ANATOMY AND DEVELOPMENT

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Development of the Skin as a Whole.—The corium constitutes the real foundation of the skin. It develops from a superficial layer of the mesoblast which Remak therefore called the skin-plate, and in the second month of fœtal life still consists entirely of round and spindle-shaped cells, with but little intercellular substance. In the third month, in consequence of the appearance of large quantities of fibrillary tissue, an inner layer becomes separated from it, and at the same time the boundary-line between it and the epidermis (which is geneticallly an entirely distinct structure) becomes more sharply defined in the shape of a light, but never double-contoured border. This inner layer is at once transformed, by the deposition of fat in its substance, into what afterwards becomes the subcutaneous tissue. Embryologically, however, it belongs wholly to the corium. The outer layer of the corium remains in an immature condition until the second half of fœtal life, fibrillæ making their appearance between the cells, at first very slowly, growing from below upwards; then vessels, and finally nerves appear. The most superficial portion of the corium, which forms the foundation of the subsequent papillary layer, consists, even at birth, of young granulation tissue, with very few fibrillæ, while the cutis proper has at this time already acquired considerable thickness and density, in consequence of the continuous deposition of collagenous substance between its cells. As the papillary layer, even in the adult, differs greatly from the cutis proper in its richness in young connective tissue and the arrangement of its fibrillary frame-work, and is characterized by certain peculiarities of circulation and the presence of terminal nerve apparatus, we would have at least the same right to regard it as distinct from the cutis as the subcutaneous tissue (hypoderm, according to Besnier). It is, however, more judicious to make neither of these distinctions. Embryology teaches us to recognize only two layers of the skin, the epidermis and cutis (corium). The subcutaneous tissue owes its recognition as a distinct layer only to the circumstance that, in consequence of the macroscopically appreciable de-

position of fat in it, a distinct border-line is visible even to the naked eye, while the equally important border of the cutis proper towards the papillary layer can be made out only by means of the microscope.

Does this mode of development give us a right to believe, with Holt C. Wilson, in a one-sided growth of the corium outwardly towards the epidermis? Assuredly not. We can only say that the entire corium matures from within outwards. And this is perfectly natural, since the vessels grow into the skin from within. It is, however, much more probable that the skin in all its parts continues to grow by cell-division and the formation of new intercellular substance than that its marked increase in thickness during the second third of fœtal life is due entirely to deposits upon its surface.

Subcutaneous Tissue.—The subcutaneous tissue is, however, not only the earliest portion of the skin to attain its full development, but even during fœtal life it increases in extent more than any other portion of the skin, and that in consequence of the steady and very regular deposit of fat-tissue in it. After birth, the fat gradually decreases in quantity, and finally remains in exceptional abundance only at certain points of predilection. Other portions of the skin, such as the eyelids, the ear (except the lobule), the external auditory canal, the nose, etc.; in short, portions of the skin which are either firmly attached or are unusually movable or pliable and at the same time muscular, are free from fat in the adult. In addition to the fat, the subcutaneous tissue contains all the larger blood-vessels, lymphatics, and nerve-trunks destined for the corium. In certain parts of it are found the mysterious corpuscles of Vater (see below), and during the course of post-fœtal development mucous bursæ are formed over projecting points of bone, such as the chin, angle of the lower jaw, pomum Adami, olecranon, on the patella, the line of junction of the sacrum with the coccyx, etc. When the fat disappears from the panniculus, the subcutaneous tissue becomes an extremely loose network, the coarser connective-tissue bundles of which are continuous with those of the cutis proper and in many places also with those of the underlying fasciæ and periostea. At such points, the connection of the entire corium with the underlying tissues is a very firm one, as on the head, the palms and soles, etc. On the trunk, the arms and legs, the neck, scrotum, penis, and the eyelids, on the other hand, the connection is established only by means of loose connective tissue and the ingoing and outgoing bundles of vessels and nerves, for which reason the skin is freely movable over the underlying tissues.

The subcutaneous tissue has therefore, on the whole, a purely mechanical importance. It effects the connection between the body and the corium, and serves as a place of deposit for the fat.

