



**UNSW**  
AUSTRALIA

Medical Sciences  
Medicine



**Department of Anatomy**

**ANAT 2241**  
**Histology: Basic and Systematic**  
**Semester 1, 2016**  
**Laboratory Handbook**

CRICOS Provider Code 00098G

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## UNITS OF CREDIT

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ANAT2241 Histology: Basic and Systematic is a 6UOC course. It is offered in the Anatomy major in the BSc and BMedSc programs. As a pre-requisite to PATH2201 Processes in Disease, it provides a vital link to the study of disorders when examined microscopically. Students need to understand normal histological morphology of cells, tissues and organs before they can appreciate pathological conditions of tissues under the virtual microscope.

### MODIFICATIONS TO THE COURSE IN 2014-2015

The 2 x 2 hour practical have been condensed into a single 3 hr session and the use of annotation has been refined through the use of the online system SLICE.

## COURSE AIM AND STUDENT LEARNING OUTCOMES

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The aim of this course is to provide students with a thorough understanding of the microscopic appearance and function of normal structures in the human body. This allows students to integrate this information with other disciplines such as Gross Anatomy, Pathology, and Physiology.

The **Basic Histology component** of the course will concentrate on the microanatomy of the **four basic tissues**, namely: epithelial tissue, including glandular tissue, connective tissue, muscular tissue, and nervous tissue. **Lectures** will provide you with an outline of the topic, but you are expected to supplement the information with private study. The **laboratory sessions** are directly linked to the lectures. At the end of each laboratory class, make sure you have covered, and understand, the specific objectives. Discussion during the class is encouraged. Each laboratory class may have one or more questions to be answered. These questions are meant to promote enquiry and discussion with the teachers acting as facilitators to guide you.

The **Systematic Histology component** of the course will investigate how these basic tissues combine to form **organs**, which operate together to maintain homeostasis. By

convention, organs, which work together to achieve a particular function are grouped together as **systems** (e.g. respiratory system, etc.). You are encouraged to use the computers during class and also for private revision. In addition, external virtual microscopy databases are continually being installed in the computers to allow greater access to a variety of microscopic material.

## **HISTOLOGY BACKGROUND**

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Anatomy is the study of the structure of organs and tissues at the **MACROSCOPIC (or gross) level**. Histology is the study of organ and tissue structure at the **MICROSCOPIC level** - it can be considered as microanatomy. Histology provides an insight into how cellular components are structurally and functionally related. It draws its foundations in Biochemistry, Molecular Biology and Physiology as well as Gross Anatomy.

Histology provides valuable information on why tissues and organs are shaped as they are. Histology is one of the bases of biomedical sciences. Modern histological techniques allow us to explore and gain an understanding of biochemical and physiological processes and how these are changed when structure is changed, as occurs, for instance, in many disease processes. By the end of this course, students should have a thorough understanding of the tissues and systems of the body by microscopic examination and to apply their knowledge to functional states examined in Physiology and diseased states examined in Pathology.

## **TEXTBOOKS**

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Several books provide adequate coverage of the material in this course. A number of suggestions have been included on the following list. An atlas on its own usually only covers the practical part of the course, so you will need access to a textbook to cover the theory part of the course.

### **Combined Texts and Atlas**

Young, B., O'Dowd, G. and Woodford, P. (2014)

*Wheater's Functional Histology. A Text and Colour Atlas* 6th ed. Churchill Livingstone, Edinburgh.

Meshner, A. (2013)

Junqueira's *Basic Histology Text & Atlas* 13<sup>th</sup> ed, McGraw-Hill.

### **Atlas**

Eroschenko, V.P. and di Fiore M.S.H. (2013)

*di Fiore's Atlas of Histology with functional correlations.* 12th ed Wolters Kluwer / Lippincott, Williams & Wilkins Int., Baltimore.

## ASSESSMENTS

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### 1. Practical exams

There will be TWO practical exams, a Mid-Session one (**Monday April 18**) and a Final practical exam at the end-of-Session.

### 2. Written examinations

There will be TWO written papers. The first one is in Mid-Session immediately before the Mid-Session Practical examination on **Monday April 18** and the second one is at the end of the Session.

ASSESSMENTS	MARKS
Mid-Session Practical Exam	10%
Mid-Session Theory Exam	20%
Final Practical Exam	30%
Final Theory Exam	40%

Practical and theory examinations are based on specific objectives, learning activities and lecture material. In practical examinations, you will be expected to be able to identify microscopic structures (cells and tissues) studied during the laboratory sessions as well as provide some brief functions. The examination is designed to test the understanding of the microscopic organisation of the normal tissues of the human body and relate them to their functional importance.

## STUDY AND REVISION FACILITIES

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The histology laboratories in rooms G06 and G07 of the Ground Floor of the Wallace Wurth building are generally open from about 8 am to 5.30 pm Monday to Friday.

They may be used by students during these hours, provided the rooms are not required for other classes. The laboratories are closed on weekends and public holidays. **Laboratory coats are NOT required in the histology laboratories. Food and drinks are NOT permitted in the laboratories.**

Please read this manual/outline in conjunction with the following pages on the

[School of Medical Sciences website:](#)

- [Advice for Students](#)
- [Learning Resources](#)

(or see "STUDENTS" tab at [medicalsciences.med.unsw.edu.au](http://medicalsciences.med.unsw.edu.au) )

## GENERAL ADVICE IN HISTOLOGY

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In Histology, you are expected to study the features of histological preparations as virtual images, which were scanned from real stained tissue sections, which were then mounted on glass slides and listed in the Learning Activities. Histological sections are slices of tissue usually from 5-8 $\mu$ m thick (see Dimensions).

**Low power sketches or notes made may help you to remember the main histological features of a section, e.g., which major tissue components are present.**

Note the 2-D shapes in the section and the major tissue components present and try to determine the approximate 3-D shape of the whole organ from which the section was taken. Is the section cut randomly through the organ?

Is there an obvious lumen in the section?

<b>Abbreviations:</b>	XS - cross section
	TS - transverse section
	LS - longitudinal section
	LM - light microscope or light micrograph
	EM - electron microscope, or electron micrograph

**Dimensions:** 1mm = 10<sup>3</sup> micrometres ( $\mu$ m) = 10<sup>6</sup> nanometres (nm)

*Note:* A micrometre is often called a "micron" ( $\mu$ m); 1 $\mu$ m = 10<sup>-6</sup>m

### Resolving Powers:

Unaided eye - approx. 0.1 mm = 100 $\mu$ m

Light microscope - approx. 0.1  $\mu$ m = 100nm

Electron microscope - approx. 1 nm

### Virtual Slides

The virtual histology slides for this and the subsequent practicals can be found at:

[moodle.telt.unsw.edu.au/course/view.php?id=21070](http://moodle.telt.unsw.edu.au/course/view.php?id=21070)

Student Key: Vslides

### Useful Histology resources to employ during the practicals or for revision

After entering the Menu, go to Class Program and then to Anatomy

- Fabric of Life
- Neocortex Virtual Microscope-Histology-Zurich
- Dr Lazer's Histology Drawings
- Digital Atlas of Electron Microscopy by J K Brueckner
- <http://www.histology-world.com/stains/stains.htm>

## **TIMETABLE**

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The course involves **5 hours per week** of instruction.

This involves 2 x 1-hour lectures followed by a 3-hour practical class where students under the guidance of demonstrators will employ a computer to examine virtual slides of microscopic material. Computers are shared between two to three students.

