The histology of the common frog

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OF THE

COMMON FROG

A THESIS

BY

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The Histology of the Common Frog.

Histology is the microscopic study of animal and vegetable tissue in relation to development and construction. Consider the advantage to be gained by a knowledge of the tissues composing different
organ, their variety and peculiarities; of the minute ramifications of blood-vessels otherwise invisible; of the size, shape and plan of blood corpuscles; of nerve and muscle; of all those mysteries in the formation of bodies, animal and vegetable, revealed by the microscope, and the importance and interest of histology can be realized. In a study of the vascular system, the first operation to be performed is the injection into the vessels of this system of some colored liquid; something that will not run out when the vessels are cut. A preparation
of carmine and gelatine is most suitable for this purpose. The injecting is done in different ways with different objects. After injection all the tissues are hardened by placing the specimen in alcohol for a number of hours. Then the particular portion to be examined is embedded in a mixture of paraffin and cresaline in whatever position is desired, and cut in very thin sections. In case of the examination for cellular structure, the specimen is first hardened in alcohol, then embedded and cut, after which the sections are allowed to remain in a staining
preparation for different lengths of time varying from twenty minutes to three quarters of an hour. The preparations most generally used are one of carmine and one of hematoxylin, the former giving a red stain to most cells, and the latter, a blue one. Out of the staining fluid the sections are put into a fixing solution for a few minutes, then washed with alcohol and cleaned with oil of cloves which was used unexceptionally in this study of the common frog. The specimen, if mounted dry, is covered by merely stick-ing the cover glass to the slide by
measure of a wax ring laid round the specimen and heated. Otherwise balsam is dropped over the specimen and the covering glass then put in place.

In this study of the frog the microscopic powers employed were the 34, 40, and the two inch objectives. The magnifying powers were measured in diameters by means of a micrometer and a camera lucida, the units of the micrometer used being 20th of a millimeter.

The Skin.

Both layers of the skin of the frog are
soft and have no portions of a bony nature such as hairs, nails, or scales. It exerts both perpiratory and respiratory action to an extreme degree; in fact a frog kept dry by the hot sun will die, and life can be sustained under water by skin respiration with no aid whatever from the lungs. For this reason the skin is most abundantly supplied with blood vessels from the anterior division of the pulmonary artery, which is one of the three trunks leading from the heart.

Plate I—shows an injected portion of the skin from the ventral side of the frog. Very minute blood vessels from
a sort of network between the larger branches, and at various places in
the section pigment cells appear as
dark irregular spots. The pigment
cells are supplied with processes
often anastomosing, and they also some-
times, though rarely, are nucleated.
The stomata which appear as round
genings through the skin (Plate I.)
establish communication between the
external surface media and the
lymph spaces between the skin and the
body. Should the external surface of
the frog for any reason become dry,
then a function of the skin as an
organ of respiration would cease and
acids under certain conditions. The skin, however, absorbs water when moisture is abundant, and this water is stored in spaces under the skin to be poured out again in case of an emergency upon the external surface. The stomata are doubtless concerned in these processes.

Plate II. gives the appearance of a vertical section of the skin showing the cellular structure. Over the lymph spaces the skin is divided definitely into three layers, as shown in the plate. There is first an external, epi-
-dermal, or more properly, an epithel-
bial layer in the lower portions of which are numerous pigment cells. These pigment cells are distributed generally throughout this external epithelium, being most abundant however in the darker patches of the dorsal surface. The middle layer is thicker than either of the other two. It consists largely of connective tissue and contains numerous irregularly shaped glands, which probably correspond to the peripharyngeal glands and assist in maintaining the necessary moist condition of the outer surface. The third layer, like the first is epi-
thelial, but is destitute of pigment cells. It is a part of the general lining of the lymph spaces.

Plate III. Here again is shown a portion of the skin injected, this time from the web of the foot. The blood vessels are, if possible, more thickly crowded than in the preceding specimen, and the pigment cells are more numerous.

The Blood Corpuscles. There are in the blood of the frog, as is usual in all vertebrates, two kinds of corpuscles, the red and the
white. The red ones in the blood of the common frog are elliptical, and furnished with comparatively large and well defined nuclei. Their function is the same as that of other red corpuscles, viz: to carry oxygen. The white corpuscles are smaller than the red, being only about the size of the nuclei.

Plate IV shows a number of the red elliptical corpuscles.

The lungs.

These are, as in all air-breathing animals, the organs of respiration, though to the frog, they are of less
importance perhaps than the skin, and alone, are not sufficient for the maintenance of life. The action, however, is the same as in any lung: oxygen is supplied to the blood and carbon-dioxide is carried off from it.

Plate V—representing a portion of the lung injected, shows the large air cells, indicated by the large divisions, and which, in the natural specimen can be distinguished with the unaided eye. Distributed through the walls of these air cells is a network of extremely minute blood vessels. Pigment cells
similar to those in the skin are scattered more or less numerous throughout all parts of these organs.