Development of the Cutis Proper.—The further development of the cutis proper is effected simply by the continuous deposition of collagenous substance, by which its cells are more and more widely separated. The form and direction of this deposition is, however, not accidental, but is very definite and different in each part of the body. The skin, as the outer covering of the entire body, is forced to follow it in its great increase in bulk, and is therefore kept in a state of permanent tension. This exerts a directing influence upon the longitudinal axes of its cells, even while the skin is still in the cellular stage. In addition, the in-growing vessels influence the cells nearest them, to arrange themselves along their own independent paths. As we may regard both the trunk and extremities of the embryo as short, thick cylinders, the relation in them of the circular growth of the skin to that in a longitudinal direction is about as $3(\frac{1}{4}) : 2$, presupposing a similar linear extent of the longitudinal and transverse axes of the individual sections of the body. The longitudinal axes of the spindle-cells of the skin, yielding to the stronger

traction, will consequently arrange themselves at right angles to the longitudinal axis of the trunk and extremities. This I have indeed found to be the case on the finger of a fœtus of two months. It does not then seem remarkable that the secondary deposition of fibrillary tissue should also take place in mainly transverse lines. This course is still followed by the bundles of fibrillæ after birth. In consequence of the extension of the flexed extremities after birth and the growth in length which now begins to preponderate, many of these lines are changed from a transverse into a spiral or longitudinal course. These alterations take place mainly in the neighborhood of the elbow, hip, and knee joint, on account of the new position of the body (Langer). Other changes in the direction of the fibrillation occur during infantile growth, in consequence of alterations in the parts under the skin (disappearance of the fat-cushion, increase in size of the muscles). In the adult, there finally results a typical arrangement of the bundles of fibrillæ for each region of the body.

Texture of the Corium. Fibrillary Tissue.—It follows that the skin by no means uniformly incloses the organs of the body like a sack. But there is no ground for the opinion that all the bundles of fibres of the corium have their ultimate origin in the fasciæ, in which case the corium would really be only a repetition of the muscular fasciæ. We find that the skin, on the contrary, bears two entirely distinct relations to its underlying structures. At the above-mentioned points, where the skin is firmly united with the aponeurosis, it resembles a true cushion. As such, it lies without tension over the underlying structures, but slightly movable in consequence of numerous points of attachment, and thickened by an abundant accumulation of fat, especially on the head, the palms of the hands, and soles of the feet. Starting from these points, it extends over the entire surface of the body, $1\frac{1}{2}$ sq. meter in extent, being comparatively movable, and under an universal, everywhere varying tension. Here it resembles neither a sack nor a cushion, but a tight-fitting elastic garment. Its general mobility is interfered with only at certain limited points, by punctate or linear adhesions. Besides, on all the larger vascular and nervous trunks of the skin such adhesions are found at those points where it passes over certain bony prominences, cartilages, and tendons, as the spinous processes of the vertebræ, the crests of the ilia, etc. Only at these and at the above-mentioned points of adhesion to flat surfaces can one imagine the skin to spring from the fasciæ. But it is more nearly correct to regard the fibrillary bundles of the skin as arising free in the connective-tissue septa of the subcutaneous cellular tissue, and as passing more or less obliquely to the surface of the corium; a constant termination and beginning of fibres, which follow the same course, taking place meanwhile. This produces, it is true, the appearance of large uninterrupted stretches of fibres, a simple view of the matter which possesses a certain advantage in enabling one to obtain a general notion of the subject.

If we look at it in this light, we find that these coarse stretches of fibres in all parts of the body cross others running in other directions, thus inclosing continuous rows of oblong rhombi. At certain points these assume a typically diagonal direction. This arrangement explains why in most parts of the skin not a round hole, but linear clefts are produced by the puncture of a round awl.

Cleavability and direction of Cleavage.—When, as is usually the case, the fibres running in one direction are much more numerous than those running in other directions, only linear clefts are produced by the awl, and the skin is, as Langer calls it, completely cleavable. But when, on the other hand, the number of fibres running in different directions is about equal, the application of the round awl produces triangular or ragged holes. In that case an incomplete or indefinite cleavage is said to prevail. Such a condition is found, *e. g.*, on the forehead and on many points of the skull, on the scalp, the chin, the epigastric region, below the olecranon, etc.

By arranging the punctures, which were made close together in rows, Langer ascertained the direction of the stretches of fibres characteristic of each region, and found

that as a rule such fibres descending on the trunk in the form of girdles, obliquely from above and behind, forwards and downwards, run specially around the extremities, for longer or shorter distances.

