Their discovery may, however, prove to be the first step in clearing up the etiology of scarlet fever.

"Morphologically the bodies resemble fairly closely the different stages in the sexual development (schizogony) of the malarial organisms. Comparing them with the tertian malarial parasite under the same conditions of fixation and staining, they seem to be about one-third larger, and to have about twice as many segments in the rosettes.

"The accompanying illustrations (Plate LXII.) are a copy in black and white of the plate of colored drawings in the original paper." *

While these bodies must be studied in the living condition to demonstrate beyond question their protozoan nature, and while still further evidence must be adduced before their etiological relation to scarlet fever can be regarded as demonstrated, yet Dr. Mallory's work is of great importance and a strong presumption in favor of the view which he advocates. For his courtesy in furnishing these results in advance of the appearance of the article itself sincere thanks are due. *H. B. W.*

RADIUM.—Radium is a radioactive substance supposed to be a new element. Professors Curie and Demarcay have isolated in small quantity and tested what they consider to be pure radium, obtaining from their samples a characteristic spectrum, and have determined the atomic weight to be 225. On account of the rarity and great difficulty and cost of isolating radium it is used in the form of a bromide or chloride.

Discovery.—The discovery of radium is due to investigations upon radioactive substances. In 1896 M. Henri Becquerel, member of the Institute of France, reported the discovery that uranium gave off radiant energy having many of the properties exhibited by the radiations from *x*-ray tubes.

The radiations from uranium were given the name of Becquerel rays, from the distinguished scientist who discovered them. These rays have the property of discharging electrified bodies and of producing chemical changes in the silver salts ordinarily used in photography, in these respects being similar to the *x*-rays.

Uranium was first discovered in 1789 by the German chemist Klaproth, and named by him from the planet "Uranus." Uranium, though widely distributed, is never found in large amounts, and forms several minerals. The most common of these is uraninite, commonly known as pitchblende. It contains about eighty per cent. of uranium. The pitchblende which contains the largest amount of radioactive substances is the Bohemian pitchblende; but it is also found in Saxony, Cornwall (England), and in Colorado (United States).

Professor Curie and Mme. Curie, in investigating the Becquerel radiations from uranium found that some samples of pitchblende, from which the uranium had been extracted, gave forth radiations much more powerful than any they had found, having, in fact, four times the radioactivity of metallic uranium. They concluded that uranium being absent, the radiations were due to some unknown substance in the pitchblende, and following out this they discovered, in 1898, a substance to which they gave the name of "polonium." Polonium passes more rays through aluminum than uranium does, but these rays do not penetrate glass, are readily absorbed by minerals, and are cut off by thin paper. In the same year, following up the discovery of polonium, M. and Mme. Curie and M. Bemont isolated a second substance from pitchblende which possesses many of the chemical characteristics of uranium, but is much more powerful. To this they gave the name "radium."

Properties of Radium.—Radium is one of the most peculiar substances known to science, and produces phenomena which were hitherto unknown as existing in any chemical element or chemical combination: (*a*) It glows constantly with a visible light; (*b*) it gives off constantly a certain degree of heat; (*c*) it produces electrical effects similar to those produced by the *x*-rays; (*d*) it causes certain chemicals to fluoresce; (*e*) it reduces the silver salts ordinarily used in photography; (*f*) it transforms white into red phosphorus, and produces other transformations, such as changing the color of glass, porcelain, white paper, rock salt, etc.; (*g*) it has a distinct effect upon living tissue.

