ERASMUS UNIVERSITY COLLEGE
THE E IS FOR EXCELLENCE

ERASMUS UNIVERSITEIT ROTTERDAM

2017

Digital Microscopy (Histology)

Life Sciences

Course instructors: Kees Vissers / Arno van Leenders (dept. of Pathology, ErasmusMC)

Course description

After an introduction of 30 - 45 minutes, the students will log in on a server on which microscopic images of a variety of tissues will be available. By using digital microscopy they will learn about cells and tissues in relation to their function and physiology. Several questions have to be answered in this document and these will afterwards be discussed in a plenary session.

Learning objectives

After taking this course the student will be able to**:**

- Understand the organisation of different types of epithelial, connective, muscle and nerve tissues.
- Identify the structure of a range of different tissues and cells in organs.
- Recognise some organs by their microscopic appearance, and the differences between these.
- Explain the structure of cells and tissues in relation to their function.

Study materials/Literature

- Mescher, A.L. (2013) ***Junqueira's Basic Histology*** (13th Edition) New York: Mc Graw Hill. (available in the study landscape);

Location

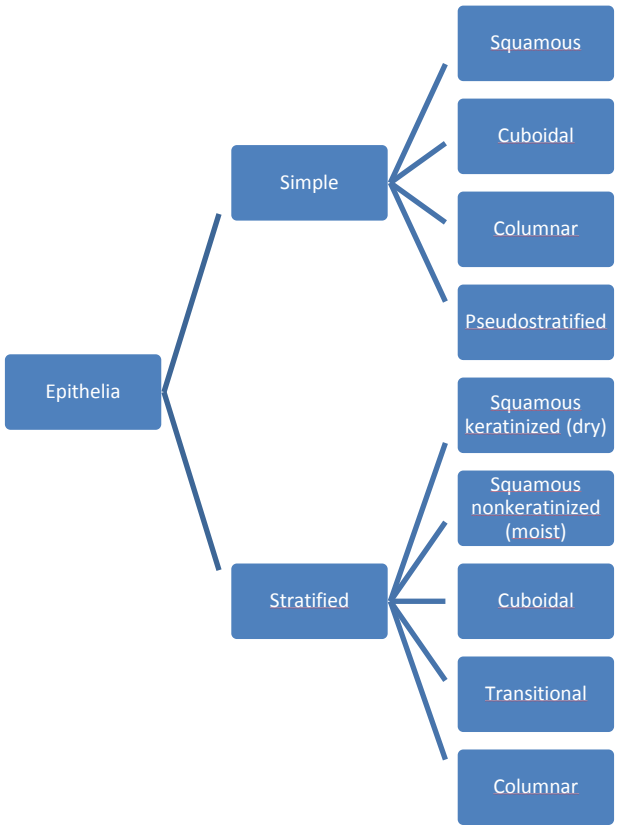
ErasmusMC,

Time

8th March 2017	**13.00 – 15.00**	**COO-5**
15th March 2017	**13.00 – 15.00**	**COO-3**

Handout:
Brief summary tissues (Introduction)

Epithelial types



1. **Simple Squamous**—single layer of uniform flat cells.

2. **Simple Cuboidal**—single layer of uniform cuboidal cells.

3. **Simple Columnar**—single layer of uniform columnar cells.

4. **Pseudostratified Columnar**—single layer of cells of varied shapes and heights.