Folds of the Skin.—He also found that the tension of bundles of fibres could never be directly overcome by flexion and extension of the joints, because they always run transversely or obliquely over these parts. For this reason the bundles of fibres are never put on the stretch in the ordinary movements of the joints. The rhomboidal meshes are, however, extended laterally, and the bundles of fibres on the opposite side of the joint are crowded together. In this way are produced not only the permanent folds of skin on the extensor surfaces of the joints, but also the furrows and wrinkles which occur on the forehead, eyelids, scrotum, and around the mouth, as the result of frequent muscular traction, and it is evident that the direction of all these folds will roughly represent the direction of the fibres in that particular portion of the skin in which they are found.

This is also the case with *the folds of emaciation*, which are the result of an excess of skin remaining after the disappearance of the cushion of fat; as the fibres were formerly spread out laterally, not extended longitudinally, the folds which are subsequently formed, of course, correspond to their original direction. This useful avoidance of too great a degree of tension of the collagenous tissue on one side, and of an excess of skin on the other side, in the ordinary movements of the joints is a natural consequence of the fact that the direction of a tissue with rhomboidal meshes may be changed by traction or pressure exerted mainly in a diagonal line. We avail ourselves of this possibility, to use a familiar illustration, when we apply an elastic bandage cut on the bias out of tissue woven on the square. In places with a well-marked direction of cleavage, the preponderating line of tension of the meshes of the tissue is a permanent one after the part has attained its full growth. In places where the cleavage is not well-marked, *e. g.*, on the abdomen, the texture of the tissue of the corium subsequently undergoes permanent alterations, in consequence of changes in the contents and in the bulk of the viscera. These should be carefully distinguished from transient alterations in the direction of tension and cleavage. Similar changes in the arrangement of the meshes of the corium are also often met with in certain pathological conditions, such as cutaneous and deep-seated tumors, subcutaneous abscesses, etc., even in parts with complete cleavage.

Furrows of the Skin.—While the folds of the skin are always associated with an excess of tissue, however slight, coarse furrows mark some of those spots which are very closely united by short bundles of fibres with the underlying structures. Such are the furrows utilized in fortune-telling, between the prominences of the palm of the hand, the dimples on the cheeks and chin, and the similar but larger depressions over the points of the crests of the ilia. the sacrum, and their bony projections.

A careful distinction must also be made between these coarse furrows and those much finer ones which occur over the whole body, but are most highly developed on the palms of the hands.

Voluntary Muscles of the Skin.—We must also allude to the active voluntary mobility found only on the head and neck of the human subject, in strong contrast with the abundance of skin-muscles possessed by other animals. It is produced by striated muscles which radiate obliquely from below in the fibrous network of the skin, and effect the large class of mimic movements.

Histology of the Corium.—The frame-work of the corium in the adult consists microscopically of a fibrillary connective tissue with but few cells, the individual bundles of which, in excised portions of the skin, run in graceful wavy lines, whereas in the living subject we must imagine all the strands of fibres as in a slightly stretched condition.

The cells are found in greatest number in the immediate vicinity of the larger vessels, while everywhere else they are equally scanty. The corium itself has no capillaries. The cells lie upon the bundles of fibres as flat nucleated plates, which send out flat processes between the finer bundles of fibres. We must regard this cellular covering as an almost complete carpet, surrounding the bundles of fibrillæ, in which the small number of the cells is compensated for by their enormous dimensions. According to this view, the cells which are from the first in contact with each other are not entirely isolated by even the most extensive deposit of collagenous substance, and their lines of union must therefore be capable of staining by nitrate of silver over a large extent of surface. It cannot be denied that this view presents a certain degree of improbability in the case of certain pathological products, such as keloids and other fibromata poorly supplied with cells; at any rate, this subject needs a new investigation, as regards the corium.

Certain minute and larger spaces remain between the bundles of fibres clothed with their endothelial sheaths, which represent in their finest ramifications the beginnings of the lymphatic channels. In the normal condition they are of extreme tenuity, but readily assume considerable dimensions at every arrest of the circulation of lymph, and at every parenchymatous congestion. The exact notion which one has of these lymphatic roots will depend, in the first place, upon the question whether or not the cellular carpet is everywhere continuous, and in the second place on the just as little settled question of the cement substance of the corium.