Nature of Radium Radiations.—The discovery of *x*-ray radiations and radium radiations has given rise to many ingenious theories, but experiments appear to show a distinct difference between radium rays and *x*-rays and the emanations from radium. Radium rays like *x*-rays pass through glass and substances opaque to ordinary light, while radium emanations are of peculiar character and appear to be more like a vapor. These emanations do not pass through glass, but settle upon all objects with which they come in contact, and like vapor of water may be condensed by extreme cold. The emanations from radium produce radioactivity in other substances, the result being, so far as is known, that all substances may be rendered radioactive through the influence of radium emanations. Substances so rendered radioactive present to a degree all the phenomena which radium itself presents, and when so charged retain the properties of radium for varying periods of time. The Curies have determined that substances thus rendered radioactive retain their induced radioactivity very much longer when guarded in a small enclosure through which the emanations cannot pass. In such cases the induced radioactivity diminishes one-half every four days, while in substances not so guarded it diminishes one-half every twenty-eight minutes.

Nature and Measurements of Radium Radiations.—There are three entirely distinct types of rays emanating from radium. These are known as the "α," "β," and "γ" rays. The α rays are the least penetrating, losing about one-half of their intensity if passed through aluminum 0.0005 cm. in thickness. The β rays are much more penetrating and much longer, and correspond in every particular to the characteristics of cathode rays. They are readily deflected by a magnet, discharge electrified bodies, etc.

The γ rays are the rays possessing the greatest penetrating power. These rays will produce radioactivity through the air at a distance of four feet or more, and are so much more penetrative than α rays that they require aluminum 8 cm. in thickness to reduce their intensity one-half.

The radioactivity of radium compounds is measured in terms of uranium, this element being taken as a standard. Professor Curie states that pure radium possesses one million times the radioactivity of uranium, but from the rarity of the substance and the difficulty of obtaining it in a pure form, the radium compounds which have so far been available for experiment have rarely been above a radioactivity of 7,000. The quantity of radium and radium compounds so far produced has been exceedingly small and the cost is very great. Professor Curie states that it would take five thousand tons of uranium residue to produce a kilogram of radium at a cost of about $2,000 per ton.

Heat-Producing Properties.—Radium has the remarkable property of maintaining its temperature at about 1.5° C. above its surroundings. Heat production like light production from radium appears to be made without any change in the radium and without any loss of weight. This remarkable force production as exhibited by constant heat production can be appreciated when it is understood that radium radiates enough heat to melt more than its own weight of ice every hour, and to continue, so far as is known, this force production for an indefinite period.

Light and Fluorescence.—When a tube containing radium is viewed in the dark it is seen to emit a distinctly visible light. The light emitted is of uniform quality and is produced indefinitely, and, so far as is known, without any change in the radium itself. When the rays from radium are directed upon the double cyanide of platinum and barium, tungstate of calcium, and certain

* Mallory: "Scarlet Fever. Protozoa-like Bodies Found in Four Cases." Journal of Medical Research, No. 4, vol. i., 1904.

other chemicals which fluoresce under the action of the *x*-ray, the radiations from radium cause these substances to glow with a visible light; the properties of the radiations from radium in this respect being like those from the *x*-rays. A sufficient quantity of radium has never been obtained to allow of the practical use of the fluorescence so obtained in the way in which the fluoroscope is used with *x*-rays, but it is possible that with a sufficient quantity of radium a fluorescence equal to that of the *x*-rays could be produced.

Photochemical Effects.—When the rays from radium are directed upon a sensitized photographic plate from which all ordinary light is excluded by having the plate enclosed in a light-tight envelope, the silver salts are reduced, and an effect similar to that produced by the *x*-rays is obtained.

This photo-chemical effect appears to be identical with that produced by the *x*-rays, except that either from the radiations from radium being less powerful in photochemical effect or from a sufficient quantity of the substance not being used, the rays have not as great penetrating power. Exposures of long duration produce outlines of the human hand with but faint indications of the bones.

Like the fluorescent effects of radium the photochemical effects have not as yet been made of practical value. Practical results may, however, be possible, provided radium can be obtained in sufficient quantities and its action can be properly controlled.