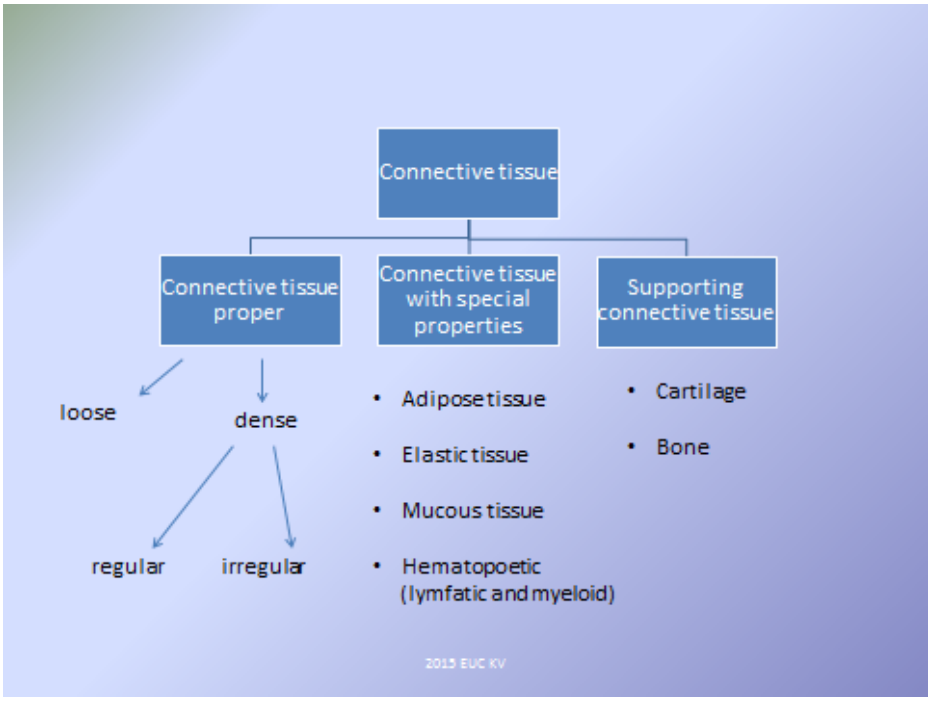
5. **Stratified Squamous**—several layers of cells whose superficial layers are flattened. These may be nonkeratinized, parakeratinized, or keratinized.

6. **Stratified Cuboidal**—two or more layers of cells whose superficial layers are cuboidal in shape.

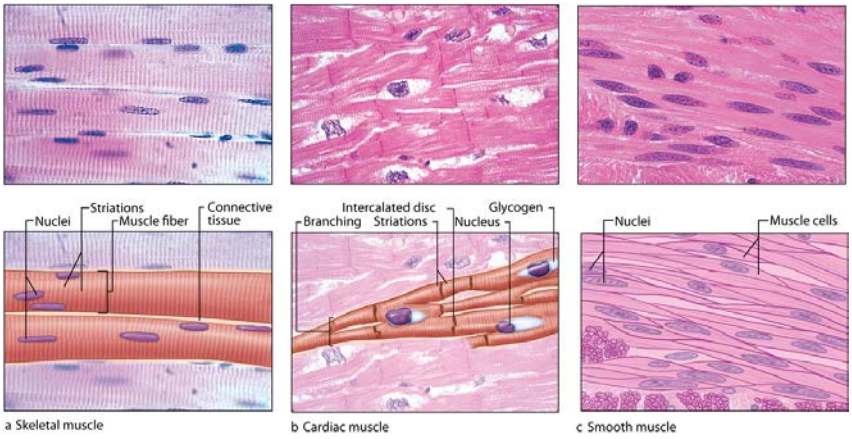
7. **Stratified Columnar**—two or more layers of cells whose superficial layers are columnar in shape.

8. **Transitional**—several layers of cells, characterised by large, dome-shaped cells at the free surface, that help maintain the integrity of the epithelium during distention of the various components of the urinary tract.

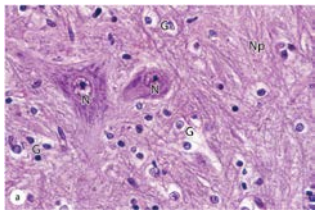
Connective tissue



Muscle tissue



Nerve tissue



Log-in Procedure:

DIGIMIC

1. Log in : Username and password *will be announced during practical*
2. Go to S – disk
3. Choose : DIGIMIC 'Digitale Microscopie'
4. Type username for this module: **EUCDIGIMIC**
5. Password is also: **EUCDIGIMIC**
6. Click on 'Browse Images'
7. Open the PDF below, slides are hyperlinked in blue.

Read, examine the microscopic views and answer during this practicum the questions in this document.

Short "intermezzo" introductions and feedback/answers will be given by the instructors.

This document contains slides of the different organ systems (some of the related organs are shown in parentheses).