Cement Substance of the Corium.—The existence of such a substance is demanded both by histologists and physiologists. Flemming describes it as an ill-defined mass, in which the bundles of fibrillæ are enveloped as in a cloud. The familiar transverse rings of the bundles of fibres, which are easily produced artificially, are said to be due to its contraction. According to this view, the lymphatic roots would, perhaps, be more accurately defined as "fissures of the cement-substance." This substance has already been physiologically made use of by Langer to explain the decided retraction of the skin which often occurs. Tomsa thinks that the cement substance holds the fibrillary frame-work and the other elements of the skin together, and is the cause of the elasticity of the fresh skin.

While we are, therefore, sufficiently instructed by Langer's investigations concerning the anatomical basis of the great extensibility of the skin, and must seek the larger part of it (primary tension) in the alteration of the rhomboidal mesh-work into one in which the fibres are more nearly parallel, and a much smaller part in their complete unrolling and final over-extension, we can at present offer no adequate explanation of the cause of the rearrangement of the tissue, by which it shows its complete elasticity.

Elastic Tissue.—It is certain, according to Tomsa's experiments, that the elastic tissue plays a very insignificant part in bringing about this rearrangement. The elastic fibres are very evenly scattered through the framework of the skin, and surround the collagenous bundles completely. When isolated, the elastic framework shows, however, a very slight degree of retractility, and it cannot, therefore, account for that of recently excised skin. But as it becomes much less swollen in the alkaline fluids of the tissues than the collagenous substance, it must necessarily, according to the quantity and composition of the surrounding fluids, exert a more or less great, but at any rate an appreciable tension upon the latter (Stirling). Its even and universal distribution must also bring it to pass that impulses of traction and pressure, exerted at certain points, must, radiating from these, be felt over a large part of the vicinity. The whole significance of the elastic constituent of the skin can be placed in the right light only by considering its relations to the involuntary muscles of the skin, to which we shall, therefore, next turn our attention.

Involuntary Muscles of the Skin.—Although these muscles operate in a very unobtrusive manner, they nevertheless are among the most important regulators of all the functions of the skin. They are of three kinds.

Muscular Membranes.—They attain their greatest size in the "muscular membranes" found in the scrotum, penis, mammary areolæ, and nipple. Here the bundles of smooth muscular fibres are deposited in layers in the corium, lying almost perpendicular to the direction of its cleavage. In the scrotum, where the rows of fissures run in a curved manner from the root to the raphe on either side, the bands of smooth muscular fibres are arranged parallel to the raphe, the longest below, the shortest nearer the surface (Tomsa). On the penis, nipple, and areola they follow a circular direction nearly at a right angle to that of cleavage, which is obliquely longitudinal in the former, and radiating in the two latter.

Similar to these concentric muscular shells is a radiating muscle, the smooth lid-muscle of Müller, which should be regarded as the involuntary antagonist of the orbicularis palpebrarum. All these muscles throw the skin into folds when they contract, which folds indicate the direction of cleavage in that particular region. Their relaxation, therefore, causes no extension of the bundles of fibrillæ. The muscular membranes have, therefore, less to do with the contents of the corium than with the external configuration of the skin.

Arrectores.—It is otherwise with the so-called "arrectores pilorum." These are so arranged that, originating with several tips from the papillary portion of the skin, they become inserted by a number of blunted ends into the middle portion of several adjoining hair-follicles. This fusion of different muscular bundles into one arrector should moreover be regarded as an acquired peculiarity, since in the fœtus every primary hair is provided with a separate muscular bundle. As we may regard the hair-follicles (incorrectly from an embryological standpoint) as involutions of the papillary layer (Tomsa), we find that the arrectores unite two points of the papillary layer, situated at different levels as regards the corium, forming at the same time loops around a part of the latter. The first effect of their contraction is therefore the approximation of these points of the papillary layer, *i. e.*, the erection of the hair, and the drawing inwards of a point on the surface. But the action of these muscles is much more general, and is especially exerted upon the contents of the corium. The muscles are in fact not only surrounded, but also traversed by a network of elastic fibres, and elastic threads pass out all over their surfaces which lose themselves in the general fibrous frame-work. At both ends of the muscles, these elastic threads arrange themselves in large bundles, which act as a tendon for the attachment of the muscles to the fibrillæ of the corium. Their contraction, therefore, produces a tension of the entire surrounding elastic frame-work, and as in the action of involuntary muscles large spaces are always simultaneously shortened, the contraction of these muscles produces a general shortening and condensation of the corium. Of course, the portions of skin nearest the muscles are most powerfully affected. It is, therefore, evident that the sebaceous gland will be relieved of its contents (Sappey) by the erection of the hairs and the opening of the funnel of the follicle (Hesse). The bundles of the corium situated above the arrector are directly compressed by it, and as they in part belong to ascending transverse bundles, this tension is transmitted over a large surface (Tomsa). But as in many parts of the skin the direction of the hairs corresponds to that of the cleavage, *i. e.*, the direction of the principal bundles of fibres, this remote action is probably not so important as the general tension of the elastic frame-work first alluded to.

