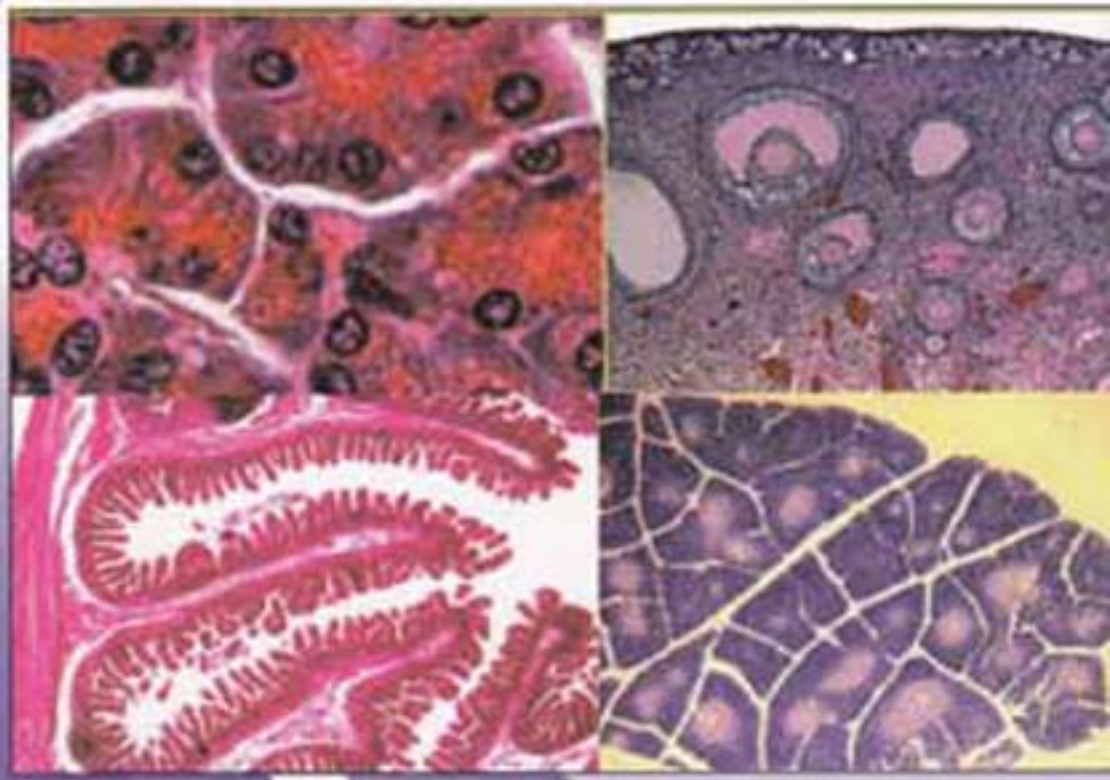
A Book of

MAMMALIAN HISTOLOGY

T.Y.B.Sc. • ZOOLOGY (ZY-332) • SEMESTER-III

Dr. KISHORE R. PAWAR Dr. ASHOK E. DESAI



NIRALI PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

A Book Of

MAMMALIAN HISTOLOGY

T.Y.B.Sc. ZY-332 : Paper II, Semester III
As Per New Revised Syllabus with Effect from June 2015

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Preface ...

It gives us great pleasure to present this book **"Mammalian Histology"** for the students of Third Year B.Sc. Zoology. This book is written according to the revised syllabus of June 2015.

We have tried our best to present the subject matter in an easy style and in a comprehensive manner. The subject matter is profusely illustrated with a number of clear and labelled diagrams. We sincerely feel that this book will fulfill the requirements of the students as well as teachers. While preparing this book several standard reference books and text books have been consulted. Emphasis has been laid on furnishing maximum information required for students in a simple and lucid language. Zoology is an interesting subject because the animal world is full of diversity, adaptations, habits and habitats and behaviour. There are several textbooks and reference books available written by Indian and foreign authors but these books are too costly and majority of the students are unable to purchase them for comprehensive study.

We express our sincere thanks to Shri. Dineshbhai Furia, Shri. Jignesh Furia, and Shri. M. P. Munde and the entire staff of Nirali Prakashan for taking keen interest in the publication of this book and bringing out the book on time.