Plate VI shows the cell structure of the lungs. The drawing, more highly magnified than in the preceding plate, is made from a specimen stained with carmine and silver nitrate. The air cells, as shown in the figure, are lined with pane-
ment epithelium, together with a sprinkling of stellate pigment cells.

The Muscles.

There are two kinds of tissue found
see the animal body, voluntary and involuntary. The distinguishing histological feature being the brownish lines or chriae shown by the fibres of the voluntary muscle. Muscles are made up of fibres and Plate VII shows parts of two such fibres. The chriae are seen and also large longitudinally elongated nuclei of granulated protoplasm. Muscle fibres are held together by a thin membrane called the sarcolemmma which however is not seen in the plate.

Plate VIII. Here is shown the structure of the mesentery, a thin
membrane made up of interlacing fibres of both white and yellow connective tissue. The intercellular substance has a fibrous many appearance and there are some what irregular, elongated cells scattered sparsely through it. Connective tissue is only of low physiological rank, and yet it important as a skeletal tissue, as surrounding, frustrating and supporting every organ of the body, forming a complete framework of the same. The structure varies according to the office that the tissue performs.
The Tongue.

The frog's tongue is large, fleshy, free behind and fastened in front, and serves the purpose of catching food. In doing this the back part is projected forward out of the mouth and over the object to be caught, and as the tongue is covered with a viscid salivary fluid, which constitute the essential part of the food of the animal, adhere to it and are carried back into the mouth. The tongue also acts to close the internal openings of the nostrils in the act of breathing. This organ
is therefore exceedingly muscular, not less than four muscles from the skull being implanted in it, in place of the single stylohyoid of the human tongue.

Plate IX represents the tip of the frog's tongue injected to show the arrangement of the blood-vessels, the large ones toward the center, and the smaller ones forming a network around the mucous glands near the edge. The various directions of the muscular fibers can also be seen.

Plate X is a figure of a stained section of the tongue. In the
The edge of the mucous glands which furnish mucus or the sticky saliva are seen extruding vertically, the folds shown above them being the longitudinal muscles.

**The Stomach.**

*Plate XI* is a cross-section of the stomach injected. The outer muscular layer is filled with blood vessels. Then comes a layer of connective tissue known as the sub-mucous layer. The larger trunks of the blood vessels run in the sub-mucous layer and give off branches to supply the capillary system.
of the muscular layer on one side, and the mucous layer on the other. Within the sub-mucous layer is a thin band of muscular tissue, (the office will be described in connection with the next plate) and following this internally is the mucous layer or mucous membrane, usually thrown into longitudinal folds or rugae, penetrated by the close set, parallel, gastric tubules, and supplied with a rich plexus of blood vessels.

Plate XII shows a section of frog's stomach, stained. Around
the outside is a thin coat of ciliated membrane. Then comes a broad layer of muscular tissue and then a layer of connective. There is a thin muscular layer between the connective tissue and the mucous membrane which is thrown into large irregular folds on the inside of the stomach. In these folds are found the gastric tubules whose secretion is produced by the thin muscular layer. Whenever they are irritated by the presence of food or other foreign substances, the connective tissue restrains somewhat also
into the folds. Mucinar epithelial cells, the real agents of secretion line the gastric tubules.

Plate XIII — Large Intestine.

The plate represents a cross section of the large intestine, stained. On the outside there is a band showing the ends of longitudinal muscles which have been cut across. In case of the large intestine, this layer is not continuous. Then we see a rather broad band of connective tissue and on the inside, the mucous membrane is thrown into large folds which
are more numerous and more irregular than those in the stomach.

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The Small Intestine.

Plate XIV. Here is a cross section of the small intestine, shown. On the outside there is a band of longitudinal muscular fibres which have been cut across, but in this case the layer is continuous. Then there is a layer of connective or sub-mucous membrane, and next to this the mucous layer, which, similar to the stomach and the large intestine, is
is thinned into large irregular folds; but here the folds are larger than in the other cases, leaving a comparatively small space in the center between them.

The Spleen:

Plate XX. This plate gives a cross section of the spleen, stained, showing the cellular structure. The pigment cells are numerous and at intervals around the edge are seen glandular bodies, known as the Malthighian bodies of the spleen, and in some way, doubtless are connected with the
Secrum function of this organ.

The Liver.

Plate XVI. Here is shown a section of liver stained. It seems to be made up of large, irregularly distributed hepatic cells. The pigment cells are also present. Above the center of the field is a view of a blood vessel cut across, showing the epithelium with which it is lined. The liver of the frog does not seem to be made up of lobules, as is the case with the liver of many other animals, but only of very un-
The Oviduct

Aside from the function indicated by its name, viz. that of being a passage way for the eggs as they are laid, the oviduct is frequently spoken of as serving another purpose and, for this has the following peculiarity. The mucal gland, from its secretion into the mucal duct, which does not open into the cloaca, as is the case with
birds and reptiles, sub into theoviduct and the oviduct and the\nintestinal duct thus open into the\ncloaca by a common aperture. How\never this is disclaimed by some\nwho assert that they have dis\ncovered distinct but minute a\nportions for the gland ducts separa\n
Plate XVII. The oviduct as shown in Plate XVII is a tubular organ\nwith walls greatly thickened at\nthe time of ovulation. In the walls\nan embedded numerous small\ntubular glands, the office of which\nis to pour out a fluid with which
the eggs become coated during their passage. Immediately after the eggs are deposited, this coating absorbs an immense amount of water, swells up, and becomes the jelly-like mass in which the black eggs appear as small scattered dots. The section from which the drawing was made was cut obliquely and is therefore in some places transverse, in other parallel to the direction of the glands.