### **Lectures**

**Monday 4–5pm, Science Theatre**

AND

**Tuesday 5–6pm, Rex Vowels Theatre**

**(All lectures are conducted from Weeks 1 to 12).**

### **Laboratory Sessions**

#### **Group A**

Thursday 2–5pm, Rooms G6 & G7, Wallace Wurth Building

(Weeks 1 to 12)

#### **Group B**

Friday 10 am – 1 pm, Rooms G6, & G7, Wallace Wurth Building

(Weeks 1 to 12)

**Group B is repeated material, which was delivered in Group A.**

**NOTE:** You must remain in your allocated Laboratory timeslots.



<b>Histology of Basic Tissues and Systems</b>		
<b>Week</b>	<b>Lecture Dates</b>	<b>Lecture and Laboratory Class Topics</b>
1 A	29/2	Introducing the course
1 B	1/3	Covering and Lining Epithelia
2 A	7/3	Glandular Epithelia
2 B	8/3	Connective tissue I: Components
3 A	14/3	Connective tissue II: Types
3 B	15/3	Bone, Bone Formation and Joints
4 A	21/3	Blood
4 B	22/3	Muscle <b>NO PRACTICALS IN WEEK 4 DUE TO GOOD FRIDAY.</b> <b>MID-SESSION RECESS 28/3/16 TO 3/4/16</b>
5 A	4/4	Nervous tissue (PNS)
5 B	5/4	Nervous tissue (CNS)
6 A	11/4	Cardiovascular system
6 B	12/4	Respiratory system
7 B	18/4	Integumentary system <b>Immediately after this Monday lecture in Week 7 in the Science Theatre there will be the mid-session Theory and Practical examinations.</b>
8 A	29/4	Liver, Gallbladder and Pancreas
8 B	25/4	Gastro-intestinal system I (Due to ANZAC Day, this lecture can be viewed on line via Echo)
9 A	26/4	Gastro-intestinal system II
9 B	2/5	Lymphatic tissue and the Immune system
10 A	3/5	Endocrine system
10 B	9/5	Urinary system
11 A	10/5	Female reproductive system
11 B	6/5	Male reproductive system
12 A	17/5	Eye
13		<b>REVISION IN THE PRACTICAL TIME SLOTS</b> <b>Final Practical Examination (date, time and place to be announced)</b>

Science Teaching Laboratory

### Student Risk Assessment



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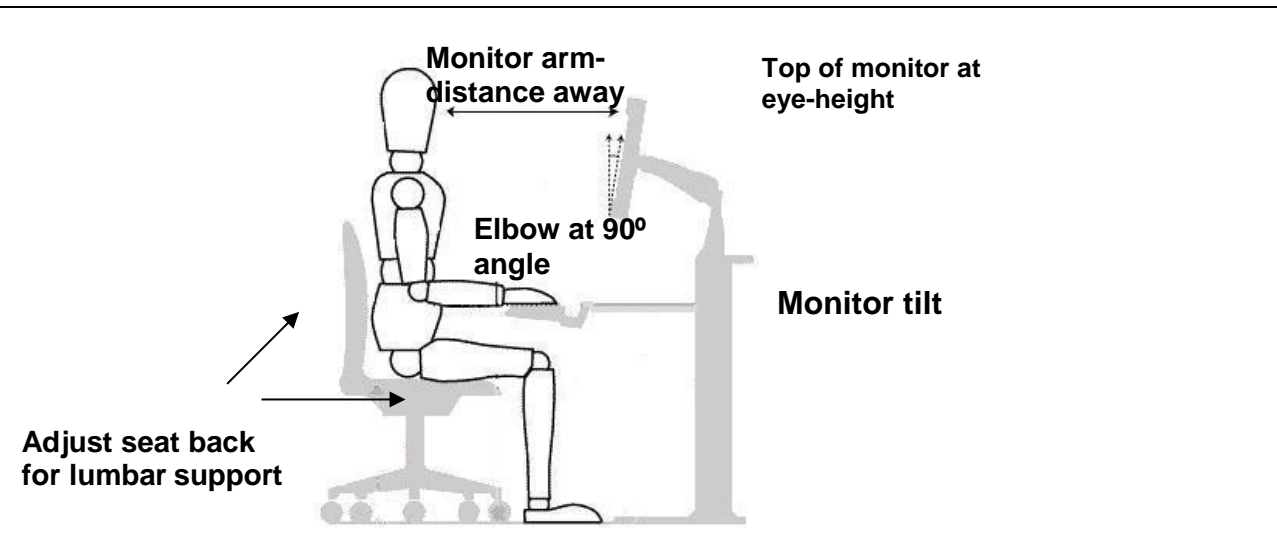
ANAT2241 in G6/G7 Wallace Wurth building

Practicals from weeks 1 to 12 in Semester 1, 2016.

Hazards	Risks	Controls
Ergonomics	Musculoskeletal pain.	Correct workstation set-up.
Electrical	Shock/fire	Check electrical equipment in good condition before use. All electrical equipment tested and tagged.

### Personal Protective Equipment

Not necessary in these practicals (see note).



### Emergency Procedures

In the event of an alarm, follow the instructions of the demonstrator. The initial sound is advising you to prepare for evacuation and during this time start packing up your things. The second sound gives instruction to leave. The Wallace Wurth assembly point is the lawn in front of the Chancellery. In the event of an injury, inform the demonstrator. First aiders and contact details are on display by the lifts. There is a First Aid Kit in the laboratory.

### Clean up and waste disposal

No apparatus or chemicals used in these practicals.

### Declaration

I have read and understand the safety requirements for these practical classes and I will observe these requirements.

Signature:.....Date:.....

Student Number:.....

## LAB WORKBOOK

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### **WEEK 1: TOPIC A: The Virtual Microscope, Histological Techniques, Artefacts, Stereology, Electron Microscopy And Cell Ultrastructure**

#### **THE VIRTUAL MICROSCOPE**

##### **General Objective**

An introduction to the use of the virtual microscope.

##### **Specific Objective and Learning Activities**

To learn the correct use of virtual microscopy using computers and to employ various virtual histological databases for enhancing learning as well as for revision purposes.

##### **The change from conventional to virtual microscopy**

Learning of histology and histopathology by undergraduate students in Medicine and Science at UNSW was limited by the technical and practical barriers imposed by conventional microscopy such as difficulty with mastering optimum focus and illumination, students being isolated at their own microscope limiting collaboration with peers and demonstrators, problems with loss or breakage of glass slides, differential staining and tissue section variability, many students were unable to view the same tissue/cells as those demonstrated by the lecturer causing students to become distracted and frustrated and histology and histopathology revision was limited by laboratory access out of class times.

UNSW was the first institution outside of North America (University of Iowa) to introduce virtual microscopy in undergraduate teaching. It started with the Department of Pathology converting their glass slide collection to virtual images in 2002. This makes UNSW the first institution outside of North America (University of Iowa) to employ virtual slides.

##### **What are virtual slides?**

High magnification scanned digital images of tissue sections on glass slides acquired using a x40 microscope lens stored in a multi-resolution file format and viewed in a web browser window with software capacity to “click and drag” and “zoom in” on the image, which simulates the examination of glass slides with a real microscope, but with the added benefits of always having optimal focus and contrast, with orientation maintained and avoiding section-to-section variability. This allows all students to examine the same scanned tissue section.

#### **HISTOLOGICAL TECHNIQUES**

**General Objective:** To understand the basic steps in preparing histological slides for light microscopy.

##### **Specific Objective**

To know the rationale and the procedures in preparing histological slides from biological specimens.

##### **Learning Activity**

Read sections below on General Hints on Staining Procedures.

## General Hints on Staining Sections

1. **Clearing** is a term used to refer to the stage where a section is immersed in a liquid, which is miscible with both paraffin wax and with alcohol (specifically, ethanol). The term arises because the tissue becomes transparent, due to the high refractive index of the clearing liquid (usually xylene).
2. **Dehydrate** means to remove water from the section, by soaking the section in increasing concentrations of alcohol (70%, 95%, and 100% also known as absolute alcohol). The converse procedure is usually described as "bringing the sections to water" or "rehydration".
3. **Differentiation** is the partial de-staining of a purposely overstained section by washing the section in a simple solution such as water, or dilute acid or dilute acid alcohol. It is a regressive step in the staining procedure whereby the water or alcohol simply redissolves the stain in the section. Acid alcohol is 1% hydrochloric acid in 70% alcohol. Differentiation preferentially removes the stain from sites where the dye is only loosely bound.
4. **Counterstaining** is the application of a second stain to the section to stain additional components of the tissue. Usually the second stain produces a complementary colour reaction to that of the first: e.g. Eosin after Haematoxylin.

## Summary of Stains

Although they are not examinable, you should have knowledge of some of the common histological stains as outlined below:

**Haematoxylin and Eosin (H&E)** is the most commonly used histological stain. It has 2 components. **Haematoxylin** is the main ingredient of a cationic (basic) stain, which appears black, blue or purple. It stains acidic structures particularly nuclei. Structures stained by Haematoxylin are said to be basophilic. **Eosin** is an anionic (acidic) dye, red in color. It stains tissues various tones of pink to red. In a well stained preparation, the following staining occurs: collagen, pale pink; cytoplasm, pink; cytoplasm of skeletal muscle; red; erythrocytes, bright red.