We shall gratefully accept constructive suggestions from the teachers as well as students for improvement of this book.

Prin. Dr. Kishore R. Pawar
Dr. Ashok E. Desai

Syllabus ...

Total lectures: 48

1. Introduction (1)

1.1 Definition and Scope

2. Tissues (6)

2.1 Definitions and Review of Tissues (Location, Structure and Functions): Epithelial, Connective, Nervous and Muscular

3. Histological Study of following Organs

3.1 Skin (V.S.) **(3)**

3.2 Tooth (V.S.) **(2)**

3.3 Tongue (C.S.) with reference to mucosa papillae and taste buds **(2)**

3.4 Alimentary canal: Basic histological organization with reference to: Oesophagus (T.S.), Stomach (T.S.), Duodenum (T.S.), Ileum (T.S.) and Rectum (T.S.) **(8)**

3.5 Glands associated with Digestive System: **(6)**

Salivary Glands: Parotid (C.S.), Submandibular (C.S.), Sublingual (C.S.), Liver (C.S.) and Pancreas (C.S.) including both Exocrine and Endocrine Components

3.6 Respiratory Organs: Trachea (T.S.) and lung (C.S.) **(2)**

3.7 Blood Vessels: Artery (T.S.), Vein (T.S.) and Capillaries (T.S.) **(2)**

3.8 Kidney (L.S.), Structure of Nephron and Juxta Glomerular Complex **(4)**

3.9 Reproductive Organs: **(6)**

(a) Testis (T.S.) with reference to Seminiferous Tubules and cells of Leydig

(b) Ovary (C.S.): Primary, Secondary and Matured (Graffian) Follicle, Corpus Luteum and Corpus Albicans

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4.1 Pituitary Gland

4.2 Thyroid Gland

4.3 Adrenal Gland

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Chapter **1**...

Introduction

Contents ...

1.1 Definition and Scope

All living organisms consist of minute elements which are called *cells*. These cells are the smallest structural and functional units possessing the properties such as growth, reproduction, metabolism and irritability which are commonly associated with life. Each multicellular organism starts its existence as a single cell, the fertilized ovum or zygote which by a process of proliferation give rise to the adult body. At first, the cells of developing embryo are similar in shape and structure but later on they are differentiated into group of specialized cells differing from other in structure and function. These specialized groups of cells form the tissues of the adult body. At a very early period of the cells of embryo become separated from each other by the formation of intercellular substance, which may be the result of cellular secretion or actual modifications of cellular substance. In some tissues, this intercellular material occurs in greater proportions. Thus, adult body is composed of cells and intercellular material and all elements are so interrelated as to form a normally functioning machine.

The word '*histology*' is derived from two Greek word *histos* means *tissue* and *logia* means *knowledge*. Thus, histology actually means knowledge of tissues or study of tissues and formation of organs by different tissue. But since the tissues are composed of cells and their products, therefore, a knowledge of the structure and activities or functions of the cells must necessarily form the basis of the histology. Thus, now histology is defined as *''The branch of biology which deals with study of microscopic structure of tissues and organs with their function''*. It is studied with the aid of microscope, therefore, it is also called microscopic anatomy. Histology has intimate relations with various disciplines such as physiology, biochemistry, anatomy and pathology.

Usefulness of Histology: The knowledge of the histology is useful for the following purposes:

1. To understand the formation of organs.
2. To find out the correlation between structure and function of an organ.
3. A thorough knowledge of normal histology is essential for understanding of the altered structure seen in cells or tissues in various conditions of disease. This helps in diagnosis of many diseases.

1.2 Techniques in Histology

Tools and Method of Study of Histology: There is tremendous advancement in the field of histology. Variety of sophisticated instruments and techniques have been used successfully now-a-days for the study of histology.

The most important tool for studying histology is the microscope which makes invisible object visible. There are two types of microscopes one using light rays are called *light microscopes* and other using electron beams are called electron microscopes. *Electron microscope* gives several time greater magnifications than the light microscope.

For light microscopic observation, cells and tissues are either examined in living condition or in dead condition. Structural details of animal tissues and organs can be studied by using the following methods singly or in combinations.