PART 1

- Circulatory system (artery, vein, heart)
- Respiratory system (lung, central perifere)

PART 2

- Digestive system (small intestine, colon)
- Skeletal system (knee, bone)

The Circulatory System

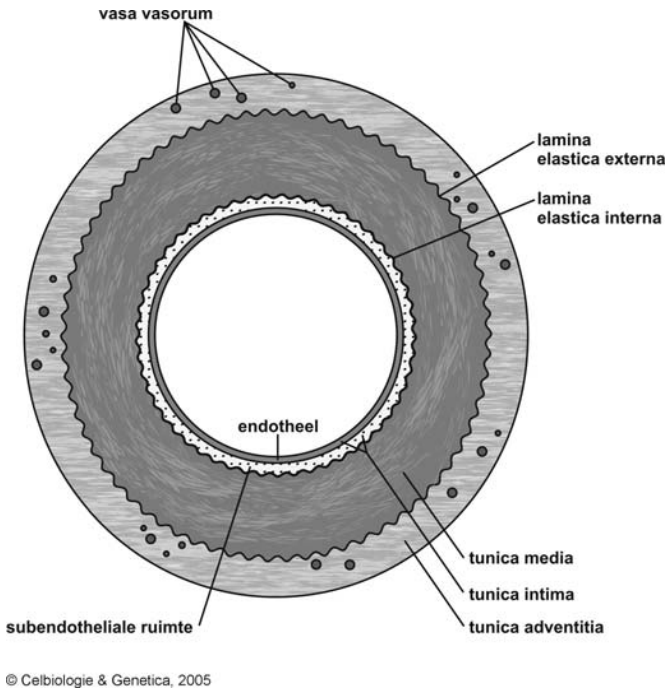
The circulatory system consists of a pump represented by the heart, and blood vessels which provide the route by which blood circulates to and from all parts of the body.
The structure of a large blood vessels can be studied by examining the following image.

Slide 1 Femoral artery and vein (monkey, HE)

At low magnification you'll see two big vessels in the middle. Other structures like connective tissue, fat tissue, muscle and nerve tissue are also visible. First identify the artery and vein.

- artery: small diameter, thick wall, undulating endothelium, vessel wall not undulating.
- vein: larger diameter, thin wall in total more undulating, endothelial layer is not undulating.

Identify the different structures of the vessel wall using this picture below.



The **tunica intima** has one layer of endothelial cells supported by a thin sub endothelial layer of loose connective tissue with occasional smooth muscle cells. In arteries, the intima is separated from the media by an internal elastic lamina, the most external component of the intima. This lamina, composed of elastin, has holes (fenestrae) that allow the diffusion of substances to nourish cells deep in the vessel wall. As a result of the loss of blood pressure and contraction of the vessel at death, the tunica intima of arteries may have a slightly folded appearance in tissue sections.

The **tunica media**, the middle layer, consists chiefly of concentric layers of helically arranged smooth muscle cells. Interposed among the smooth muscle cells are variable amounts of elastic fibres and lamellae, reticular fibres of collagen type III, proteoglycans, and glycoproteins, all of which are produced by these cells. In arteries, the media has a thinner external elastic lamina, which separates it from the tunica adventitia.

The **tunica adventitia** or tunica externa consists principally of type I collagen and elastic fibres This adventitial layer is gradually continuous with the stromal connective tissue of the organ through which the blood vessel runs.

Question 1 : Which differences can you detect between arteries and veins ?
In this microscopic picture you can detect other vessels. Try to discriminate between all of these vessels.

Question 2: Besides vessels, in this slide other tissues can be noticed. Try to identify: connective tissue, skeletal muscle, nerve tissue, fat tissue.

The following two slides are both arteries . The staining in slide 3 shows the elastic connective tissue in brown/black.

Slide 2 Aorta and renal artery (HE) and Slide 3 Aorta and renal artery (Orceine)

Question 3: What could be the main reason for the difference in the amount of elastic fibres in the vessel wall ?