**Haematoxylin and Van Gieson** has 2 acidic dyes, namely **Picric acid** and **Acid Fuchsin**. Collagen is stained red by the acid Fuchsin, nuclei black by the Haematoxylin and all other tissue elements yellow by the Picric acid. It can be combined with Verhoeff's elastin to show elastic fibers as black.

**Romanowski** stains are used for blood. They consist of a mixture of dyes derived from Methylene Blue and Eosin. Objects are stained and described for 4 colours namely basophilic (blue), acidophilic or eosinophilic (red), azurophilic (purple) and neutrophilic (salmon pink).

**Osmium tetroxide** is used to stain lipids, e.g. in adipose tissue or myelinated nerve fibers. Unsaturated bonds in the lipids reduce the osmium tetroxide to black osmium.

**Periodic acid and Schiff's reagent (PAS)** show up carbohydrate groups (eg mucins, glycogen, glycocalyx) as pink or magenta. This is very useful for goblet cells and basement membranes.

## ARTEFACTS

Tissue is usually fixed and embedded in such material as paraffin, gelatine, resin etc. prior to sectioning. A range of knives (metal, glass, diamond) are used on various cutting machines -**microtomes** to obtain the sections.

As a result the tissue can sometimes be pushed out of shape and scratches, tears, or folds can appear. Excessive drying can create spaces that do not exist, and uneven thickness can cause unusual colouring effects. These extra features are called artefacts.

Virtual Slides	Description of Artefact
Kidney (LS), human	
Small intestine, (jejunum), primate	
Aorta (TS), human	
Trachea, human	
Tendon, cat	
Thyroid gland, primate	
Gall bladder, human	

## STEREOLOGY

### General Objective

To understand the principles of studying 3-dimensional shapes (morphology) of biological structures based on examination and interpretation of 2-dimensional light microscopic and electron microscopic images (stereology).

### Specific Objectives

1. To recognise the shapes found in sections of basic tissues using the light microscope. **A demonstration on virtual slides showing testes, (LS, cat), kidney tubules (human kidney, LS) and of motor cells in the spinal cord (ox) will clarify this.**
2. To summarize the main problems in the interpretation of histological sections, including the reconstruction of 3-dimensional form and the interpretation of artefacts.

A histologist needs to think geometrically so as to build a 3-dimensional picture of a structure, which is essentially 2-dimensional. This is an important skill to develop. Remember that the structure of the tissue is intimately related to its function; therefore the 3-D reconstruction is an important step to understanding the function of a particular tissue. A section contains numerous elements cut at different angles, common terms used to describe the orientation of planes of section are: **transverse, longitudinal, and oblique.**

## ELECTRON MICROSCOPY AND CELL ULTRASTRUCTURE

**General Objectives:** To understand electron microscopic techniques and recognise the structure of basic cell organelles

### Specific Objectives:

1. To understand the differences between what is viewed under the light microscope and the electron microscope.
2. To recognise the most important organelles viewed in electron micrographs (EM) and to appreciate the correlation between their ultrastructure and their light microscopic (LM) structure.

### Learning Activities:

Examine the following light microscope virtual slides, identify, draw and label the structures and note their function.

Virtual Slides	Tissue	Structures	Drawing
Blood Smear	Human (Buffy Coat)	Erythrocytes Platelets Leucocytes	
Spinal cord	Ox	Motor neuron Nucleus Nucleolus Cell membrane Nuclear envelope Nissl granules	

After viewing the light microscopic features outlined above in the virtual slides of blood and the spinal cord, you should examine the EM equivalent structures using the Digital Atlas of Electron Microscopy and your histology textbook(s).

**Examine electron micrographs** and make sure you understand the EM appearance and structure of: nucleus, nucleolus, nuclear envelope, nuclear pore, mitochondria, endoplasmic reticulum (smooth & rough), ribosomes, Golgi apparatus, lysosomes, microtubules, microfilaments, plasma (cell) membrane, microvilli, stereocilia, cilia, and junctional complexes.

Virtual Slides	Tissue	Structures	Drawing
Small intestine, primate	Jejunum	Microvilli (striated, brush border) Goblet cells	
Trachea, human	Tracheal wall	Cilia	

**Again examine the EM equivalent appearance of the LM structures shown in the small intestine and trachea, namely microvilli, Goblet cells and cilia.**

**Question:** Draw a typical cell and include many of the cell organelles described above.

**Question:** What do Nissl granules represent under the electron microscope?

## WEEK 1: TOPIC B: Covering and Lining Epithelia

### General Objective

To learn the structure and function of covering and lining epithelia.

### Specific Objectives

1. To identify covering and lining epithelia.
2. To understand the terms endothelium, and mesothelium.
3. To classify epithelia on the basis of cell morphology and cell arrangement (e.g. layering), noting the general absence of blood vessels in epithelia.
4. To study the surface specializations of some epithelial cells: brush or striated border (microvilli) and motile cilia and to recognise these specialisation in electron micrographs.

### Learning Activities

To identify, draw and label the various types of epithelium (simple, stratified and pseudostratified) and to discuss some of the special functional features associated with their structure.

#### 1. Simple epithelium.

Simple epithelium consists of a single layer of cells covering a tissue. It is usually found lining structures such as blood vessels, ducts or glands. The cells may be flattened (squamous), cuboidal or columnar according to their function. The epithelium is classified according to the shape of the cells:

##### A. Simple squamous epithelium:

The lumen of blood vessels of all sizes is lined by a single layer of squamous endothelial cells providing a smooth, low-friction surface to circulating blood cells (**virtual slides of human aorta**). In the **virtual slide of rat kidney**, Bowman's capsule is lined with a layer of simple squamous cells called the *mesothelium* indicating their origin.

##### B. Simple cuboidal epithelium:

Thyroid follicles are lined a single layer of cuboidal cells (**virtual slide of primate thyroid gland**).

**Describe** the position of the nuclei within the cell.

*Note:* These cells are secretory cells, and the height of the cell in the follicles indicates activity. Low cuboidal cells have low level activity.

The simple cuboidal epithelium in the tubules of a kidney has an absorptive function (**virtual slide of rat kidney**).

In this virtual slide, note the basement membrane (purple-red) and the brush border (microvilli), which is characteristic of absorptive cells.

##### C. Simple columnar epithelium (virtual slide of human gallbladder):

**Question:** Where is the nucleus found in columnar cells?



2. **Pseudostratified epithelium (virtual slide of human trachea).**

All the epithelial cells in pseudostratified epithelium make contact with the basement membrane, but not all cells reach the surface of the epithelium. This may be quite difficult to visualise, **discuss** the reasons for this.

The cells may be ciliated (**trachea**).

3. **Stratified epithelium (virtual slides of human oesophagus, and human thick skin (palm))**

Stratified epithelium has a least 2 distinct layers of cells. The basal layer is in contact with the basement membrane the other(s) is/are on top. The uppermost (apical) layer classifies the epithelium as squamous, cuboidal or columnar.

**Examine** the slides listed and **classify** each type of epithelium. Examine the epithelium in the sweat gland ducts in the **virtual slide of thick skin**.

Epithelial type	Example	Function
Stratified squamous		
Stratified cuboidal		

**Stratified squamous epithelium may be keratinized (cornified) or non-keratinized.**

**Question:** Describe the structural and functional differences between keratinized and non-keratinized epithelium.

4. **Transitional epithelium (virtual slide of primate urinary bladder)**

Transitional epithelium is only found in a few places in tissues subject to periodical stretch/relaxation, as for example in the urinary tract. It may be stratified or pseudostratified, Note that the cell shape in the luminal region is different when the bladder is stretched compared to when it is relaxed.

**Question:** Describe the difference between the relaxed and the stretched state?

The cell cytoplasm has vacuoles when relaxed which disappear when stretched.

## WEEK 2: TOPIC A: Glandular Epithelia

**General Objective:** To recognise exocrine and endocrine glandular epithelium.

### Specific Objectives

1. To know the morphological characteristics of mucous and serous secretory cells.
2. To identify the following types of exocrine glands: unicellular (Goblet cell), secretory sheet, simple tubular (straight and coiled), simple and branched alveolar (acinar) glands, compound tubular and tubulo-alveolar (tubulo-acinar) glands.
3. To recognise the different arrangement of endocrine glands when compared to exocrine glands.

### Learning Activities

The arrangement of the gland cells and the presence or absence of branched ducts.

Examine the following virtual slides, identify draw and label the following types of glands.