(A) Examination of Living Cells and Tissues without any Chemical Treatment:

(1) Fresh, uncoloured: For this purpose little bits of tissue or drops of blood taken for smear or film on glass slide and examined under a microscope. Saline solution is often used for keeping tissue moist and in physiological state.

(2) Transparent chamber method: In this method, holes made in the Rabbit's ear and covered with glass discs. Through the glass we can see the growth of blood vessels and nerves directly under the microscope.

(3) Tissue culture: The cells and tissues can be removed from animal and grown in culture medium under aseptic conditions. The cultured cells then examined.

(4) Organ culture: In this method, instead of cells or tissues, a part of organ is cultured such as limb buds from embryo can be cultured in culture medium and examined.

(B) Examination of Living Cells after Chemical Treatment:

(1) Supra-vital staining: The living cells or tissues can be stained by adding a dye on slide and dye does not kill the cells and then cells can be examined under the microscope. Janus Green is commonly used supra-vital stain used for staining mitochondria.

(2) **Vital staining:** In this method, also the dye which is used do not kill the cells. The dye can be administered either by injection or through food. After some time cells or tissue is removed from the animal body and examined under microscope.

(3) **Cell fractionation and centrifugation:** Cell organelles can be separated into layers of different specific gravity by homogenizing the cells in a homogenizer. The homogenate is centrifuged in sucrose solution and after centrifugation cell organelles of different specific gravity get arranged into different layers. After this desired organelles such as nuclei, mitochondria etc. can be separated which are called fractions.

(C) Examination of Killed Cells and Tissues:

1. **Maceration:** In this method the tissue is kept in strong and dilute acid and intercellular substance are removed. Due to this treatment individual cell, tissues can be isolated.
2. **Corrosion:** Tissues are treated with strong alkaline solution so that soft parts are dissolved. Calcareous parts are maintained.
3. **Radio autography:** In this technique, radioactive precursor is applied to the tissue for determination of its location in cells and tissues. The substances are called labeled substances. The commonly used substances are ^{14}C, ^{3}H, ^{128}I, OR ^{131}I. They are visible in both the light and electron microscopes.
4. **Histochemical methods:** Certain substances in tissues and cells have special affinity for certain chemical substances and dyes. These affinities are studied in histochemical method. This method is useful in locating glycogen, ascorbic acid, lipids, steroids and enzymes.
5. **Historadiography:** When X-rays are used for photographing tissues to identify elements, called historadiography.
6. **Ultraviolet microspectro-photometry:** The pressure of nucleic acid RNA and DNA is detected by ultraviolet rays. When the sections of tissues are photographed with ultraviolet rays these acids absorb the rays resulting dark spots in the photograph indicating the presence of the nucleic acid.
7. **Immunohistochemical method:** In this method, antigen (foreign body) antibody reaction is carried in presence of fluorescent dye molecule. It is useful for identifying some substance in the cells.

Exercise

1. Define histology. Describe the different techniques for the study of cells or tissues.
2. Write short notes on:
   (i) Usefulness of histology
   (ii) Examination of living cells
   (iii) Radio-autography
   (iv) Histochemical methods
   (v) Immuno-histochemical method
3. Define:
   (i) Maceration
   (ii) Vital staining
   (iii) Tissue culture
   (iv) Organ culture
   (v) Histo-radiography.

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Chapter 2...

The Tissues

Contents ...

2.1 Definitions and Review of Different Tissues

The normal development or new life begins from the egg fertilized by sperm i.e. zygote. The zygote undergoes division and multicellular mass is formed. The cells begin to be arranged in three distinct layers which are called as three germ layers (gastrula). Because of their position in the developing embryo, they are known as *ectoderm (outer), mesoderm (middle) and endoderm (inner)*.

The cells of each of the three *germ layers* divide, differentiate and group themselves into specialised tissues, which in turn are organised into organs and organ systems. The process by which undifferentiated cells of a germ layer develop into specialised cells of tissues is called *histogenesis*.

Initially, the cells of different layers are somewhat similar but gradually change occurs and groups of cells are formed which are different in structure and function. However in one group all the cells are somewhat similar. Therefore, the group of cells having common origin and similar structure and perform a particular function is called *tissue*.