Heart

Slide 4 Heart muscle (Human , He)
This is a human heart. Use a small magnification to orientate. Select an area in which the fibres have a longitudinal orientation. Observe the cells with an higher magnification.
See the branching cardiac muscle cells, with oval nuclei located centrally in the cell, and light stained cytoplasm containing striated fibres. Between the muscle cells loose connective tissue and capillaries are present.
Between the bundles of cardiac muscle, you can also see larger intramural arteries.

Question 4:
a From which blood vessel do these arteries originate?
b In these arteries, does the blood flow from the epicardium to the endocardium or from the endocardium to the epicardium?

The Respiratory System

The respiratory system functions by exchanging carbon dioxide for oxygen, which is then distributed to all of the tissues of the body. To accomplish this function, air must be brought to that portion of the respiratory system where exchange of gases can occur. The respiratory system, therefore, has two compartments:
• conducting compartment.
• respiratory compartment.

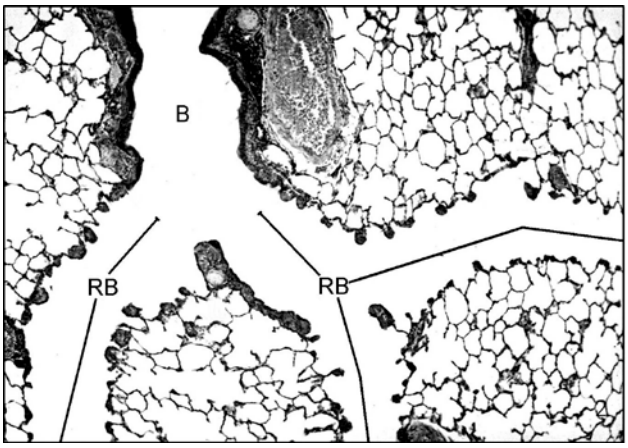
Slide 5 Lung hilum - central (monkey, HE)

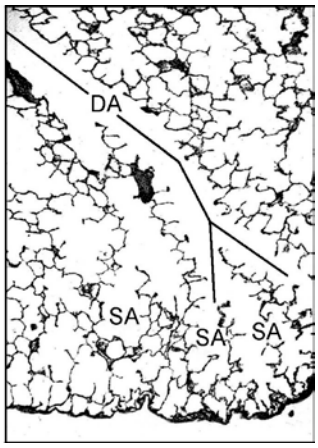
At low magnification you can recognise the bronchi by their cartilage component; these are surrounded by lung alveoli an large blood vessels.

Slide 6 Lung - peripheral region (rat , HPS)

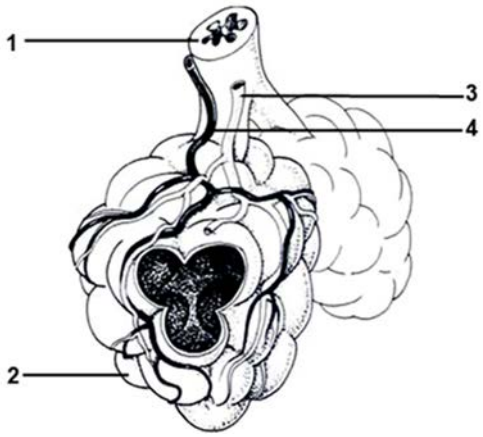
This slide shows the more peripheral region of the lung. The staining which is different compared to the

HE stain. It shows the bronchiole and blood vessels. See the differences. Bronchioles contain no glands or cartilage and the wall contains smooth muscle and elastic fibres.
In this slide, try to detect a respiratory bronchiole (RB), alveolar ducts (DA) and alveolar sacs. (SA)





An alveolus is a small air space partially surrounded by highly attenuated epithelium. Two types of cells are present in the lining: type I pneumocytes (lining cells) and type II pneumocytes (which produce surfactant). The opening of the alveolus is controlled by elastic fibres.
Alveoli are separated from each other by richly vascularized walls known as interalveolar septa, some of which contain alveolar pores (communicating spaces between alveoli). Dust cells (macrophages), fibroblasts, and other connective tissue elements may be noted in interalveolar septa. The blood-air barrier is a part of the interalveolar septum, and comprises a thin layer of surfactant, a lining of type I pneumocytes and their intervening fused basal laminae, and continuous endothelial cells of the alveolar capillaries.