Vitochemical Effects.—The effect produced by the radiations from radium on living tissue are most remarkable. These effects, in certain ways, resemble the effects produced by *x*-rays, but appear also to have peculiar properties which, so far, have not been found to be produced by *x*-rays. Radium rays, like *x*-rays, are capable of producing "burns." The discovery of this effect of radium was made by Professor Becquerel, who, when journeying from Paris to London, carried in his waistcoat pocket a small tube of radium. About a fortnight later the skin under the pocket began to redden and fall away, and finally a deep and painful sore formed which was several weeks in healing. Like the burns produced by the *x*-ray these pathologic effects of radium radiations do not appear until several days after the part has been exposed. Many other important vitochemical effects are produced by the peculiar force thrown out from this remarkable substance. Becquerel found that if seeds were exposed for a long time to the emanations from radium their germinating power was destroyed.

M. Banysz, in experiments in the Pasteur Institute, found that the emanations from radium produced remarkable effects upon rabbits, guinea-pigs, and other small animals. These experiments show that radium has the remarkable power of so interfering with organic processes as to inhibit growth and even destroy life. A small amount of radium suspended over a cage containing mice will, after a few days, cause loss of hair and blindness, followed later by death. The same experimenter reports that exposure to the radiations from radium will cause arrest of development in certain lower organic forms. He exposed the larvæ of Ephestia kuehniella in a glass flask to the emanations from radium for a few hours. After a few weeks it was found that most of the larvæ were killed, but that a few had escaped the destructive action of the rays by crawling into distant corners of the flask where they were still living, but living as larvæ; whereas in a control flask similar larvæ had changed into moths.

M. Bohn has shown that radium may so modify various lower forms of life as to produce "monsters," and he has caused remarkable deviations from the original type in tadpoles exposed to radium emanations.

The vitochemical effect of radium seems to be particularly expended upon the skin and subcutaneous tissues and the nervous system. Thus, Danysz reports that the application of a tube containing a salt of radium to the skin produces an ulcer in from eight to twenty days. A few moments' application produces congestion of the human skin. When applied to the skin of a rabbit destruction of the epidermis follows, but when applied under the skin there is only a feeble reaction on the epidermis. Danysz found that when tubes containing radium were introduced into the intestines and serous cavities of guinea-pigs very little effect was produced, but its action was noted upon the nerve centres of all animals subjected to experiment. This action, however, was comparatively feeble in those whose osseous tissues protected the nerve centres. Application of tubes containing the salt to the cranium caused paresis, ataxia, and convulsions, followed later by death.

Professor Curie introduced a few milligrams beneath the skin of a mouse over the vertebral column, causing death of the mouse in three hours.

The rays of radium have a direct effect upon the optic nerve. This was shown by Giesel, who found that when radium salts were brought near the closed eyes a sensation of light was produced. This is attributed by Hammer to phosphorescence of the humors of the eye and also to effect upon the nerves of the retina. Prof. M. Javal proposes a diagnostic use of this phenomenon, and suggests that blindness with alteration of the retina can be distinguished from that due to glaucoma or corneal opacity, because patients with the latter condition see rays from radium as well as those of sound vision, while patients who have alteration of the retina have no sensation of light when a salt of radium is placed near the eyes.

Therapeutic Uses.—The vitochemical action of radium is so like that of the *x*-rays that its use for the cure of conditions for which the *x*-rays have been used was at once suggested. Experiments seem to show that the vitochemical action of the rays of radium are much more powerful than those of *x*-rays. There seems every probability, when radium can be produced in sufficient quantity and its action properly controlled, that it will be a valuable therapeutic agent. So far, its use has been mainly confined to the treatment of lupus, epithelioma, and superficial skin diseases. Favorable reports of results of its use in these diseases have been given by a number of clinicians. Danlos reports a case of lupus of the face, exposed to the action of a salt of radium which had a radioactivity of 19,000 for from twenty to thirty-six hours, with the result of the disappearance of the disease and with the formation of a smooth, white cicatrix. Other clinicians have reported equally favorable results and have called attention to the good effect as shown by the smooth, soft, and white resulting scar.