Relation of the Arrector to the Hair.—Tomsa is right in insisting that we should

regard the attachment of the muscles to the hair as the relatively fixed point, and that to the papillary-layer as the movable one. It is thus easy to understand how muscular irritation of medium severity is not followed by erection of the hairs, but only one of the

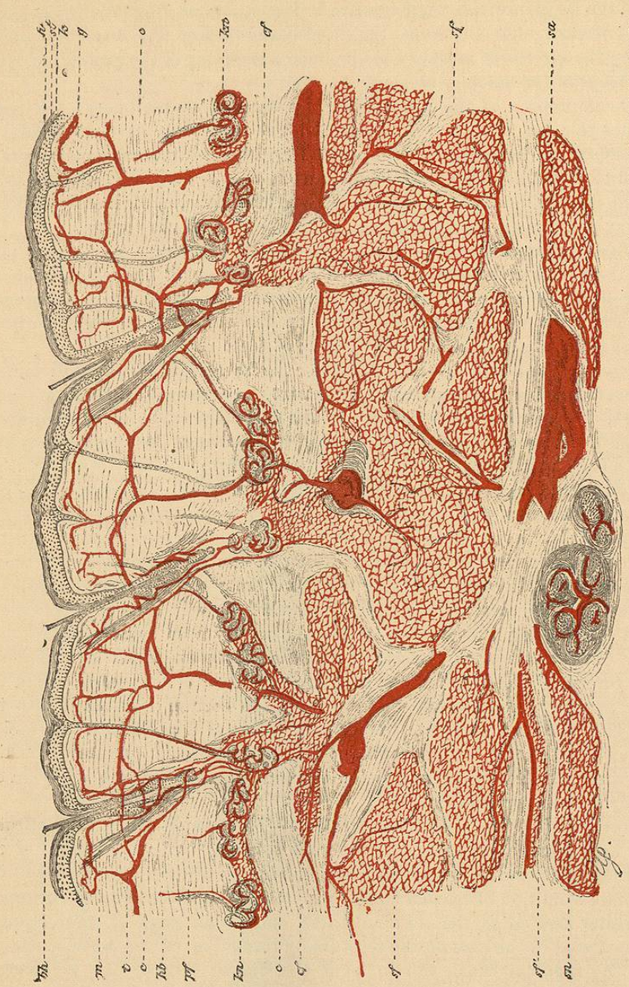

FIG. 1.—General view of the skin of the new-born child, arteries injected with carmin-gelatin, hardening with alcohol, staining with hæmatoxylin. *h*, horny-layer; *k*, granular-layer; *st*, prickle-layer; *g*, excretory duct of the coil-gland; *t* sebaceous gland; *p f*, productive epithelial process; *h, h*, hair-bed; *b h*, bed-hair (hair with a full root); *kn*, coil-gland; *c*, cutis; *s f*, subcutaneous fat-tissue; *c f*, cutaneous columns of fat which ascend from the subcutaneous fat-tissue into the loose perifollicular tissue, and send lateral branches in the direction of the coil-glands; *s a*, large subcutaneous artery; *s n*, large subcutaneous nerve; *s f*, fat-tissue, lying by the side of a large subcutaneous vessel with short lateral branches.

greatest intensity. Tomsa defines the action of the arrectores to be as follows: with the aid of the frame-work of the skin, which is drawn in the opposite direction, they definitively fix the bottom of the follicle to which they are attached, and turn towards them-

selves, upon its bottom as a fulcrum, the nearest hair-follicle towards which their papillary end is turned, and which is also in a fixed position. Although this explanation is correct as applied to regions with a thick covering of hair, it is by no means adapted to those parts of the body in which the hairs are widely separated from each other, as a glance at Fig. 1 teaches; but the same Fig. 1 also shows that the retraction of the papillary layer by the arrectores must at once produce a lessening of the quantity of blood in the terminal loops of the vascular plexus.