Virtual Slides	Gland type	Features	Drawing
<b>Soft palate, dog</b>	Unicellular on nasal surface	Goblet cells  Mucous secreting glands and ducts	
<b>Stomach body, primate</b>	Secretory sheet	Mucous producing epithelial cells in all surface cells	

Virtual Slides	Gland type	Features	Drawing
<b>Small intestine (jejunum), primate</b>	Simple tubular	Straight, no branching duct	
<b>Skin (thick, palm), human</b>	Simple coiled tubular	Sweat gland Compare duct (darker) with secretory (lighter) part	
<b>Stomach (pylorus), primate</b>	Simple branched tubular	Branched tubules	
<b>Skin (thin, scalp), human</b>	Simple branched Alveolar Simple coiled tubular	Sebaceous glands  Sweat glands	
<b>Skin (thin, axillary), human</b>	Apocrine sweat glands	Myoepithelial cells	

**Question:** What epithelium lines the duct of sweat glands?

Virtual Slides	Gland type	Features	Drawing
<b>Salivary gland (submandibular), human</b>	Compound tubulo-acinar	<p>Serous acini</p> <p>Mucous acini</p> <p>Serous demilunes</p> <p>Interlobular ducts</p> <p>Striated ducts or / Intralobular ducts</p> <p>Intercalated ducts</p>	
<b>Pancreas, human</b>	Compound acinar	<p>Serous acinar</p> <p>Zymogen granules</p> <p>Centro-acinar cells</p>	
<b>Pancreas, human</b>	Endocrine	<p>Islets of Langerhans paler staining "islands" with a rich capillary network</p>	

**Question:** Describe the structural differences between exocrine and endocrine glands and how it affects their mode of secretion.

## WEEK 2: TOPIC B: Connective Tissue I: Components

### General Objective

To recognise various components of connective tissue and understand their functions.

### Specific Objectives

1. To understand the structure and functions of the cell types found in connective tissues: fibroblasts and fibrocytes, macrophages, plasma cells, mast cells, lymphocytes.
2. To understand the connective tissue fiber constitution and function of reticular, elastic, areolar or loose fibrous tissue and dense fibrous tissue.
3. To recognise the different types of general connective tissue, loose, dense irregular, dense regular.
4. To understand the origin of tissue fluid and intercellular ground substance.

### Learning Activities

Examine the following virtual slides and identify, draw & label features and note their function.

Virtual Slides	Tissue	Features	Function	Drawing
<b>Mesentery, rat and Liver (phagocytosis), rat</b>	Loose connective	Elastic fibres (branching) Collagen Fibroblasts Macrophages (slide of liver, rat) Mast cells Mesenchymal cells		
<b>Stomach (pylorus), primate and Salivary gland (submandibular), human</b>	Loose connective: e.g. lamina propria	Fibroblasts  Lymphocytes  Plasma cells with eccentric nuclei in salivary gland		

Virtual Slides	Tissue	Features	Function	Drawing
<p><b>Liver, rabbit and Lymph node, cat</b></p>	Reticular connective tissue	<p>Reticular fibers (black)</p> <p>Collagen (stained blue)</p> <p>Reticular fibers in the cat lymph node</p>		
<p><b>Neurovascular bundle, primate</b></p>	Elastic fibers	<p>In artery wall.</p> <p>Crenated &amp; fenestrated</p>		
<p><b>Skin (thick, palm), human</b></p>	Dense irregular	<p>Collagen bundles</p> <p>Adipose tissue</p> <p>Delicate elastic fibres</p> <p>Fibroblasts</p>		
<p><b>Tendon, cat</b></p>	Dense regular connective tissue	<p>Collagen bundles</p> <p>Fibrocytes</p>		

## WEEK 3: TOPIC A: Connective Tissue II: Types

### Specific Objectives

1. To recognise the histological appearance of mesenchymal and mucoid connective tissue, and revise loose and dense fibrous connective tissue.
2. To recognise adipose tissue (white and brown fat) and understand its functions.
3. To recognise the histological appearance of the different forms of cartilage: hyaline, elastic and fibrocartilage.
4. To understand the role of the perichondrium in the formation of cartilage, and the mechanisms of appositional and interstitial growth.

Examine the following virtual slides. Identify, draw and label the main features and note their function.

Virtual Slides	Tissue	Features	Function	Drawing
<b>Neonatal head, rat</b>	Mesenchyme	Undifferentiated cells Fine collagen fibers		
<b>Subscapular region, rat, Peripheral nerve, cat</b>	Adipose	White, unilocular  Brown, multilocular  (Note difference in appearance of cytoplasm, size of cells & position of nuclei)		
<b>Trachea, human</b>	Hyaline cartilage	Chondroblasts  Chondrocytes  Lacunae  Cell nests (isogenic groups)  Matrix (territorial & interterritorial)  Perichondrium (fibrous and cellular)		

Virtual Slides	Tissue	Features	Function	Drawing
<b>Epiglottis, dog &amp; Ear, human</b>	Elastic cartilage in ear pinna	Elastic fibres  Chondrocytes  Lacunae  Cell nests  Perichondrium Adipose		
<b>Vertebrae, cat</b>	Fibrocartilage in IV disc (vertebrae)	Chondrocytes  Cartilage matrix  Fibroblasts  Collagen		

**Question:** How does articular cartilage differ from normal hyaline cartilage?



## WEEK 3: TOPIC B: Bone, Bone Formation and Joints

### General Objective

To recognise bone and understand its structure and understand the processes by which bone can be formed. To know the structure of a synovial joint and a symphysis joint (intervertebral disc).

### Specific Objectives

1. To know the architecture of compact and spongy (cancellous) bone, the structure of the Haversian system (osteon), the importance and position of Haversian and Volkmann's canals, interstitial systems.
2. To understand the arrangement of compact and spongy bone in a long bone.
3. To differentiate between osteoblasts, osteocytes and osteoclasts and understand their roles in bone formation.
4. To identify and describe the processes of intramembranous and endochondral bone formation
5. To identify the components of a symphysis joint (intervertebral disc).
6. To identify the components of a synovial joint.

### Learning Activities

Examine in the following virtual slides. Identify, draw & label the following structures and note their function.

Virtual Slides	Tissue	Features	Function	Drawing
<b>Bone (ground, TS), adult human</b>	Compact bone	Haversian systems (osteons)		
		Concentric lamellae		
		Interstitial lamellae		
<b>Bone (ground, LS), adult human</b>		Circumferential lamellae		
		Osteocytes		
<b>Bone (TS, femur), adult</b>		Radial canaliculi		
		Periosteum		
		Endosteum		
		Volkmann's canals		
		Haversian canals		

Virtual Slides	Tissue	Features	Function	Drawing
<b>Neonatal rat head</b>	Intra-membranous ossification	Osteoblasts Osteocytes Osteoclasts  Trabeculae Blood vessels		
<b>Femur, (developing) cat and neonatal tail, rat</b>	Endochondral ossification	Zone of reserve cartilage  Zone of proliferation  Zone of maturation and hypertrophy  Zone of calcification and cell death  Periosteal collar  Periosteum and perichondrium		

Note also the **nucleus pulposus** and the formation of intervertebral ligaments between the ends of adjacent tail vertebrae.

<b>Femur (developing) cat</b>	Developing long bone	Diaphysis  Epiphysis  Zones of metaphysis (Endochondral ossification)  Hyaline cartilage  Articular cartilage		
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Examine perforating blood vessels in cartilage undergoing ossification and the absence of capillaries in hyaline and articular cartilage.

## JOINTS

Examine in the following virtual slides. Identify, draw & label the following structures and note their function.

Virtual Slides	Tissue	Features	Function	Drawing
<b>Vertebrae, cat</b>	Symphysis joint (developing)  Intervertebral disc  Bone of vertebrae	Nucleus pulposus  Anulus fibrosus  Hyaline cartilage  Cancellous (spongy) bone		
<b>Knee joint, kitten</b>	Synovial joint (Knee joint)	Patella (unossified)  Articular cartilage  Synovial cavity  Synovial membrane  Articular capsule  Cruciate ligaments		

**Note:** Observe adipose tissue associated with the lamina propria of the synovial membranes.

**Question:** What is the difference between periosteum and endosteum?

**Question:** What is the function of adipose tissue in and around a joint?

**Question:** What is (are) the major difference(s) between bone and cartilage?

## WEEK 4: TOPIC A: Blood and Blood Formation

### General Objective

To know the formed elements of human blood and to appreciate that blood could be regarded as a “tissue” in which plasma constitutes the intercellular substance.