Tissues are usually classified into four main categories:

1. **Epithelial tissue:** It is formed from the cells of ectoderm, mesoderm and endoderm.
2. **The connective tissue:** It is mainly formed from mesoderm and mesenchyme.
3. **The muscular tissue:** It is formed from mesoderm.
4. **The nervous tissue:** It is formed from ectoderm.

All or some of these tissues combine to form an organ.

2.2 Epithelial Tissue

The term epithelium means a covering and it covers the surface of the body as epidermis and lines all passages leading to the exterior, such as the lining of digestive, respiratory and urinogenital systems. It also lines most of the closed cavities of the body. Epithelium also involves in the formation of exocrine and endocrine glands. It lines the pleural, pericardial and peritoneal cavities there it is known as *mesothelium,* while it lines blood and lymph *vessels is called endothelium*.

In the epithelial tissue, cells are arranged into a single or multilayered sheet with very little intercellular material. The individual cells of tissue are cemented together by little quantities of viscous inter-cellular substance or matrix which is secreted by epithelial cells themselves and it contains mucopolysaccharide and calcium. The epithelial cells are joined or attached by special mechanism called desmosomes or *intercellular* bridges. The cells are also provided internal structural support by fine filaments within the cytoplasm. This supporting cytoplasmic network is called *cell web* or *cytoskeleton*. The cytoplasmic filaments are also called *tonofibrils* or *tonofilaments*. The epithelial cells in certain parts shows modifications like formation of microvilli and cilia.

Below the epithelial cells, there is a thin supporting layer called *basement membrane*. It shows structural variations because of functional differences. It also serves for holding the basal cells of the epithelium firmly to the underlying connective tissue and exchange of substances between epithelium and blood vessels.

With few exceptions, epithelium is entirely a vascular i.e. it has no capillary network in it. Nutritive materials and oxygen is supplied to epithelium by diffusion through the cells and intercellular substance.

Epithelial tissue also shows wear and tear; however, the cells are replaced by active cell division which occurs in epithelial cells.

Classification of Epithelial Tissue: Epithelium is classified into different types on the basis of number of cell layers and the shape of the cells at the surface layer. Thus, the epithelia (plural) of only one layer are called *simple epithelia* and they are subdivided according to the height of the cells into four types.

(i) Simple squamous (ii) Simple cuboidal

(iii) Simple columnar (iv) Pseudo stratified.

An epithelium composed of two or more layers or strata is called *stratified* or *compound epithelium* and it is subdivided into four types according to the shape of the surface cells.

(i) Stratified squamous (ii) Stratified cuboidal

(iii) Stratified columnar (iv) Transitional.

Simple Epithelia:

1. Simple Squamous Epithelium: It consists of flat-scale like or plate like thin cells. The cells are joined to one another side by side. The edges of the cells are usually serrated but may be smooth. The nucleus is spherical or ovoid situated in the centre of the cell causing buldging of the cytoplasm. On surface view the cells appear large, polygonal and closely fitted. When the cells having serrated edges then they are called *tessellated* cells and found in mesothelium.

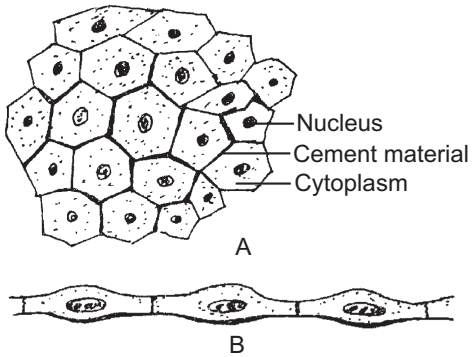


Fig. 2.1: Simple squamous epithelium

A – Surface view, B – Side view

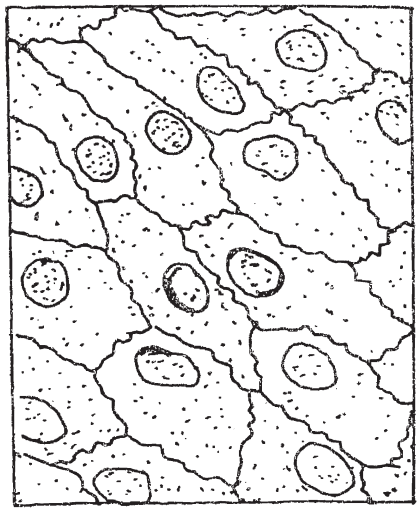


Fig. 2.2: Tessellated cells of mesothelium

In profile view, the cells appears as spindle shaped, thiner at the ends than at the centre where the nucleus is located. Simple squamous epithelium is found only inside the organ where there is no chance of abrasion such as in certain parts of kidney tubule (Henle's loop), inner lining of lung alveoli. It lines the peritoneal, pleural and pericardial cavities (mesothelium), the heart and all blood and lymph vessels (endothelium).