The general compression of the skin begins, therefore, at its periphery; the papillary layer becomes pale and anæmic. The view that the arrectores have no absolutely unalterable relation to the hair-follicles is supported by the fact that many hairs have no muscles attached to their follicles, viz., those of such regions as are richly supplied with other smooth and striated muscles. It is evident that these muscles, such as the musculi palpebrarum, may perform all the functions of general tensors of the corium.

Diagonal Muscles of the Corium.—On the other hand, in many parts of the skin, particularly in those with indefinite cleavage, a large number of smooth muscles are found ascending obliquely in the corium, which possess an importance entirely analogous to that of the arrectores as regards their action on the corium, but which form no attachments to the small follicles of the downy hairs of these parts.

Oblique Tensors of the Corium.—In looking over the facts already brought forward, it seems most convenient to group together, in contrast to the muscular membranes, the *horizontal tensors*, the arrectores of the hairs, and the free diagonal skin-muscles, under the common name of "*oblique tensors of the corium*," without regard to whether they have a fixed point on a hair-follicle or not. It is possible that the firm hair-follicle plays for the oblique muscles only the rôle of certain long projections for the striated muscles which pass over them, that of furnishing new points of origin for them. *The real beginning and end of the oblique tensors of the skin is the elastic tissue*, and through it *the entire corium*. Just as the elastic tissue automatically prevents an over-filling of the lymph-spaces with tissue-fluid, by exercising an elastic compression upon the more readily swelling collagenous substance, the skin-muscles scattered through the elastic frame-work are capable with its aid of exerting a compressing force in response to the much more delicate stimulus of sensitive nerves. In the first place, the secretion of the sebaceous glands is pushed outwards into the funnel of the hair-follicle, and blood and lymph are pressed out of the capillaries of the papillary layer and the upper part of the corium downwards into the larger vessels. The secretion of the coil-glands or as much of it as has already reached the excretory duct must also be forced outwards; but upon the coils themselves, which lie in the lower third of the corium and below the muscles, they cannot exert an expressing, but only a retaining influence.

Tension of the Skin a Function of Temperature.—The tension of the skin effected by the muscular apparatus and the elastic frame-work is largely under the control of the *temperature*. As can be beautifully seen on the large muscles of the tunica dartos of the scrotum, a moderate condition of tension corresponds to a medium temperature, complete relaxation to greater heat (*e. g.*, that of a hot bath), and a high grade of contraction to intense cold, manifested in the case of the scrotum by retraction of the testicle against the opening of the inguinal canal, and in hairy portions of skin by the well-known "goose-skin." It will be readily understood that by means of the elastic transmission in all directions the effects of external and internal changes in temperature may be regulated with extreme delicacy—a circumstance which has all the greater significance, in view of

the fact that the muscular apparatus of the blood-vessels which ascend into the corium is but very slightly developed.

Functional Connection between Elastic Frame-work and Muscles.—The elastic frame-work is therefore a kind of inhibitory apparatus which, in general, equably distributes pressure and traction, and specially helps the oblique skin muscles contained in it to regulate secretion on the one hand, the circulation of the blood on the other, and in this way to influence the movements of the fluids, nutrition, and the interchange of gases.

Thickness of the Skin.—In the infantile skin, the corium is still very thin, whereas the subcutaneous tissue occupies considerable space. This fact accounts for the ease with which furuncular abscesses push it outwards and break through it. The corium of the adult offers a much greater resistance to attacks from within and without. Its thickness is tolerably constant, varying between one and one-half and two mm. An exceptionally slight development of the corium is found in the skin of the eyelids, the external auditory canal, the free border of the lips, the glans penis, prepuce, and the inner surface of the labia majora. In these places, the corium is simply a thickening of the papillary layer, which lies in almost immediate contact with the subcutaneous tissue. It is but feebly developed in the face, the ears, penis, scrotum, perineum, areola of the nipple, and very highly developed over the entire back, the buttocks, and the palms of the hands and soles of the feet (as much as three mm. in thickness). It attains a remarkable degree of development in negroes. The mode of life has an important influence in causing this; the corium becomes especially thick when it is constantly exposed to wind and weather (Krause).

