A Laboratory Guide to the
ANATOMY OF THE RABBIT

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BY

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PREFACE

AFTER many years of teaching mammalian anatomy the author is more than ever convinced of the advantages of the rabbit as a type for student dissection.

The present work does not in any way aim to replace *Bensley's Practical Anatomy of the Rabbit,* which has long since proved its value beyond question. The attempt has been to meet a need for a shorter and less detailed laboratory guide adapted to courses for which *Bensley's Anatomy* has been found too extensive. Classes for which the present book is designed have assignments of time for this subject varying from about twenty-four hours to about sixty hours. Some of them have two-hour periods and some have three-hour periods. Some, moreover, have need for special emphasis on certain parts which are of less immediate interest to others.

Hence it was felt undesirable from every point of view to prepare a text fitted to one particular course. Rather the aim has been to present a reasonably brief account in such a way that an instructor can assign from it the chapters most suited for a particular class and can easily omit parts which he feels less important or which his time-schedule does not allow him to include. At the same time the occasional student with sufficient curiosity can extend his study beyond class assignments.

For a more complete account the curious student would naturally have to turn to *Bensley's Practical Anatomy* and the present author has inevitably leaned heavily upon that work, his indebtedness to which he gladly acknowledges.

In the hope of making it easier for beginning students to integrate the parts studied in their minds and to understand the body as a living, working mechanism, an attempt has been made to arrange the presentation so as to bring together wherever practicable the different parts of each organ system, these being inevitably somewhat scattered in the strict regional method of dissection. The inter-relations of systems, which are more high-lighted by the latter method, are nevertheless still kept in view. Although the current term "functional anatomy" is not used, it is hoped that the essence of this very fundamental concept has been kept before the dissector. Some modified approaches in dissection have been introduced with this aim.

Of the twenty-eight illustrations, fifteen are new and the remainder have been borrowed from *Bensley's Practical Anatomy*. Four of the latter were the work of the late Dr. Bensley, the rest were prepared by the present author.

For permission to use illustrations as well as descriptive material from *Bensley's Practical Anatomy* the author is grateful to the University of Toronto Press, which owns the copyright for that work. He is also grateful for the co-operation of the Press in preparation of this new text-book.

E. HORNE CRAIGIE

Toronto, December, 1950

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CHAPTER I

MICROSCOPIC ANATOMY

STUDY of the structure of the bodies of animals is commonly divided into microscopic anatomy and gross anatomy. This classification, however, is based merely upon the sizes of the parts to be examined and the consequent need of somewhat different technical methods of study. The two are essentially one in outlook and they are equally essential for an understanding of the structure, a knowledge of which is a prerequisite for any intelligent study of functions, of behaviour, of development, of diseases, and so on.

The present work is to be concerned with gross anatomy, but in view of the considerations just suggested an introductory glance at some fundamentals of microscopic structure appears to be desirable.

The basic unit of living matter, both structurally and functionally, is a cell. Though this can be further analyzed, none of its component parts can be regarded in the same ways as a complete living unit. Each cell consists of a mass of living, jelly-like, protein material, protoplasm, which comprises an inner, differentiated nucleus and a surrounding layer of cytoplasm. The surface of the cytoplasm forms a cell-membrane and within it various other structural elements often appear (Fig. 1).

All animals except the simplest (protozoa) have many cells associated to form their bodies and usually there are marked differences among the cells in a single animal body as well as in the intercellular materials which hold them together. Cells of more or less similar character are assembled into tissues, in which they are held together by intercellular materials that vary greatly in amount and in nature but are characteristic for each type of tissue.

Tissues are associated in various ways to form organs. The definition of the word organ lacks precision but in general it is a part of the body devoted to some special function, such as digestion or respiration. The study of organs and of their larger assemblages, known as organ-systems, is the role of gross anatomy, while tissues and cells belong to microscopic anatomy, or histology.

In gross anatomy, however, it is necessary for the student to recognize the main types of tissues and their more important subdivisions. These main types are epithelial, connective, muscular, and nervous tissues, besides blood and lymph, which are sometimes classed as liquid tissues.

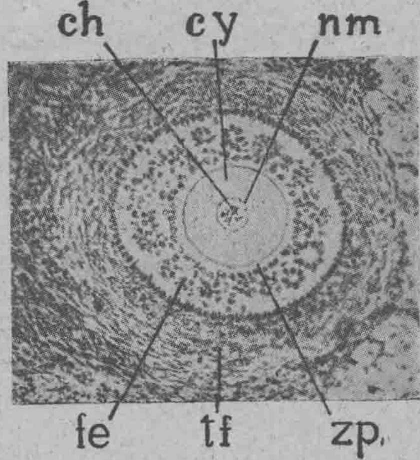

FIG. 1. Photomicrograph of a section of a developing ovum in the ovary of a rabbit. X150. From *Bensley's Practical Anatomy of the Rabbit*. ch, chromatin; cy, cytoplasm; fe, follicular epithelium; nm, nucleur membrane; tf, theca folliculi; zp, zona pellucida.