Plate XVIII. This plate shows the oviduct injected. The large- or blood vessels evidently lie near.
on the outer edge and send in branches to the center. On the outside of the oviduct is a non-vascular serous membrane, then comes a wide band occupied by the glands already noticed and filled with blood vessels which form a plexus around the glands and supply them with materials needed in producing their peculiar secretion.

The Kidney.
The kidneys are the organs devoted to the excretion of the nitrogenous wastes of the body.
in the kidney of the frog, the Maltighian bodies are supplied with arterial blood and the ple-
ure around the convoluted tu-
tules is furnished with vei-
ous blood.
Plate XIX shows a section of
kidney injected, the Maltighi-
an bodies are plainly seen, al-
so the blood vessels supply-
ing them.

The Central Loths.
The central lots of the frog con-
stitute the second segment of
the brain and lie back of the
factory lobes. These lobes each contain a cavity, one of the lateral ventricles, and the two cavities open by a common aperture into the brain segment next behind.

Plate XX. In this plate the two central lobes are represented in their natural position. The lobes are made up of gray matter entirely, but immediately around the ventricle it is more dense than in the cortical portion forming the remainder of the lobes.

Plate XXI shows a portion
of a stained lobes just around the ventricle, with a much higher power, and marks the difference in the shape of the cells and their position.

The Optic Thalamus.

**Plate XXII.** Behind the pineal gland which lies next to the central lobes is the optic thalamus, a large, broad part of the brain and which forms the third segment of it. At each side and a little below are the optic ganglia composed of concentric rings of cells. The plate
above the broad thalamus with one ganglion at the right side. The large opening in the center with the peculiar concentric rings around it, is the third ventricle, and the opening below is the aperture by which it communicates with the fourth ventricle. A few pigment cells are seen on the edges. 
Plate XXIII shows the concentric rings of the optic ganglion, their position, and number with some pigment cells on the outside.
Plate XXX. In this plate we have a section of the layers of the eye from the outside inward. The two different layers, beginning at the lower side of the figure, belong to the sclerotic coat: the first is of fibrous connective tissue, the second of cartilage, and showing large cartilage cells. The first black layer forms the choroid coat, and the rest of the layers belong to the retina, the structure of which will be described in the next plate.
Plate XXVI. This plate shows a cross section through the layers of the retina, highly magnified. Beginning at the lower part of the figure which is the inner part of the retina, the layers are as follows:
1. Nerve fiber layer.
2. " cell "
3. Internal molecular layer.
4. " granular "
5. External molecular "
6. " granular "
7. Rods.
8. Pigment cells.
Plate I.

Section of Skin, injected (X 69)
Plate II.

Vertical section of skin, stained (× 77.3)
Plate III.

Section of Web injected (X 71)
PLATE III.
Plate IV
Red Blood Corpuscles (X310)
Plate V
Section of Lung injected (X 773)
Plate VI.
Section of Lung—stained (X 40).
Plate VII

Fibres of Voluntary Muscle

($\times 356\frac{2}{3}$)
PLATE VI
Plate VIII
Section of Mesentery stained
(× 385)
Plate IX

Section of Tongue, injected

(X 29)
Plate X

Section of Tongue - stained

(X 45)
Plate XI
Section of Stomach— injected
(× 26$\frac{2}{3}$)
Plate XII

Section of Stomach stained X
Plate XIII

Section of Large Intestine stained (x 26\(\frac{2}{3}\))
Plate XIV

Section of Small Intestine

Stained (x 50)
Plate XV.
Section of Spleen, stained
(X 29)
Plate XVI
Section of Liver—stained
(X 348)
Plate XVII

Section of Oviduct - Stained

(× 26 $\frac{2}{3}$)
Plate XVIII

Section of Oviduct injected

(X49)
Plate XIX
Section of Kidney injected
(X 29)
Plate XX

Section of Cerebral Lobes.

stained (X 31)
Plate XXI.
Section of Central Lobe. Stained. (x 368)
Plate XXII

Section of Optic Thalamus

stained (X28)
Plate XXIII

Section of Optic Ganglion

stained (× 77%)
Plate XXIV

Section of Spinal Cord. Stained. (X 33½)
Plate XXV.

Section of Layers of the Eye, stained. (X 80.)
Plate XXVI

Section of Layers of the Retina

Stained (x 375)