2. Simple Cuboidal Epithelium: It is somewhat like squamous epithelium but the cells, instead of flattened are cuboidal. The term cuboidal epithelium is applied when the height and thickness of the cells are about equal i.e. isodimetric. In surface view, they are roughly hexagonal in appearance but not exactly cube-like. In a vertical section, they show equal height and thickness.

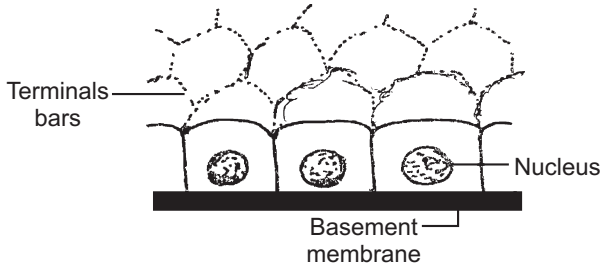


Fig. 2.3: Simple cuboidal epithelium

Each cell possesses round nucleus and centrally placed in the cytoplasm cuboidal epithelium is modified into secretory tissue and occurs in kidney tubules, small ducts of glands, in acini and in normally active thyroid follicles. The secretory cuboidal cells have numerous mitochondria in the basal part and granules or droplets (zymogen, mucin etc.) at the apical portion.

3. Simple Columnar Epithelium: It consists of single layer of tall cells which appear column-like i.e. much taller than wide. But the height of the cells varies considerably in different locations. Columnar epithelium tissue is also modified for secretory function. If the cells are not secretory the nuclei are situated in the middle of the cells and if they are secretory the nuclei are at the base. The nucleus is oval in shape.

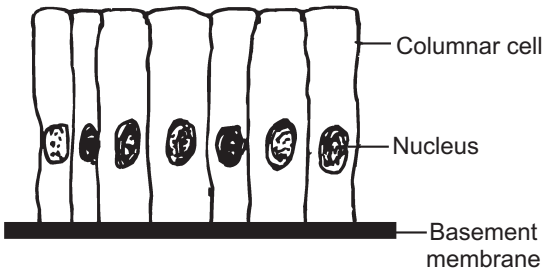
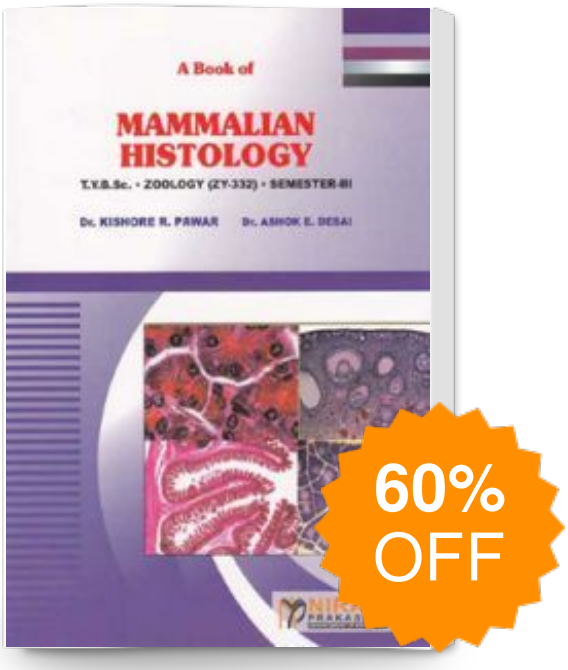


Fig. 2.4: Simple columnar epithelium

The columnar epithelium is found as a inner lining of stomach, intestine rectum, and ducts of glands. The cells protect the wet surfaces.

Mammalian Histology



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