EPITHELIAL TISSUE

Epithelial tissue is the characteristic covering of free surfaces. It may be only one cell in thickness (simple epithelium) or may have many layers (stratified epithelium). Also it may produce a variety of secondary structures such as hairs, claws, etc. The amount of intercellular material present is relatively small.

Examples of simple epithelium are surface layers of the mesenteries and the lining of most parts of the alimentary canal. Stratified epithelium forms the outer part of the skin, the epidermis.

Specialized epithelium constitutes most (though not all) glands, the essential structure of which is either an assemblage of epithelial tubules or an assemblage of flask-shaped structures (acini) which are also epithelial. Such glands may either retain their connection with a free surface by a duct through which the secretion passes (exocrine glands) or lose this connection so that the secretion must be conveyed by the blood or lymph (endocrine glands). The various digestive glands are examples of the former, the thyreoid gland is an example of the latter. An example of an endocrine gland which is not epithelial is the suprarenal body.

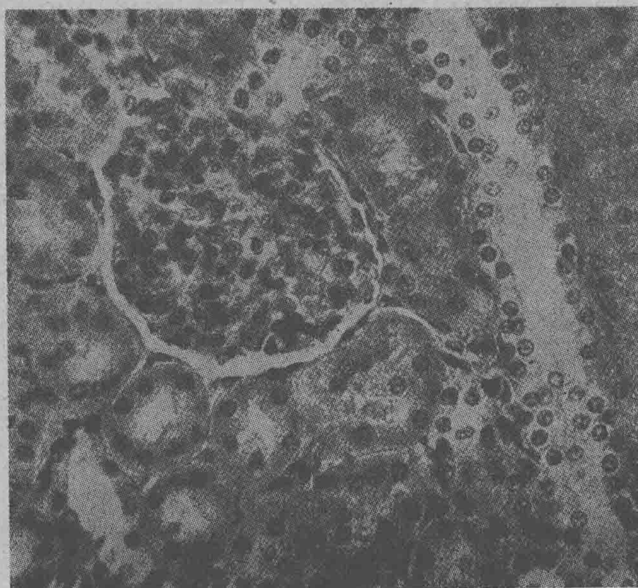

FIG. 2. Photomicrograph of a small part of a section of the kidney of a rabbit. X360. From *Bensley's Practical Anatomy of the Rabbit.* A collecting tubule running through the right third of the field shows the appearance of simple epithelium both in section and in surface view. A glomerulus appears in its Bowman's capsule, the latter lined by flattened epithelium, and the rest of the field contains mainly sections of convoluted tubules, which also illustrate simple cuboidal or low columnar epithelium.

Certain epithelia differ from the rest in that they are formed not over originally free surfaces but as linings of internal cavities developed within primarily continuous masses of embryonic tissue. According to location they are distinguished as mesothelium and endothelium. The lining of the peritoneal cavity, including the surfaces of the mesenteries mentioned above, is mesothelium, the lining of the blood-vessels is endothelium.

CONNECTIVE TISSUE

The general function of connective tissue is just what, in a broad sense, that term implies. Such tissue is characterized by the presence of a relatively large amount of intercellular material, the diversified nature of which distinguishes different varieties of connective tissue and confers upon them the properties which particularly fit them for their special rôles. These various types may be classified into ordinary or soft connective tissues and skeletal tissues (cartilage and bone).

The ordinary connective tissues have the cells scattered through an intercellular matrix (produced by the cells themselves) containing usually three kinds of fibres—white, yellow, and reticular—with a watery or viscid liquid between them. This is frequently known as fibrous connective tissue, its commonest variety being called areolar, exemplified by the loose white subcutaneous tissue which attaches the skin and by the fascia between muscles. The fibres of the matrix are interlaced in a felt-like manner. When these fibres are more numerous and concentrated, they may form a strong, tough sheet, as in the deeper layer of the skin, the corium. Still more compact and with the white fibres mostly parallel are the ligaments which hold bones together and the tendons which attach muscles to bones.