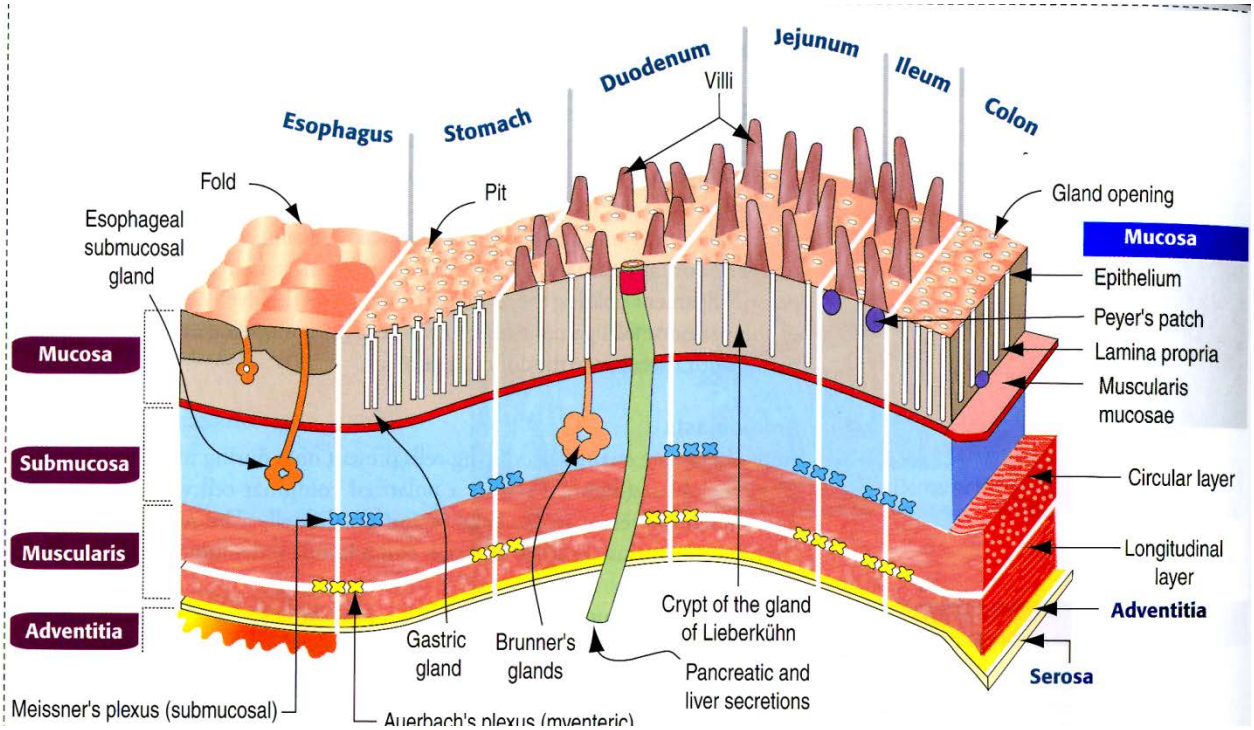


Question 5:

a What could be the reason of the cartilage component in a bronchus?
b What are the differences between bronchi and bronchioles?
c Imagine a red blood cell in the capillary system absorbing oxygen from the lung alveoli. What is the path that will be passed for the oxygen molecule? (be aware of endothelium, basal membrane, pneumocyte and interstitium)

The Digestive System

The digestive system plays a role in the movement and transportation of food. Also, the absorption of nutrients is important. The main architecture is shown below. The main layers are mucosa, submucosa, tunica muscularis, and adventitia/serosa.



These bothe slides represents the small intestine

Slide 7 small intestine 1 and Slide 8 small intestine 2

Question 6: What kind of epithelium covers the mucosa ?

Study the sub mucosal layer.