### Specific Objectives

1. To differentiate blood cells on the basis of morphology and staining properties.
2. To understand the principles of blood formation and the tissues and cells involved.

Note the following tables:-

Leucocytes in peripheral blood (Australian data)		
Cell type	Numbers	Diameter
Neutrophils	40 - 75%	10 - 12µm
Lymphocytes	10 - 45%	7-8 & 12 µm (small & large)
Monocytes	2 - 10 %	10 - 15 µm
Eosinophils	1 - 6 %	10 - 15 µm
Basophils	<1%	10 - 15 µm

Leucocyte distribution (steady state)		
38%	undergoing maturation at site of formation	
57%	outside blood vessels e.g. in connective tissue, spleen etc.	
5%	in circulating blood	

Note that the Leucocyte: Erythrocyte ratio is about 1:1000 (normally)

### Learning activities

Examine the virtual slides in the following table, identify draw and label the different blood cell types. Note whether the leucocytes or white blood cells (WBC) are granular or not.

For each WBC, carefully note the shape of the nucleus, the relative amount of cytoplasm compared to the size of the nucleus, and the relative size of each cell type compared to erythrocytes or red blood cells (RBC).

Virtual Slide	Cell type	Granules	Drawing
<b>Blood smear, and (buffy coat), human</b>	Erythrocytes		
	Neutrophils		
	Lymphocytes		
	Monocytes		
	Eosinophils		
	Basophils		
	Platelets		

Note that RBC's are normally found in blood vessels (arteries, veins, capillaries). White blood cells are most often found outside blood vessels.

Virtual Slides	Cell Types	Function	Drawing
<b>Stomach (pylorus), primate</b>	Lymphocytes		
	Tissue eosinophil		
<b>Femur (developing), cat and Femur (adult), cat</b>	Blood vessels		
	Fat droplets		
	Sinusoids		
	RBC		
	Megakaryocytes		
<b>Head (neonatal rat)</b>	Red blood cells with nuclei		
<b>Chronic gastric ulcer</b>	Good for tissue eosinophils		

**Question:** Which tissues have very large numbers of white blood cells and why?

**Question:** Which is the most common type (s) of white blood cell (s) found in tissues?  
Why?

**Question:** What is the function of various blood cells?

## **WEEK 4: TOPIC B: Muscle**

### **General Objective**

To know the structure and ultrastructure of the three main types of muscle and how it relates to their varied functions.

### **Specific Objectives**

1. To identify striated skeletal (striated), cardiac and smooth muscle on the basis of histological features.
2. To distinguish connective tissue in association with muscle cells and fascicles of muscle cells.
3. To describe the ultrastructural features of the different types of muscle cells.

### **Learning Activities**

Examine **electron micrographs** of skeletal muscle in longitudinal section (LS) and identify the following features:

1. A band (dark staining; anisotropic)
2. I band (light staining; isotropic)
3. H band (pale zone in centre of A band)
4. M line in centre of H band
5. Z discs (in centre of I band) delineating the sarcomere
6. Sarcoplasmic reticulum
7. T tubules (transverse tubular system) and triads.

**Question:** What is the significance of the various bands?

**Draw a model of striated skeletal muscle** showing how the filaments are arranged in a sarcomere and label the various bands. Show how these change when the muscle contracts.

**Question:** What are thin filaments and thick filaments composed of?

View the electron micrographs showing striated muscle in longitudinal section. Each myofibril has a regular spaced arrangement of thick and thin filaments. Skeletal muscles are composed of a mixture of fast and slow fibres. Fast, or white, fibres give very rapid and very powerful muscle contractions for short periods (sprinting). Slow, or red, fibres give prolonged, continuous muscle activity (marathons!). The proportion varies from muscle to muscle and from person to person for the same muscle.

Now examine the following virtual slides and identify the features:

Virtual Slides	Tissue	Features	Drawing
<b>Tongue, rabbit and Tongue, primate and Toad</b>	Striated muscle LS & TS	A band I band Endomysium Perimysium Nuclei	
<b>Small intestine, primate, &amp; Gallbladder, human, &amp; Neurovascular bundle, primate</b>	Smooth muscle. LS & XS	Spindle-shaped cells  Nuclei (some show a corkscrew contraction)  Endomysium  Collagen fibres	
<b>Oesophagus, human</b>	LS & TS (middle third)	Smooth muscle  Striated muscle	
<b>Left ventricle, human &amp; IV septum, sheep, &amp; Cardiac muscle, rat</b>	Cardiac muscle. LS & XS	Nuclei position Striations Intercalated discs Purkinje fibres Branching fibres Capillaries	

**Question:** What are Purkinje fibres and what is their function?



Examine electron micrographs of cardiac and smooth muscle. Compare and contrast the ultrastructure of skeletal, cardiac and smooth muscle.

	<b>Skeletal muscle</b>	<b>Cardiac muscle</b>	<b>Smooth muscle</b>
<b>Features</b>			
<b>Drawing</b>			

## WEEK 5: TOPICS A and B: Nervous Tissue (PNS & CNS)

**General Objective:** To understand the main histological features of the peripheral and central parts of the nervous system (PNS and CNS).

### Specific Objectives

1. To know the histological features of peripheral nerves in cross, oblique and longitudinal section.
2. To identify peripheral nerves in routinely stained sections of various organs.
3. To know the structure of muscle spindles, Pacinian and Meissner's corpuscles.
4. To know the ultrastructure of a CNS synapse and the morphology of the neuromuscular junction.
5. To distinguish between the components and location of grey and white matter, using the spinal cord and cerebellum as examples.
6. To describe the parts of the neurone: perikaryon (soma), dendrites, axon, axon hillock, and dendritic spines.
7. To identify large multipolar neurones in the ventral horn of the spinal cord, Purkinje neurones in cortex of cerebellum, multipolar neurones in peripheral autonomic ganglia and pseudounipolar neurones in sensory ganglia.
8. To know the basic histological features of astrocytes, oligodendrocytes, microglia and ependymal cells.
9. To identify the nucleus of astrocytes and oligodendrocytes.

### Learning Activities

Examine the following virtual slides and draw and label the features listed and state their function(s):

#### Peripheral nerves:

Virtual Slides	Tissue	Features	Function and Drawing
<b>Peripheral nerve, cat, &amp; Peripheral nerve, rat &amp; Sciatic nerve, cat</b>	Peripheral nerve XS & LS  <b>Note:</b> not all features are shown in each slide	Fascicles Epineurium Perineurium Endoneurium Vasa nervorum Collagen & fat Myelinated & Unmyelinated fibres Neurokeratin Schwann cells Nodes of Ranvier	

Virtual Slides	Tissue	Features	Function and Drawing
<b>Gallbladder, human &amp; Small intestine, primate</b>	Nerve bundles	Fascicles between muscle fibres and Auerbach's plexus(myenteric)	

### Nerve endings

Virtual Slides	Tissue	Features	Function	Drawing
<b>Subscapular muscle, rat</b>	Muscle Spindle	Intrafusal fibres Extrafusal fibres Capsule Nerve		
<b>Skin, human</b>	Thick skin (palm)	Pacinian corpuscle  Meissner's corpuscle		

**A slide of the neuromuscular junction (NMJ) will be demonstrated.**

### Peripheral ganglia:

Virtual Slides	Tissue	Features	Function and Drawing
<b>Trigeminal ganglion, cat</b>	Sensory Trigeminal ganglion	Pseudounipolar somata Nuclei (central) Satellite cells Axons Axon hillock Neurokeratin	
<b>Sympathetic ganglion, human</b>	Autonomic ganglion	Multipolar cell Nuclei (eccentric) Lipofuscin pigment Satellite cells	

### WEEK 5: TOPIC B: Central Nervous Tissue

Examine the following virtual slides and draw and label the features listed and state their function(s):

Virtual Slides	Tissue	Features	Function and Drawing
<b>Spinal cord, ox and Spinal cord, cat</b>	Spinal cord (XS)	Grey and white matter Ventral & dorsal horns Central canal lined by ependymal cells Pia mater Arachnoid mater Subarachnoid space with dorsal and ventral rootlets and blood vessels Dura mater Motor neurones Nucleus and nucleolus Nissl granules Axon hillock Axons, dendrites Astrocytes Oligodendrocytes	
<b>Cerebellum, cat</b>  <b>Cerebrum, human</b>	Cerebellum  Brainstem portion of the cerebellum  Cerebrum	<b>Following layers:</b> Molecular Purkinje Granular Pia and Arachnoid Choroid plexus & fourth ventricle Grey & white matter Astrocytes, Oligodendrocytes Blood vessels	

**Question:** What are astrocytes and oligodendrocytes and where will you find them?

**Question:** What is the function of an **astrocyte** and an **oligodendrocyte**?

**Question:** How does the arrangement of grey and white matter differ in the spinal cord and brainstem?

Examine the electron micrographs and identify the following features:

- 1. Peripheral nervous system:** Myelinated axon, myelin, unmyelinated axon, Schwann cells, and synaptic vesicles.
- 2. Central nervous system:** Synapses, synaptic vesicles, synaptic cleft.

