them away; for example, the palms of the hands and the soles of the feet. In some places it is reinforced by nails and by hair, which are in structure simply modified epidermis. As the outer layer of epidermis is worn off it is replaced from the deeper layers.

Lying immediately under the epidermis comes the dermis (cutis vera, true skin), and beneath this is the subcutaneous connective tissue (superficial fascia). In this connective tissue there is a large amount of fat in an ordinarily well-nourished individual. This fat, in proper quantity, not only covers the angularity of muscles and joints, thus giving beauty to the figure, but it forms a protective pad, which breaks the force of blows, prevents the penetration of foreign bodies (as in puncture wounds and cuts) to important deeper-lying structures (arteries, nerves, etc.), and otherwise adds to the protective function of the skin. As a protection against mechanical violence the hair often plays an important part, as on the scalp.

II. The Skin as an Excretory Organ.—The chief excretions of the skin are the sebum (oil) and the sweat. In many of the lower animals the skin is an important respiratory organ—a frog will live for days with his respiratory centre destroyed—and this function is not entirely lost in man. It is certain that some carbon dioxide is given off by the skin of man, and it is probable that a very slight amount of oxygen may be taken in, but in either case the amount is so small that for practical purposes it may be disregarded.

The sebum (oil) is secreted by the sebaceous glands, which are found all over the skin with the exception of the palms of the hands and the soles of the feet. Where hairs occur the sebaceous glands commonly empty into the hair follicles. One of the chief functions of the sebum is to keep both the hair and the skin from becoming harsh and brittle.

The sweat glands are the most important excretory organs of the skin, but it is a common error to suppose that *in health* they play a *prominent part* in the elimination of waste products, such as urea and allied substances. Chemical analysis shows that the sweat contains about 98.8 parts of water and 1.2 parts of solids. Of these solids common salt (sodium chloride) is the most abundant—the salty taste of sweat is probably known to every one. By weight there are only 8 parts of urea to 10,000 of sweat, and sometimes it is present merely in traces; while the amount of urea in urine is about two per cent. In disease, however, this relation is greatly altered, and when the kidneys refuse to secrete nitrogenous waste products, the sweat glands take up this function to a large extent, so that they form the great safety valve against what is commonly called uræmic poisoning. By far the most important function of the sweat is to furnish the surface of the skin with water, which, by its evaporation, produces a loss of heat from the surface of the body. This will be more fully taken up under the temperature-regulating functions of the skin. The quantity of sweat varies greatly. It depends upon the temperature of the surrounding air, muscular activity, the amount of liquid drunk, the activity of the kidneys, etc.

The secretion of sweat is intimately under the control of the nervous system. The effect of certain mental states (such as fear) upon sweating is proverbial. There is a definite set of secretory nerves to the sweat glands. The course of these fibres has been fairly well mapped out. The best experimental evidence is also in favor of the view that there are sweat centres in the spinal cord, and that these are all dominated by a chief sweat centre in the medulla oblongata. This arrangement helps us to understand the localized sweating in certain nervous diseases; and the moist skin, in the crisis of fevers, can best be interpreted as a return of the centres to normal action after a temporary suspension of activity.

When the skin of an animal is varnished, the animal in most instances dies. A case is on record in which a boy was covered with gold foil in order to represent an angel at a religious ceremony, and lost his life as the result of such coating. These cases are often quoted as showing the baneful effects of retention of the perspiration with the poisonous waste products which it was supposed to contain. This explanation, however, is erroneous. In numerous animals, experimented upon by varnishing, it was found that the body temperature falls with great rapidity, that they may be kept alive for a long time by artificial warmth, and that there is no such accumulation of poisons in the blood as would be called for by the old theory. The cause of death is the excessive and rapid loss of heat from the skin.

III. Temperature-Regulating Function of the Skin.—This is certainly one of the most important functions which the skin has to perform. The temperature of the body depends upon two factors, viz., the heat produced in the body, and the heat lost from the body; or, as they are generally called, heat production and heat dissipation. Each of these is controlled by the nervous system, and each may vary independently of the other. The constant temperature of warm-blooded animals depends upon a constant balance between these factors. For a fuller discussion of this question, see article *Calorimetry*, this Handbook, Vol. II., especially pp. 567–570.

The skin is the chief seat of heat dissipation. This is regulated by the nervous system in two ways, viz., through the blood supply to the skin, and by perspiration. When heat dissipation is to be increased, the vaso-motor centre, acting through the vaso-dilator nerves to the blood-vessels of the skin, causes these vessels to dilate, and thus to receive an extra supply of blood. The skin becomes flushed and warm, and a large amount of heat is radiated off. On the other hand, when heat dissipation is to be reduced, the vaso-motor centre acts through the vaso-constrictor nerves to the vessels of the skin, causing their calibre to diminish. The blood is driven from the skin to the deeper parts of the body; the skin becomes pale, or blue, and cold, and the radiation of heat from the surface is consequently diminished.