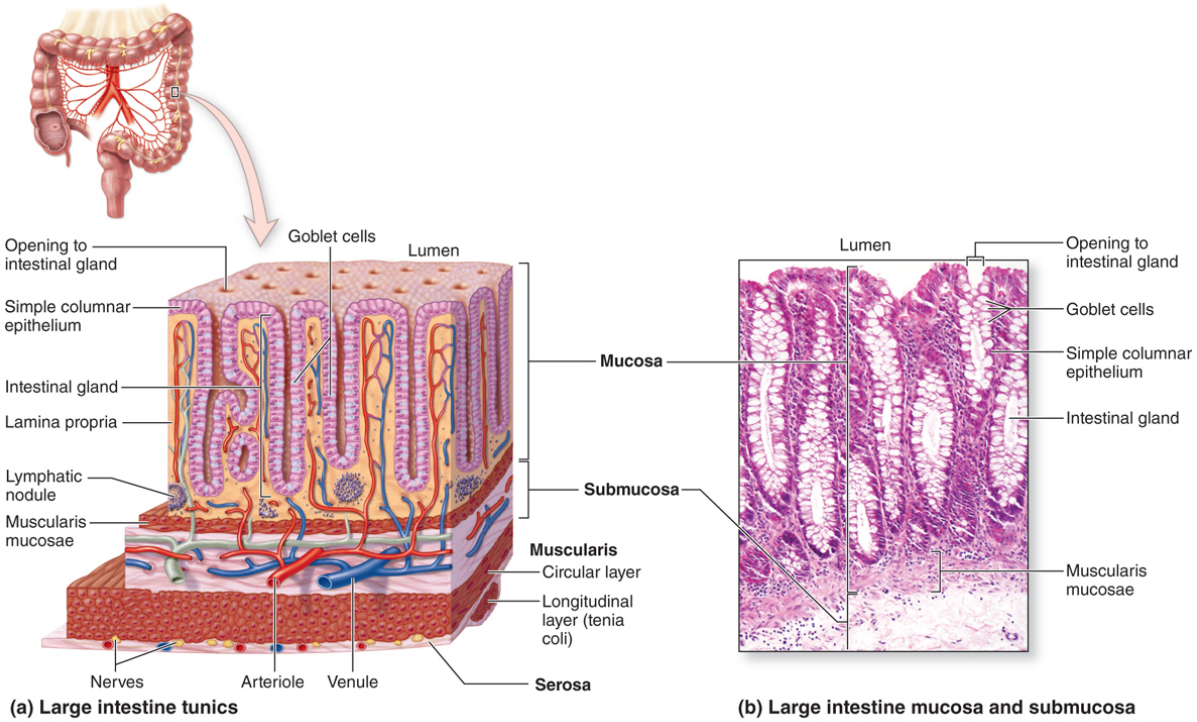
Question 7 : Which slide represents the duondenum and why ?

Study the tunica muscularis

Question 8:

a Of how many layers does the tuncica muscularis consist?
b What kind of muscle can be identified? (smooth, striated or both?)

Try to find the ganglia (nerve tissue) which innervates the musculature.
These ganglia (Meissner's plexus and Auerbach's plexus) innervate the musculature.
The colon has the same architecture of a mucosa, submucosa, muscularis and serosa (adventitia). Try to recognise the layers and their tissue types.



There are no villi as in the duodenum, jejunum and ileum (small intestine), but only crypts.

Slide 9; Colon

Question 9:

A What kind of epithelial cells can be recognised in the mucosa?
B What could be their specific function?