Senile Changes.—The senile changes in the corium have been studied by I. Neumann. He found them to consist in part of granular opacities, which, at first appearing as coarse granules, run in rows through the corium, and give it a dull, greenish-yellow tint, and subsequently, in the shape of finely granular masses, entirely supplant the fibrillary tissue, and in part of a gelatiniform, glassy swelling of the bundles of fibres, in which all the nerves and vessels seem to have perished. The muscles also degenerate in the senile skin.

Development of the Papillary Layer.—The papillary layer of the skin, as we call the upper part of the corium which borders on the epidermis, is developed in most intimate connection with the epidermis, so that no pathological process affects either the epidermis or the papillary layer alone. Up to the fourth fœtal month, the border line between the two is perfectly straight, but at that time there appear, first on the palms and soles, linear thickenings of the epidermis, which, projecting into the corium, produce groove-like depressions in it, so that from this time on epidermis and corium are dove-tailed together, as it were. In the sixth month, the epidermis becomes thickened over the ridges of the corium which were left standing, and penetrates into them, growing around the more resisting portions. These firmer points of the surface of the corium, which are at first characterized solely by an unusual accumulation in them of young cells, are thus transformed into papillæ, and subsequently receive capillary loops of their own. They constitute the centres of nutrition nearest the epidermis, and therefore play a prominent part in its physiology and pathology. Towards the end of fœtal life, the primary, ridge-like, and the secondary papilla-forming epithelial processes appear on the rest of the skin, but not with the same regularity as on the hands and feet. At birth, the papillary layer has not yet attained its full development.

Fields of the Epidermis.—The papillary layer is therefore formed by the growing into each other of the epidermis and corium, the active part being played by the former. The corium determines the form of the papillary layer to a certain extent, owing to the fact that it possesses many resisting lines and points which remain intact in the shape of ridges and papillæ. These spots, which, as a rule, mark the situations of subsequent

blood-vessels, form on the palms and soles regular, parallel, usually crooked ridges, which inclose between them the well-known fine furrows of these parts. On the rest of the body rows and groups of papillæ are divided by deep epithelial processes into distinct fields, which produce an irregular formation of grooves between them. Although the primary epithelial prolongations are formed much too early and superficially to have any connection with the lines of direction of the fibrillary tissue of the corium, the general direction of the epidermic fields produced by them (*i. e.*, the main diagonals of the oblong) coincides, on the whole, with the direction of cleavage of the corium (O. Simon). The fields of the epidermis, which, besides on the hands and feet, are especially well-developed on the joints, the extensor surfaces of the extremities, and the hairy scalp, seem therefore to be subject to the general laws of tension of the skin. Only where well-marked cleavage predominates do they appear distinctly in an oblong form, while on parts with indefinite cleavage they are square, triangular, or irregular in shape.

Papillæ.—The papillæ are very irregularly distributed, and vary greatly in shape and size. They have, as a rule, the shape of a blunt cone, being 1½ to 2 times higher than they are broad. Their height varies between 0.05 and 0.2 mm., the latter dimension being attained on the palms and soles. There they are arranged in two rows of simple or compound papillæ, inside the ridges already described, frequently inclosing smaller papillæ between them. They are still more numerous on the clitoris and penis, the labia minora, and the areola of the nipple. In many parts of the body they are entirely wanting or appear only as flat elevations. Mention must also be made of the fact that the surface of the corium, which is plastic to a high degree, accommodates itself to all the changes of the epithelial structures which penetrate it. In consequence of the advance of the epithelial processes into it, the papillæ are rendered longer and narrower, while new ones are formed by the surrounding of new portions of the corium by the growing epithelium. When they undergo atrophic involution, they become shorter and broader, and finally sink again into a level surface, as in old age. During this process, the natural irregularities of the part produce dendritic forms of the surface of the corium, so-called compound papillæ, or flat, mound-shaped figures, and almost completely isolated, globular portions of the corium are sometimes seen.