The vaso-motor centre responds readily to impulses reaching it through afferent nerves, and is also probably capable of being stimulated by changes in the temperature of the blood itself, so that it forms a self-regulating machine for controlling heat dissipation, and is probably the most delicate mechanism involved in maintaining the temperature of the body constant. For a more detailed discussion of vaso-motor nerves, containing much that has a direct bearing on vaso-motors to the skin, the reader is referred to the article *Circulation of the Blood*, this Handbook, Vol. III., especially pp. 115–118.

As an important adjuvant to vaso-motor changes in the skin, and their influence on body temperature, we have the sweat glands. These are directly under the control of the nervous system, and are commonly called into activity at the same time that the vessels of the skin are dilated. This relation is so pronounced that for a time it was contended that the blood supply was the cause of their secretion. The question was settled, however, by the simple experiment of stimulating the sciatic nerve in an amputated leg (cat), and observing that drops of sweat appeared on the balls of the feet; though, of course, the blood pressure was *nil*, thus proving that true secretory nerve fibres to the sweat glands exist. The sweat centres are therefore important regulators of the body temperature.

The sweat glands are always in a state of greater or less activity. Most of the time the sweat evaporates as soon as it reaches the surface, and is not perceived by us. This is commonly called insensible perspiration. The amount thus evaporated from the entire surface of the body in twenty-four hours may be considerable. Some have estimated it as high as two litres, though this is probably excessive. Half that amount would be a fairer average. When much heat is produced in the body, as during muscular work, or when the air about us is hot, the quantity secreted may be several times as great. In this case the amount of heat lost through the warm sweat which rolls off the body is considerable, but the main loss of heat is always by evaporation. In the dry hot skin of certain fevers, the trouble is probably in the nervous system (involving the sweat centres), and the lack of sweat and evaporation helps materially to keep up the fever temperature (see article *Calorimetry*, § 6).

IV. Absorptive Function of the Skin.—Under ordinary circumstances the skin absorbs practically nothing, so that from a physiological standpoint it might be disregarded; from a practical standpoint in clinical medicine its absorptive powers are of great importance, especially as a channel for the administration of drugs. It is commonly stated that medicines injected hypodermically will produce their effects four or five times more rapidly than when given by the mouth, when the skin and the stomach each exhibit their normal powers of absorption; but far more important than this is the *certainty* of absorption by the hypodermic method. The stomach is very treacherous as an absorptive organ. In many cases its absorptive function seems to be suspended for hours, and is then suddenly resumed with full vigor; repeated doses of strong medicines fail to produce any effect, and then without warning the patient exhibits symptoms of an overdose, amounting even to poisoning. When given by the hypodermic method the medicine is thrown into the subcutaneous tissue where the absorption takes place by the blood capillaries. When the skin is used for the absorption of drugs by inunction, the material to be absorbed is finely divided and rubbed up with some fat. The fat penetrates the skin and carries the drug with it. The old method of blistering the skin to raise the epidermis, and applying the drug to the raw surface for more ready absorption, has now been replaced by the hypodermic method.

V. Sensory Functions of the Skin.—A superficial view of the sensory functions of the skin would make them appear to be manifold and complex, though a more careful study will reduce them to compounds of several simpler senses. In order to understand this a certain knowledge of the central nervous system is absolutely necessary. In attempting to get at them from a skin standpoint merely, we should be very much in the position of one who would try to study the electrical call apparatuses of a great city, and who would consider only the fire-alarm boxes, the police-patrol boxes, the telephones, etc., without going into the engine houses, the police stations, and the telephone central offices to see how the calls were received and how they were treated

there. It is, therefore, necessary to remember that the nerves from the skin communicate with centres in the nervous system, just as the wires referred to above run to definite offices. These centres are in communication with each other, and the effect of a nervous message from the skin may be simple or complex according to the centres which are called into activity. Again, it must be remembered that what we call a "sensation" is a function of the brain centres and not of the skin which contains the call-box or sending organ. Properly speaking, there is no sensation in the skin; it is entirely in the brain. The brain centres *interpret* the receipt of a message from the skin in accordance with their *experience*, and they act accordingly. This often gives rise to sensory illusions, as is illustrated by Aristotle's experiment. If a small round pebble be held, as shown in Fig. 4299, position A, we feel only one pebble; but in position B, while we know from sight that we have only one pebble, we "feel" two. This is especially marked if we rotate the pebble. The explanation is that we have never, as the result of experience, had a small round surface touch the thumb side of the index finger and the outer side of the middle finger at the same time, unless there were two small round bodies to furnish the touching surfaces, so we *interpret the message* received by the brain in accordance with the *past experience* of the *receptive centres*. After the amputation of a limb the patient often has sensations of pain, of heat or cold, of tingling, of numbness, etc., "in the amputated member." This is due to irritation of the nerve in the stump. A certain message reaching a certain centre has always meant a certain condition in the part where that nerve formerly ended, and he continues to interpret the receipt of such a message as he had always done before.