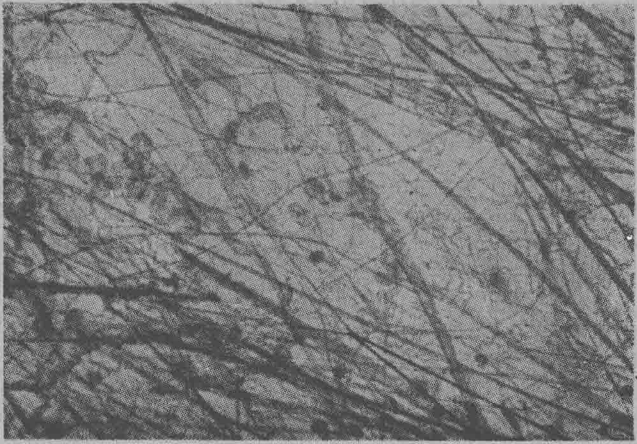

FIG. 3. Photomicrograph of part of a stained preparation of areolar connective tissue (subcutaneous tissue of a rabbit). X150. From *Bensley's Practical Anatomy of the Rabbit.*

Fat or adipose tissue differs from those just mentioned in that the matrix is quantitatively less than the cells and the latter are distended by large droplets of fat within their cytoplasm. The tissue derives from this substance an opaque white, yellow, or even brownish colour and a peculiar consistency.

The skeletal tissues have fewer fibres in the matrix but this matrix is largely solid instead of liquid, so that such tissues are suitable materials for the supporting framework of the body as well as for protective shields.

Cartilage is the more flexible type of skeletal tissue. Hyaline cartilage has an apparently homogeneous matrix with a certain amount of elasticity and a pale, translucent, blue-grey colour. It occurs in such places as the nose or the larynx and as a thin layer over the articular surfaces of bones in the joints. Fibrocartilage differs in that many white fibres are imbedded in the hyaline matrix, giving increased toughness. It occurs, for example, in the pelvic symphysis and at the margins of the capsules in joints. The epiglottic cartilage and that of the external ear, which are very flexible, contain many yellow fibres and exemplify elastic cartilage.

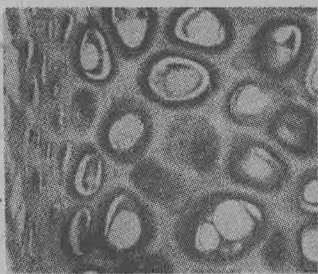

FIG. 4. Photomicrograph of part of a stained section of cartilage from the ear of a rabbit. X230. From *Bensley's Practical Anatomy of the Rabbit.*

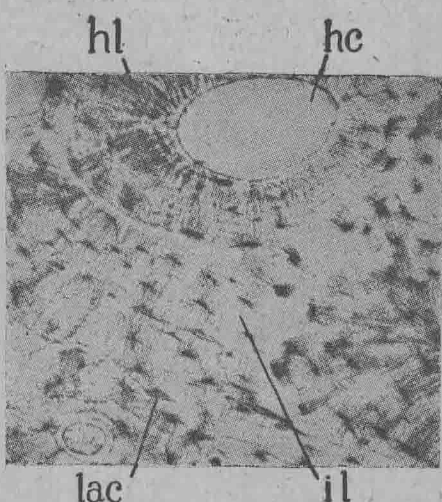

FIG. 5. Photomicrograph of part of a ground transverse section of the bone of a human radius. X120. From *Bensley's Practical Anatomy of the Rabbit.* hc, Haversian canal; hl, Haversian lamella; il, interstitial lamella; lac, lacuna.

Bone is a denser, harder, tissue with relatively little elasticity, its matrix being strengthened by the presence throughout of much inorganic material (mainly salts of calcium). Within the matrix, the cells lie within minute cavities, the lacunae, which are connected with each other by fine canaliculi and are arranged in definite patterns differing according to the manner of origin of the particular bone.

Developmentally, bone may replace cartilage, which is slowly eaten away while bone is formed in its stead—cartilage or replacing bone—or it may be produced directly in the soft connective tissue—membrane or derm bone. The adult tissue is the same in either case.

Most bones of the skeleton contain cavities filled with soft, highly vascular, connective tissue, the bone-marrow, which is the most important of several regions where red blood cells develop.

Muscular Tissue

Muscular tissue is the principal agent of movement in the body. It composes the active portions of the organs known as muscles and occurs in the constitution of many other organs where movement is required, as in the walls of the digestive tube and other visceral organs. The colour is usually reddish in the fresh condition though it may be quite pale. Red muscle acts more slowly and is less subject to fatigue than "white" muscle.

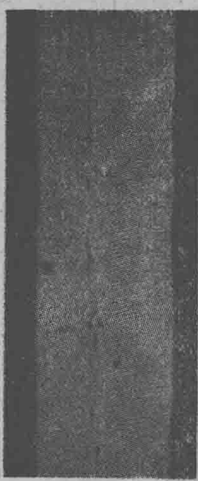

Fig. 6. Photomicrograph of parts of two striated-muscle fibres from a teased preparation of skeletal muscle of a rabbit. From *Bensley's Practical Anatomy of the Rabbit.*

Muscular tissue is characterized by the elongation of the individual cells into long, parallel fibres held together by a minimum of intercellular substance, these fibres having the primary protoplasmic function of contractility accentuated and restricted to the direction of their length. They are grouped in parallel bundles surrounded by small quantities of connective tissue and attached by tendon or directly to the points upon which they are to pull, these bundles often giving a muscle a very finely lined appearance.