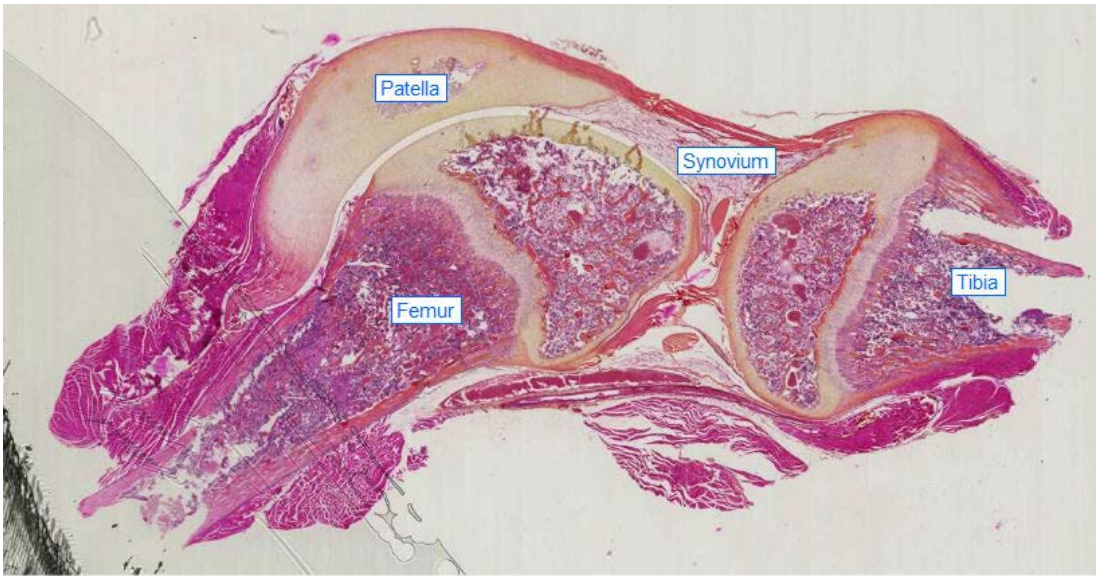
The Musculoskeletal system

Cartilage

Cartilage is a non-vascular, strong, and somewhat pliable structure composed of a firm matrix of proteoglycans whose main glycosaminoglycan's are chondroitin-4-sulfate and chondroitin-6-sulfate. The fibrous and cellular components of cartilage are embedded in this matrix.
The cellular components are the:
• chondrocytes, which are housed individually in small spaces known as lacunae.
• chondroblasts and chondrogenic cells, both of which are located in the perichondrium.
Most cartilage is surrounded by a dense irregular collagenous connective tissue membrane, the perichondrium, which has an outer fibrous layer and an inner chondrogenic layer.
• The outer fibrous layer, although poor in cells, is composed mostly of fibroblasts and collagen fibres.
• The inner cellular or chondrogenic layer is composed of chondroblasts and chondrogenic cells. The latter give rise to chondroblasts, cells that are responsible for secreting the cartilage matrix. It is from this layer that the cartilage may grow appositionally.

As the chondroblasts secrete matrix and fibres around themselves, they become incarcerated in their own secretions and are then termed chondrocytes. These chondrocytes, at least in young cartilage, possess the capacity to undergo cell division, thus contributing to the growth of the cartilage from within (interstitial

growth).
When this occurs, each lacuna may house several chondrocytes and is referred to as a cell nest (isogenous group).
This slide shows a rib (hyaline cartilage)
Slide 10 ; Knee , cartilage and Slide 11: Knee, cartilage



Question 10: . What kind of tissue are the menisci composed of?

This slide 15 : normal bone.

Slide 12 ; Bone (He)

Bone

Osteoblasts are responsible for the synthesis of the organic components of bone matrix, consisting of type I collagen fibres, proteoglycans, and several glycoproteins. Osteoblasts are located exclusively at the surfaces of bone matrix, usually side by side in a layer somewhat resembling a simple epithelium. When they are actively engaged in matrix synthesis, osteoblasts have a cuboidal to columnar shape and basophilic cytoplasm. When their synthesising activity declines, they flatten and cytoplasmic basophilia is reduced. Osteoblasts are polarized cells: matrix components are secreted at the cell surface in contact with older bone matrix, producing a layer of new (but not yet calcified) material called osteoid between the osteoblast layer and the bone formed earlier. Individual osteoblasts are gradually surrounded by their own secretions and become osteocytes enclosed singly within spaces called lacunae. Osteoclasts are very large, motile cells with multiple nuclei. The large size and multinucleated condition of osteoclasts is due to their origin from the fusion of bone marrow-derived cells. In areas of bone undergoing resorption, osteoclasts lie in the matrix known as resorption bays .

The slides 15 and 16 gives a better discrimination between mineralised and non-mineralised bone tissue.

Slide 13 ; Bone (Goldner) and Slide 14 ; Bone (Thionine)

Question 11: Which colour does osteoid have in the Goldner stain?