For therapeutic use the radium compounds have in some cases advantages over the *x*-ray. In superficial diseases of the skin and mucous membrane these radium compounds, being enclosed in small hermetically sealed glass receptacles, can readily be employed as therapeutic agents. All that is necessary is to place the receptacles containing the compound in close apposition to the parts, so insuring a local action. Furthermore, radium compounds being permanent these glass receptacles can be used for an indefinite time in any number of cases, and this apparently with more surety of definite results, so far as tissue reactions are concerned, than can be obtained from the radiations from *x*-ray tubes.

William Cline Borden.

SKIN AND ITS APPENDAGES: ANATOMY.—The skin, or integumentum commune, of the body acts as a covering and a protection for the deeper portions, besides being an organ of secretion, of excretion, of special sense—the sense of touch,—of common sensation, and the conservator of animal heat. Embryologically, it is developed from those two primitive layers of the blastoderm, the ectoderm and the mesoderm, which are formed by the cellular division of the impregnated ovule. The epidermis, or most external layer of the skin, is formed from the ectoderm, while a superficial portion of the mesoderm furnishes the remaining constituent parts—the corium, or cutis vera, and the subcutaneous or fatty tissue.

General Characteristics.—When fully formed the skin can be regarded as a completely closed sac, which

models itself so closely upon the portions of the body which lie immediately below it, that it allows their shape and configuration to be more or less accurately distinguished. This, naturally and to a great extent, will depend upon the amount of intervening fatty tissue. When the latter is present in excessive amount, symmetry and roundness of form dependent upon its presence in moderate quantity is naturally lost.

The skin does not stop abruptly at the natural openings of the body. It is continuous at these points with the mucous membrane which clothes the cavities. At the nares, on the labia majora and minora, and on the external surface of the anus, the transition of the skin over to the mucous surface is gradual, not abrupt. At the mouth, however, on the eyelids, and at the meatus urinarius, the transition is abrupt.

The integument is very variable in thickness. In general, it varies between 0.5 and 4 mm. ($\frac{1}{50}$ to $\frac{1}{6}$ in.), exclusive of the subcutaneous tissue. It is thinnest on the eyelids, and thickest on those portions which are subjected more especially to pressure, as on the palms of the hand and soles of the feet, or which serve as points of insertion for muscles, as on the upper lip, alæ nasi, etc.

Density and Elasticity.—It has been found that the skin possesses considerable solidity and very perfect elasticity. Sappey concluded from his experiments that a strip of skin 3 mm. long and 10 mm. broad was able to support a maximum weight of 12 kgm. (26½ lb.). The solidity was also in direct ratio to the thickness of the piece of skin used in the experiment. As mentioned, the elasticity is very perfect, but slight; a considerable amount of stretching may result from the application of a small weight, and complete rectification takes place after its removal. The skin is not of uniform texture, but consists of bundles of connective-tissue fibres arranged like a net, between which are spaces of various sizes which are rhombic in shape. In these spaces there is found a cementing substance, and it is due to it and the enormous network of elastic fibres that the former are able to regain their natural shape after having been stretched.

Cleavage.—The cleavage lines of the skin were demonstrated by Langer. He pierced the skin with small, round awls in multiple places, and, after removal of the instruments, observed that the wounds which were made were linear. He then made series of them in rows and close together, and from uniformity in the direction of the long axes of a more or less greater number of them, he was able to conclude that the skin possessed complete linear cleavage over the greater part of the surface of the body. Not on all of it, however, for in some places, as on the forehead, on many points on the scalp, etc., the wound made was a triangular one, and he found that these occurred where two spaces met together which possessed linear cleavage in opposite directions.