# SYSTEMS HISTOLOGY COMPONENT

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## WEEK 6: TOPIC A: Cardiovascular System

### General Objective

To know and recognise the histological structure of blood vessels and the heart and to relate vascular structure to function.

### Specific Objectives

1. To know the basic architecture of vascular structures.
2. To identify the tunica intima, tunica media and tunica adventitia in arteries and veins.
3. To describe the types of capillaries and sinusoids and their light and electron microscopic features.
4. To know the histological features of the epicardium, myocardium and endocardium.

### Learning Activities

Examine the following virtual slides, identify, draw, label and give the functions of the following structures:

Virtual Slide	Tissue	Structure	Function	Drawing
<b>Aorta (TS), human</b>	Wall of the aorta	Tunica intima Tunica media Elastic laminae Smooth muscle cells Collagen Tunica adventitia Vasa vasorum Adipose tissue Nervi vasorum Lymphatics (i.e. thoracic duct)		

**Question:** What type of adipose tissue is found around the aorta?

**Question:** Why does the aorta have so many elastic laminae?

Virtual Slide	Tissue	Structure	Function	Diagram
Vena cava, human	Vena cava	Tunica intima Tunica media Tunica adventitia Vasa vasorum Longitudinal smooth muscle		

**Note:** The intimal, medial and adventitial layers are present in veins but less clearly demarcated than in arteries.

**Question:** Describe the differences in the distribution of smooth muscles fibres between the aorta and the vena cava and relate this to the function of these vessels.

Virtual Slides	Tissue	Structure	Function	Diagram
Neurovascular bundle, primate	Muscular artery	Tunicae (as above) Internal elastic lamina. External elastic lamina (more diffuse)		

**Question:** Compare structurally, an elastic artery (e.g. aorta) and a muscular artery and relate the structural differences to their function.

Virtual Slides	Tissue	Structure / Function	Diagram
<b>Gallbladder, human</b>	Arteries Arterioles Veins Venules  Lymphatics	Compare the distribution of tunicae in these structures  Valves if present	
<b>Aorta, human</b>	Capillaries	Endothelium	
<b>Liver (reticular fibers), primate</b>	Sinusoids	Reticular fibres (liver slide)	

**Question:** Discuss how the structural differences between arteries, veins and capillaries are related to their varying functions

Virtual Slides	Tissue	Structure / Function	Diagram
<b>Left ventricle, human and Cardiac muscle, rat</b>	Heart	Epicardium Myocardium Endocardium Coronary vessels Trabeculae carnae  Chordae tendinae	

Examine electron micrographs of the various types of capillaries.

## WEEK 6: TOPIC B: Respiratory System

### General Objective

To know the histological components of the conducting and respiratory portions of the respiratory system.

### Specific Objectives

1. To know the cytology of the nasal cavity and upper respiratory tract.
2. To know the structure of the trachea and extrapulmonary bronchi.
3. To know the microanatomy of the lung and histological features of intrapulmonary bronchi, bronchioles, terminal bronchioles and respiratory bronchioles.
4. To know alveolar ducts and alveoli, and the ultrastructure of their walls.

### Learning activities

Examine the following virtual slides, identify, draw and label the following structures and note their function:

Virtual Slides	Tissue	Structure	Function	Diagram
<b>Nasal cavity, primate</b>	Nasal cavity	Respiratory & olfactory epithelium Basement membrane Olfactory nerves Olfactory glands (Bowman's) Conchae (turbinates) Bone & cartilage Blood vessels		
<b>Neonatal, rat</b>	Neonatal rat (LS)	Venous sinuses Olfactory nerves Cribriform plate		
<b>Soft palate, dog</b>	Soft palate	Respiratory epithelium on one side with Goblet cells Diffuse lymphatic nodules  Non-keratinized stratified squamous epithelium on the other side.		

**Question:** Give the full classification of respiratory epithelium and how does it differ from olfactory epithelium?



**Question:** What is the function of the conchae?

Virtual Slides	Tissue	Structure	Function	Diagram
<b>Larynx, human</b>	Larynx	Vestibular fold (false cord) Vocal fold (true cord) Vocal ligament Laryngeal ventricle (of Morgagni) Glands Thyroid & cricoid cartilages Vocalis muscle Epithelium types		
<b>Trachea, human</b>	Trachea	Epithelium Lamina propria Muco-serous glands Smooth muscle (trachealis) Blood vessels Hyaline cartilage		

Virtual Slides	Tissue	Structure	Function	Diagram
Lung, cat	Lung	Intrapulmonary bronchus  Bronchioles (Terminal and Respiratory)  Hyaline cartilage plates  Smooth muscle  Muco-serous glands  Alveolar duct  Alveoli  Pneumocytes Types I & II  Blood vessels  Dust cells (alveolar macrophages)		

Examine electron micrographs of respiratory epithelium and lung.

Identify pulmonary capillary endothelium; pneumocytes (types I and II); basal laminae.

Examine scanning electron micrographs of trachea and lung.

**Question:** What is the function of a dust cell? Is it sedentary or motile?

## WEEK 8: TOPIC A: Integumentary System (Skin)

### General Objective

To know the structure and function of skin and its appendages (derivatives).

### Specific Objectives

1. To know the microscopic structure of the epidermis, dermis and hypodermis.
2. To know the histological differences between hairy (thin) and glabrous (thick) skin.
3. To know the formation and histology of skin appendages: eccrine and apocrine sweat glands, sebaceous glands, hairs, nails and specialised glands.
4. To know the histological features of Pacinian and Meissner corpuscles and free nerve endings.

### Learning activities

Examine the following virtual slides, identify draw and label the following structures and note their function

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Skin (palm), human</b>	Thick skin	Epidermis containing keratinocytes Dermal papillae Epidermal pegs Dermis with collagen, elastic, fibers, fibroblasts, and lymphocytes Hypodermis with adipose Layers (strata) of epidermis E) Corneum D) Lucidum C) Granulosum B) Spinosum A) Basale  Pacinian corpuscle Meissner's corpuscle  Sweat glands & ducts		

**Question:** What does the term 'stratum germinativum' refer to?

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Skin (scalp, LS &amp; TS), human</b>	Thin (hairy) skin	Hair follicles  Hair  Hair bulb  Dermal papillae  Hair shaft: Medulla & Cortex  Erector pili muscle  Eccrine sweat glands  Sebaceous glands		
<b>Skin (axillary), human</b>	Hairy thin	Apocrine sweat glands  Sebaceous glands  Myoepithelial cells  Eccrine sweat glands  Hair follicles		

**Question:** What is the difference between the epithelium of thick (glabrous) and thin (hairy) skin?

**Question:** What are the structural and functional differences between apocrine and eccrine sweat glands?

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Lip, human</b>	Lip	Skin surface  Mucosal surface  Red (vermilion) margin  Orbicularis oris muscle  Mucoserous glands  Sebaceous & sweat glands  Hair follicles		
<b>Finger (neonatal, LS), human</b>	Digit	Nail matrix  Blood vessels  Eponychium  Nail bed  Hyponychium  Nail  Bone & Bone Marrow  Dermis & Epidermis  Epidermal pegs		

## WEEK 8: TOPIC B: Liver, Gallbladder and Pancreas

### General Objective

To know the histological structure and major functions of the liver, gall bladder and pancreas.

### Specific Objectives

1. To know the histology of the liver, including the hepatic lobule, portal area, and histological features of the vascular and biliary systems.
2. To appreciate the 3-D arrangement of hepatocytes and know their major functions.
3. To know the histological features of the wall of the gallbladder.
4. To know the histological features of the exocrine and endocrine pancreas.

### Learning Activities

Examine the following virtual slides, identify, draw and label the following features.

Discuss and make a note of their function(s).