The term striated muscle, however, refers not to the appearance just mentioned but to fine lines running across each fibre and visible only under the microscope. Such fibres constitute all the skeletal muscles and are usually under the control of the will, so are often called voluntary.

Smooth muscle, in contrast, has fibres which show no such markings and are usually shaped like much-elongated spindles, though shorter than striated fibres. They are involuntary and occur mainly in the walls of visceral organs and blood-vessels.

Cardiac muscle is a third main type, which is also involuntary but is striated. The fibres are branched and continuous with each other. This type composes most of the heart and is confined to that organ.

Nervous Tissue

Nervous tissue is composed essentially of nerve-cells, or neurons, imbedded in supporting material. Each neuron typically has a cell-body, some short receptive processes (dendrites), and one longer, emissive process, the axon or nerve-fibre. Neurons differ greatly in structural details as well as in size, in shape, and in the length and thickness of their processes. The nerve-fibres may or may not be provided with white myelin sheaths of a peculiar fatty substance.

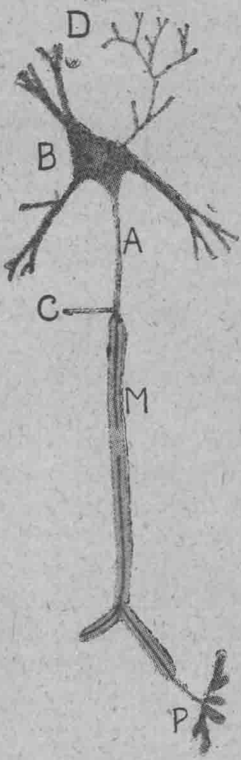

Fig. 7. Diagram of a typical neuron. A, axon; B, cell-body; C, collateral; D, dendrites; M, myelin sheath; P, motor end-plate.

A peripheral nerve is composed of parallel bundles of the microscopic nerve-fibres held together by sheaths of white connective tissue, usually with no nerve-cell bodies, though a few may be scattered along the nerve in certain places. Swellings upon the nerves at particular points are accumulations of cell-bodies and are known as ganglia.

In the brain and in the spinal cord also the cell-bodies tend to be assembled in more or less definite masses which, on account of their smaller content of myelinated fibres, have a greyer colour than the rest of the nervous tissue and are consequently known as grey matter. Elsewhere the fibres preponderate very largely, and the myelin sheaths of the myelinated fibres give such regions a whiter colour, so that the tissue is called white matter. Thus white matter is concerned mainly with simple conduction of nervous impulses and it is in grey matter that most of the connections between neurons are situated.

The neurons are imbedded in a supporting mass of tissue derived embryologically from the same source (the outermost embryonic layer) but taking no part in nervous functions. This material is the neuroglia. Through the nervous organs there run also strands of ordinary connective tissue constituting a supporting and protective framework and carrying blood-vessels, though quantitatively these form only a small part of the brain or spinal cord.

Blood and Lymph

Blood is the liquid medium for transportation through the body of oxygen, carbon dioxide, digested and absorbed food materials, waste products of metabolism besides carbon dioxide, hormones from endocrine organs, etc. Most of these are carried in solution in the intercellular liquid, the plasma, but oxygen is transported in reversible union with a red pigment, haemoglobin, which in vertebrates is confined within cell-bodies. Cells containing haemoglobin are the erythrocytes or red blood corpuscles. In mammals these have the form of biconcave discs and when mature usually lack nuclei. Very much less numerous are the leucocytes or white blood corpuscles, which are of several different kinds. Most of the leucocytes are actively motile, amoeboid cells which act as scavengers (phagocytes). They are capable of pushing through the walls of the smallest blood-vessels (capillaries) and escaping into the surrounding tissues.

In most tissues, and particularly in the connective tissues, there is a certain amount of tissue-fluid in the intercellular matrix. This is partly secreted by the cells and is supplemented by leakage of plasma and leucocytes from the blood-vessels. It is collected by minute vessels which terminate blindly in the tissue-spaces and which take in the tissue-fluid through their walls. These vessels are the lymphatic capillaries and the liquid within them is lymph.

The lymph passes through lymph glands which serve both as strainers for foreign material and as sources of new lymph cells. It is then conveyed through lymphatic vessels, which ultimately empty it into the superior caval veins. The lymphatic vessels are so thin-walled that they can not usually be observed in dissection unless specially injected with coloured materials.