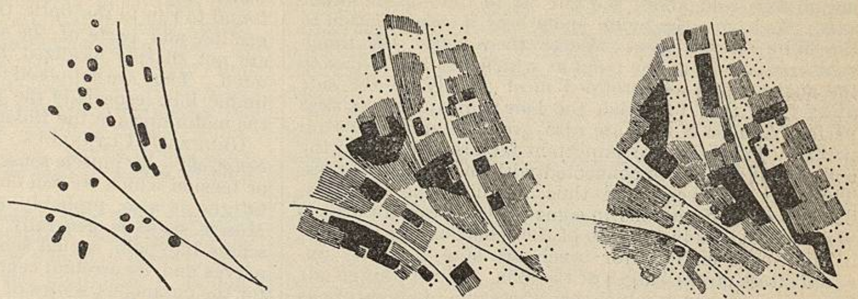
A B C

Fig. 4300.—Chart of Portions of Palm of Left Hand, showing the Distribution of Sense Spots for Touch, for Heat, and for Cold. In *A* the black spots mark the areas on which touch can *not* be perceived. In *B* are shown the areas which may be stimulated by heat. The degree of sensitivity is marked by the shading; the black areas are most sensitive, the line-shaded next, the dotted next, and the blank areas cannot be stimulated by heat at all. In *C*, the same thing is shown for cold as is shown in *B* for heat. (After Goldscheider; from Sherrington, in "Schäfer's Physiology.")

The compound character of the sensations referred to the skin may be illustrated by the following example: If we touch a knife-blade to our finger, we may feel simply a gentle touch or pressure, or we may perceive that it is cold or hot, or that it is rough or smooth. If we draw it along, we perceive the sense of motion and

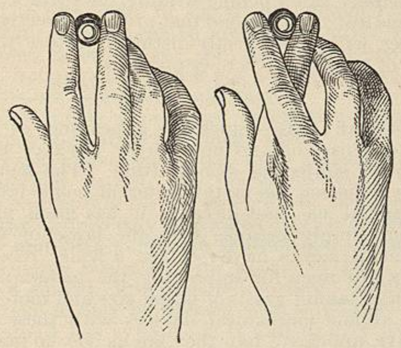
A B

Fig. 4299.—Aristotle's Experiment.

notice whether it is sharp or dull. If it cuts we have the added feeling of pain. Touch (including pressure), heat, and cold, are generally regarded as simple special senses, because they obey laws which hold good for other special senses, have definite areas on the skin which, when stimulated, produce a definite sensation, and probably have definite nerve fibres and end-organs which belong to them exclusively, and more or less definite cerebral centres which receive the impulses over these fibres. All of this, however, cannot be regarded as definitely proved at present.

Pain is usually classified with what are called common sensations, because it does not obey all the laws of the special senses, its skin areas are not as sharply localized as those of touch and temperature, and its possession of exclusive nerves and end organs is more doubtful, though continued researches are tending to lessen this distinction rather than to accentuate it. In accordance with the above we will, therefore, classify the cutaneous sensations as follows:

- Special sensations
  - Touch (including pressure).
  - Heat.
  - Cold.
- General sensations
  - Pain.
  - Muscle sense, etc.

Special Cutaneous Sensations.—*Touch (Including Pressure), Heat, and Cold.*—If the skin be tested by appropriate experiments, it may be mapped out into areas which are connected with one kind of sensation but not with another. For example, if we touch one point of the skin with a small warm body, like a blunt needle, we shall feel the sensation of touch, but not of heat, while on an adjacent area we shall feel the heat, but not the touch. In the immediate vicinity another area might be found where the warm needle would give rise to no sensation, but where a cold needle would "feel cold," and still produce no sensation of touch. Touching either of these latter areas with a needle having the same temperature as the skin would elicit no sensation whatever. Again, areas might be found which did not call forth any sensation of touch or temperature, but whose stimulation would produce pain. These various areas are called "sense spots," and are designated as "touch spots," "hot spots," "cold spots," and "pain spots," respectively. They nearly always overlap, so that we commonly find the same area of the skin capable of awakening at least two or three of the four sensations mentioned. This is well shown in Fig. 4300, which is Goldscheider's chart for the distribution of the spots for touch, for heat, and for cold, in part of the palm of the left hand. By superimposing *A*, *B*, and *C*, it is readily noticed that most of the area is connected with all three sensations, but the parts marked by black spots in *A* would be devoid of the sensation of touch.

The touch spots are not evenly distributed over the surface of the body. In some parts they lie very close together, and practically cover nearly all of the area in question, as is shown in Fig. 4300, *A*, the whole white area being covered by them; on the finger tips they