Virtual Slides	Tissue	Structure	Function	Drawing
Liver, pig,	Liver	Hepatic lobule		
Liver, human,		Portal area (triad)		
Liver, primate,		Central vein		
Liver (reticular fibers), primate		Sinusoids		
Liver (phagocytosis), rat		Hepatocytes		
		Bile canaliculi and fat vacuoles in hepatocytes (in primate liver slide)		
		Kupffer cells (in rat liver slide)		
	Reticular fibres (in primate liver slide)			
	Capsule (Glisson's) (in human liver slide)			

**Question:** What is the major difference between the pig liver and the human liver?



## WEEK 9: TOPIC A: Gastro-Intestinal System I

### General Objectives

1. To know the histological features and functions of the oral cavity and its associated structures.
2. To know the general organization of the alimentary tract and the histological features of its various anatomical subdivisions: oesophagus, stomach, duodenum, small intestine, large intestine, appendix and rectum.

### Specific Objectives

1. To know the microanatomy of the tongue, including epithelial types, muscles, glands, papillae and taste buds.
2. To know the histological features of the submandibular gland.
3. To know the general architecture of the wall of the alimentary tract and the functions of the mucosa, submucosa, muscle layer and serosal or adventitial layer in the various anatomical divisions of the canal.
4. To know the structure of the oesophagus, cardio-oesophageal junction and stomach wall.
5. To identify the cells of gastric epithelium and distinguish the histological features of the cardiac, body and pyloric regions of stomach.
6. To know the histological features of the duodenum and ileum, including villi, intestinal mucosal glands (crypts of Lieberkuhn), lymphatic tissue and intramural nerve plexuses.
7. To know the structure of the large intestine, appendix and rectum.

### Learning activities: Mouth, oesophagus & stomach

**Note:** The lip and soft palate have already been studied and will not be repeated here. You are reminded however, that they are part of the oral structure.

Examine the following virtual slides, identify, draw and label the following structures and note their function.

Virtual Slides	Tissue	Structure	Function	Drawing
Tongue, human, Tongue, rabbit and Tongue (filiform papillae), human	Tongue	Papillae Circumvallate Fungiform Foliate Filiform Taste buds Von Ebner's glands  Muscle fibres Nerves and blood vessels		

**Question:** What type of glands are von Ebner's glands ?



Virtual Slides	Tissue	Structure	Function	Drawing
Salivary gland, human	Submandibular	Serous acini Mucous acini Serous demilunes Lobes Lobules CT Septa  Ducts A) Intercalated  B) Striated (Intralobular)  C) Interlobular  Blood vessels		

**Question:** What is the function of the glands?

**Question:** Describe the epithelium found in the larger intralobular and interlobular salivary ducts.

Virtual Slides	Tissue	Structure	Function	Drawing
Oesophagus, human	Oesophagus (mid region, TS & LS)	Epithelium Submucosa Muscularis mucosa Meissner's plexus Muscularis externa Smooth muscle Striated muscle Auerbach's plexus (myenteric)		

<b>Oesophagus/ stomach, primate</b>	Cardio- oesophageal junction	C-O junction zone Stomach epithelium Cardiac glands Muscle layers Nerve plexus		
<b>Stomach, primate</b>	Body	Secretory sheet Rugae Gastric Pits Mucous neck cells Parietal cells Chief cells Layers of wall Nerves		
<b>Stomach, primate</b>	Pylorus	Pyloric pits Pyloric glands Wall layers Nerves Lymphatic nodules		

**Question:** What is the difference in the muscle in the upper, middle and lower parts of the oesophagus?

**Question:** Describe the cells which make up the secretory sheet of the stomach.

**WEEK 9: TOPIC B: Gastro-Intestinal System II**

Virtual Slides	Tissue	Structure	Function	Drawing
<p><b>Stomach / small intestine, primate</b></p>	<p>Pyloro-duodenal Junction</p>	<p>Pyloric glands</p> <p>Gastric pits</p> <p>Villi</p> <p>Goblet cells</p> <p>Crypts of Lieberkuhn</p> <p>Pyloric sphincter</p> <p>Brunner's glands</p> <p>Muscle layers</p> <p>Lymphatic nodules</p>		
<p><b>Small intestine, primate and ileum (TS), cat</b></p>	<p>Jejunum Ileum</p>	<p>Epithelium</p> <p>Goblet cells</p> <p>Villi and microvilli</p> <p>Plicae circulares</p> <p>Lacteals</p> <p>Crypts of Lieberkuhn</p> <p>Peyer's patches (ileum slide)</p> <p>Lymphatic tissue (Plasma cells, lymphocytes)</p> <p>Muscle layers</p> <p>Nerve plexi:</p> <p>1) Meissner's)</p> <p>2) myenteric (Auerbach's)</p>		

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Large intestine, human</b>	Large Intestine	Goblet cells Crypts of Lieberkuhn Lymphatic tissue (aggregations) Taenia coli Myenteric (Auerbach's) nerve plexus Muscularis mucosa		
<b>Appendix, human</b>	Appendix	Epithelium with goblet cells Lymphatic follicles marginal zones germinal centres Tunica serosa		
<b>Recto-anal junction, human</b>	Recto-anal Junction	Submucosal folds Epithelium (change of type) Muscularis mucosa Goblet cells Intestinal glands Lymphatic nodules Smooth muscle Blood vessels Hair follicles Sebaceous glands		

**Question:** Compare the thickness of the stomach and duodenal walls.

## WEEK 10: TOPIC A: Lymphatic Tissue and the Immune System

### General Objective

To know the structure and function of lymphoid tissues and organs.

### Specific Objectives

1. To know the two principal components of lymphatic tissue: reticular tissue (reticular cells, reticular fibres, macrophages) and lymphatic cells.
2. To recognise the different arrangements of lymphatic tissue in the different organs: diffuse and nodular (follicular) lymphatic tissue, lymph nodes, and tonsils.
3. To describe the structure of a lymph node and to identify cortex, medulla, trabeculae, medullary cords and sinusoidal system.
4. To know the significance of the paracortical zone of the node.
5. To describe the microanatomy of the spleen, including red and white pulp, blood vessels of red and white pulp, splenic sinusoids and cells.
6. To describe the structure of the thymus gland and its morphological changes during development.

### Learning Activities

Examine the following virtual slides, identify, draw and label the features listed and note their function where appropriate:

Virtual Slides	Tissue	Structure	Function	Drawing
Lymph node, cat, Lymph node, human and Lymph node, cat	Lymph Node	Capsule Cortex Medulla Medullary sinuses Macrophages  Cortical nodules  Paracortical zone (dark staining below nodules)  Trabeculae  Lymphatics at hilus Reticular fibers (in cat lymph node virtual slide)		

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Tonsil, human</b>	Palatine	Epithelial lining Crypts Lymphocytes Nodules Germinal centre Marginal zone		
<b>Spleen, human</b>	Spleen	Capsule Trabeculae Trabecular blood vessels Red pulp White pulp Splenic nodules (Malpighian follicles) Central arteries Splenic sinusoids Lymphocytes		
<b>Thymus (neonatal), human,</b>  <b>Thymus (juvenile), human</b>  <b>Thymus (adult), human</b>	Thymus gland	Thymic lobule (Cortex & Medulla) Lymphocytes Hassal's corpuscle Trabeculae (septae) Adipose tissue		



## WEEK 10: TOPIC B: Endocrine System

### General Objective

To know the histological features and hormones of the endocrine glands.

### Specific Objectives

1. To know the structure of the thyroid and parathyroid glands and the hormones secreted.
2. To know the histology of the adrenal cortex and medulla and the hormones secreted by each section.
3. To understand the close relationship between the hypothalamus and the pituitary.
4. To know the parts of the hypophysis (pituitary). To identify chromophil (acidophil, basophil) and chromophobe cell types and the hormones associated with each group of cells. To describe the structure of the neurohypophysis and the process of neurosecretion.
5. To know the histology of pancreatic Islet cells and their hormonal secretions.

### Learning Activities

Examine the following virtual slides, identify draw and label the following structures. Note the hormone secreted by the various structures and their major function.