The explanation of the fact that the skin is, to a great extent, cleavable linearly, is to be found in the arrangement of the spaces between the bundles of fibres. These spaces are of various sizes and shapes, and in many places are so stretched longitudinally and so narrowed that the fibre bundles run almost parallel to each other. The course of the cleavage lines of the skin can be well understood by consulting the accompanying figure (Fig. 5195).

Tension.—Except upon the scalp, the palms of the hands, and the soles of the feet, the skin is, more or less, in a state of tension. When a portion is excised, it will be seen that it diminishes in size to such an extent that it will no longer cover the surface which has been laid bare. This cannot be ascribed entirely to the retraction of the borders of the wound, but is also due to the diminution in size of the excised piece, which is then no longer subjected to its former tension. Where the skin possesses linear cleavage, the tension is in the direction of these lines; but where this condition does not exist, it occurs uniformly in every direction in the plane of the surface. The tension likewise depends upon the movements of the joints and muscles, the amount of fat deposited in the subcutaneous tissue, and also upon morbid conditions, such as œdema, or upon the existence of pregnancy. In this latter condition the degree of tension may be so great that a permanent change may result in the direction in which the bundles of fibres run.

Color.—The color of the skin differs according to the individual, the race, and the age, and it also varies upon different portions of the body. It cannot be ascribed in certain races to climatic influences alone, since in the same zones people of different color are found, as in Africa, negroes, and in a corresponding portion of America, the much lighter colored Indians. The difference in color depends entirely upon the amount of pigment present in the rete Malpighii, where, under the form of granules, it is found especially in its lower layer or stratum basale. This is easily demonstrable in the skin of the negro two or three days after death, and before decomposition has set in. If the skin is, under such conditions, sharply rubbed, the epidermis is detached and rolls up under the finger, and the corium or true skin is seen to be of a dull white color. In the white race the color changes, within certain limits, in the various seasons of the year. When the skin is exposed to the heat and the sun in summer, there is an increase in pigment deposit and it appears darker, but this disappears and the whiter color returns in winter.

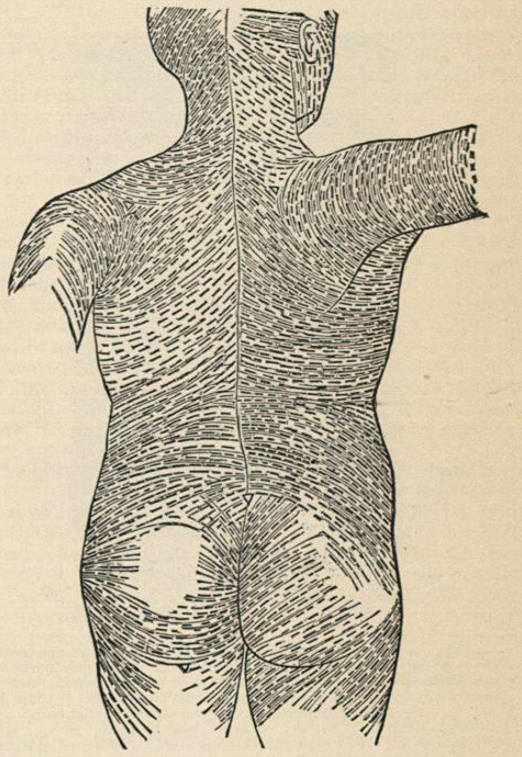

Fig. 5195.—Cleavage Lines of the Skin. (Langer.)

Under certain physiological conditions, such as pregnancy, there is likewise an increase in the amount of pigment in particular portions of the skin—the areola around the nipple, the linea alba, etc.—and this may in some instances be to an exaggerated extent. A large portion of this increase often disappears after the birth of the child, but a considerable amount usually remains. In the male the scrotum and penis, and in the female the vulva, are of a darker color than the rest of the skin. The pink or red color seen on certain portions of the body, as the cheeks, or induced by certain temporary causes, as those which produce flushing, is due to the blood in the vessels of the cutis. These latter becoming filled with blood its color is conveyed to the eye through