Morphological Significance of the Papillæ.—The custom of regarding the papillary layer as a tissue of permanent form, constructed after a definite plan, cannot stand the test of more careful observation. There is no normal standard for the papillæ of each region of the body, which might perhaps serve as a means of comparison in the employment of the common terms, hypertrophy and atrophy. The papillary layer can be regarded only as an extremely variable border phenomenon, which in each case represents only the relation between the pressure exerted by the growth of the epidermis on one side and of the corium on the other. The only standard for judging pathological conditions is consequently comparison with the adjacent normal skin. There still prevails, however, a tendency to ascribe every change in form of the papillary layer to the sole activity of the connective tissue. The real truth of the matter was first clearly made known by Auspitz in 1870. It is true that an ingrowth of young connective tissue into the epithelium does sometimes occur under pathological conditions. But in such a case the epithelium is always found to be pathologically altered, filled with wandering cells, disarranged, and destroyed. A dendritic splitting up of healthy epithelium by growing connective tissue does not occur in the skin, although it may well be possible after a partial loss of epithelium. At an early period of the development of the sheep, it is true, the striking picture of masses of granulations are found here and there on the head, which push out the still very thin epidermis. But the human epidermis is from the first too strongly developed for this, and too much inclined to local hyperplasiæ. As opposed to all the processes which it sends downwards for the formation of the hairs and coil-glands, the activity of the corium is restricted to this, that it in part from the first diverts the ingrowing epithelium from firm to less resisting

points, and in part afterwards arrests its progress in many places by local hyperplasiæ, which later develop into isolated papillæ (hairs), while other processes press onwards without encountering resistance (sweat-glands). Thus far, the matter is very simple. The only point which demands an explanation is that of the penetration of the epithelium. Why does not the epidermis become thickened in spots externally? Why does it send its processes inwards? The reason for this can be found only in the firmer cohesion which the cornified cells acquire externally; and in fact the inward growth of the epithelial processes occurs in fœtal life only after the epidermis has attained considerable thickness and coherence, and even later on the superpapillary epidermis, as compared with the interpapillary, is so much thicker the slighter the cornification of its cells (condylomata acuminata et lata).

Histology of the Papillary Layer.—The internal structure of the papillary layer corresponds to its function as a cushion and filter of nutriment for the epidermis. It represents a delicate piece of felt, the extremely wavy fibres of which arise from the collagenous fibrillary network of the corium. By virtue of this arrangement, every strain which reaches the corium is transmitted to the papillary layer also, being meanwhile converted into a tension of the latter from all sides (Tomsa). A definite direction of cleavage the papillary layer cannot, of course, possess. Preparation is already made, in the uppermost layer of the connective tissue, for the everywhere identical arrangement of the epidermis, without which protecting substratum the latter would hardly be capable of adapting itself to the variations in the tension of the corium. The elastic fibres also penetrate into the papillary layer, in which they are just as evenly interwoven into the collagenous bundles as in the corium. Their principal function is the transmission of the action of the oblique tensors of the skin to the papillary layer.

Furrows and Ridges of the Papillary Layer.—The external surface of the papillary layer and its connection with the epidermis is best studied after the careful maceration of fresh skin in citric acid (formic acid), and subsequent staining with gold or osmium. The naked papillæ, as well as the interpapillary grooves and hollows, then show a beautifully wavy system of lines, which remind one of the furrows on the ends of

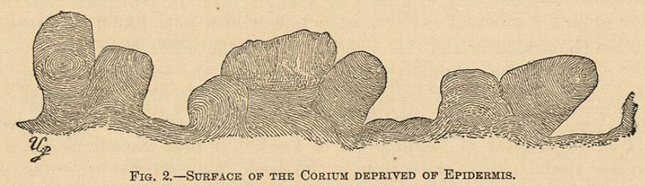

Fig. 2.—Surface of the Corium deprived of Epidermis.

the fingers (see Fig. 2). That we here have to deal with a system of alternating grooves and ridges is best seen from a profile view. These grooves receive ridge-like projections of the epithelial cells between them, which come from their under surfaces. This accounts for the fact that, on some sections, the layer of epithelial cells nearest the corium is provided with coarse dentations, while, in other places, the border-line is perfectly straight. In the latter case, the section has fallen in the direction of these fine furrows, whereas, in the former, they were cut at right angles. In places not completely macerated, it can be plainly seen that an epithelial cell is welded by its basal ridges into three or four grooves of the papillary layer, an attachment of hitherto unsuspected completeness.

A Basal Membrane does not exist.—These fine grooves of the surface do not, however, correspond to connective-tissue fibrillæ. They are rather channelled out of a trans-