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Thyroid gland, human and Thyroid/parathyroid, primate</b>  <b>Thyroid/parathyroid, primate</b>	Thyroid gland  Parathyroid gland	Capsule Follicles Follicular cells Colloid C cells (parafollicular cells)  Chief cells Oxyphil cells (reddish)		
<b>Adrenal gland, primate and adrenal gland, human</b>	Adrenal gland	Capsule Cortex Zona Glomerulosa Zona Fasciculata Zona Reticularis Sinusoids Medulla Blood vessels		



Virtual Slides	Tissue	Structure	Function	Drawing
<b>Pituitary gland, human and Pituitary gland, ox</b>	Hypophysis (Pituitary gland)	Adenohypophysis (Pars Distalis, anterior pituitary) Acidophils-40% Basophils-10% Chromophobes-50%  Pars Intermedia Colloid Sinusoids  Neurohypophysis (Pars Nervosa, posterior pituitary) Pituicytes Herring bodies		
<b>Pancreas, human</b>	Pancreas	Islets of Langerhans (Pancreatic) Alpha cells Beta cells		

**Task:** With the help of a diagram summarise the effect of the hypothalamus / pituitary complex on the rest of the body i.e. hormones secreted and their action on target organs and tissues.

## WEEK 11: TOPIC A: Urinary System

### General Objective

To know the histology of the kidney, ureter, urinary bladder and urethra.

### Specific Objectives

1. To describe the microanatomy of the kidney: cortex, medulla, and pelvis.
2. To know the structure and ultrastructure of the nephron including the glomerulus, Bowman's capsule, proximal and distal tubules, loops of Henle.
3. To identify collecting tubules in the medulla.
4. To know the vascular circulation in the kidney.
5. To describe the structure of the ureter, urethra and urinary bladder and changes, which occur in the bladder during stretching.

### Learning Activities

Examine the following virtual slides, identify, draw and label the features listed and note their function.

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Kidney (LS &amp; TS), rat</b>  <b>Kidney (LS), human and Kidney (vascular injection), cat</b>	Kidney	Capsule Cortex Medulla Pelvis Ureter Hilus  Glomerulus Capillaries Basement membrane Bowman's capsule Urinary pole Vascular pole Macula densa PCT DCT Loop of Henle Collecting tubules Vasa rectae (in the virtual slide of cat kidney)		

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Ureter, human</b>	Ureter	Epithelium Connective tissue Muscle layers		
<b>Urinary bladder (distended/relaxed), primate</b>	Urinary Bladder	Epithelium (Compare stretched versus relaxed) Smooth muscle (plexiform arrangement) CT & blood vessels		
<b>Prostate gland, dog</b>	Prostatic urethra	Epithelium Lumen		
<b>Penis (neonatal, TS), human</b>	Penile urethra	Corpus cavernosum  Corpus spongiosum  Mucous glands of Littre  Paccinian corpuscle  Peripheral nerves  Hair follicle and sebaceous glands		

**Question:** Give the full name of the type of epithelium found in the urinary tract. Describe what happens to the epithelium when it is stretched (eg. as bladder fills).

**Examine** electron micrographs of the glomerulus and identify podocytes and filtration slits.

## WEEK 11: TOPIC B: Female Reproductive System

### General Objective

To know the histological structure of the major organs of the female reproductive system.

### Specific Objectives

1. To describe the microanatomy of the ovary and to identify: peritoneal mesothelium, developing ovarian follicles, Graafian and atretic follicles.
2. To know the layers of the wall of the uterine tube (Fallopian tube or oviduct).
3. To know the structure of the uterus and the morphological changes of the endometrium during the menstrual cycle.
4. To know the structure of the mammary glands.

### Learning Activities

Examine the following virtual slides, identify draw and label the structures listed below and note the function.

Virtual Slide	Tissue	Structure	Function	Drawing
Ovary, cat	Ovary	Epithelium Tunica albuginea Cortex Medulla Cortical stroma  Follicles primordial primary (pre-antral) secondary (antral) Graafian (mature) atretic Zona pellucida Antrum Cumulus oophorus Granulosa cells Corona radiata  Theca interna Theca externa Oviduct (Fallopian tube)		

Virtual Slide	Tissue	Structure	Function	Drawing
<b>Ovary, human</b>	Corpus luteum	Corpus luteum Granulosa lutein cells (secrete progesterone) Theca lutein cells (secrete estrogen) Corpus albicans		
<b>Uterine tube, human</b>	Oviduct (ampulla)	Epithelium Muscle Mesosalpinx (mesentery of uterine tube)		
<b>Uterus, human</b>	Late proliferative endometrium	Epithelium (endometrium) Endometrial glands  Myometrium Blood vessels Connective tissue		
<b>Uterus, human</b>	Secretory endometrium	Epithelium Endometrial glands (Compare with late proliferative endometrium) Myometrium Helicine arteries (spiral)		

**Question:** Discuss the differences between late proliferative and secretory endometrium.

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Cervix (LS), human (2 slides)</b>	Cervix	Cervical canal Transition of epithelium Nabothian (mucous) glands		
<b>Vagina, human</b>	Vagina	Epithelium Lack of glands Vascular tissue Smooth muscle Peripheral nerves		
<b>Mammary gland, cat</b>	Lactating	Interlobar septa Secretory alveoli Nipple Lactiferous ducts Epithelium (nipple) CT Hair follicles Sebaceous glands		

**Question:** What tissue is taken in a “pap” smear and why are checks important?

## WEEK 12: TOPIC A: Male Reproductive System

### General Objective

To know the histological structures of the major components of the male reproductive system.

### Specific Objectives

1. To describe the microanatomy of the testis and epididymis.
2. To identify cells of the germinal epithelium of the seminiferous tubule: Sertoli cells, spermatogonia, spermatocytes, spermatids and spermatozoa.
3. To know the structure of the ductus deferens, seminal vesicle, prostate gland and penis.

### Learning Activities

Examine the following virtual slides, identify, draw and label the following structures and note their function.

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Testis (epididymis), primate</b>  <b>Testis (LS), cat</b>  <b>Testis, human</b>	Testis	Seminiferous tubules Basement membrane Leydig (interstitial) cells  Sertoli cells Spermatogonia Spermatocytes Spermatids  Mediastinum  Rete Testis  Efferent tubules  Epididymis Stereocilia		

**Question:** What are stereocilia and what is their function in the epididymis ?

Virtual Slides	Tissue	Structure	Function	Drawing
<b>Vas deferens, human</b>	Vas Deferens	Epithelium Lamina propria Muscle layers Adventitia		
<b>Seminal vesicle, ox</b>	Seminal vesicle	Epithelium Lamina propria Muscle layers Adventitia		
<b>Prostate gland, dog and Prostate gland, primate</b>	Prostate Gland	Capsule Prostatic urethra Epithelium Prostatic concretions Ejaculatory ducts		
<b>Penis (neonatal, TS), human</b>	Penis	Tunica albuginea Corpus cavernosum Corpus spongiosum Urethra Mucous glands of Littre  Helicine arteries Nerve fascicles Pacinian corpuscles Dorsal blood vessels Hair follicles Sebaceous glands		
<b>Sperm Smear</b>	Sperm, human	Head, mid piece and tail		



## WEEK 12: TOPIC B: Special Sense Organ: The Eye

### General Objective

To know the main structural features of the eye and their major functions.

### Specific Objectives

1. To know the microanatomy of the retina, and the structure of the cornea, iris, lens, and ciliary body.
2. To know the cellular structure of the eyelid.

### Learning Activities

Examine the following virtual slides, identify, draw and label the structures listed below and note their function.

Tissue	Structure	Function	Drawing
Eye (anterior segment)	Cornea Corneal epithelium (stratified squamous) Basement membrane (Bowman's) Basement membrane (Descemet's) Corneal endothelium (simple squamous) Corneal stroma  Iris  Sphincter pupillae m. Iridial epithelium (pigmented) Iridial stroma Canal of Schlemm  Lens fibres (inside the lens) Lens capsule Zonule ligaments attach to lens  Ciliary body		

**Question:** What causes opaqueness in the lens (cataracts)?

Tissue	Structure	Function	Drawing
Eye (posterior segment)	Sclera Melanocytes Ora serrata (junction of retina with ciliary body, area where rods and cones disappear) Retina Basement membrane (Bruch's) Pigment epithelium Photoreceptors: Rods and Cones Outer nuclear layer Outer plexiform Inner nuclear layer Inner plexiform Ganglion cell layer Retinal blood vessels Nerve fibre layer Optic nerve Fovea centralis		
Neonatal head	Developing eye Eyelid still closed Cornea Lens Retina		
Eyelid	Conjunctiva with Goblet cells Skin surface (strat. squamous) Orbicularis oculi skeletal muscle. Eyelashes Tarsus plate  Tarsal (Meibomian) gland  Apocrine sweat glands (Moll)  Sebaceous glands (Zeis)		

**Question:** Describe the different types of photoreceptors and the function of each type.