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# Histology Laboratory Drawings

A. Kent Christensen

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**These sketches were drawn by Dr. Christensen for the laboratory sessions he conducted in the Medical Histology Course for first year medical students. The drawings were done with felt markers on a white board in the lab during the morning of the day a particular topic was being studied in the course. When the laboratory session began he briefly discussed the drawings, which could then be seen by the students throughout the laboratory period.**



List of histological topics, arranged in the order they were considered in the course (with page numbers). For full screen, press Ctrl-L.

Epithelium - 4	Oral cavity, salivary glands - 64
Connective tissue - 10	Esophagus, stomach - 70
Muscle - 15	Small and large intestine - 76
Peripheral nervous system - 20	Liver, pancreas, gall bladder – 82
Skin, mammary gland - 26	Endocrine - 88
Cartilage, bone - 31	Male - 93
Bone formation - 36	Female – 98
Cardiovascular - 42	Lymphatics – 109
Blood, bone marrow - 47	Central nervous system - 117
Respiratory - 53	Ear and eye - 122
Urinary - 58	

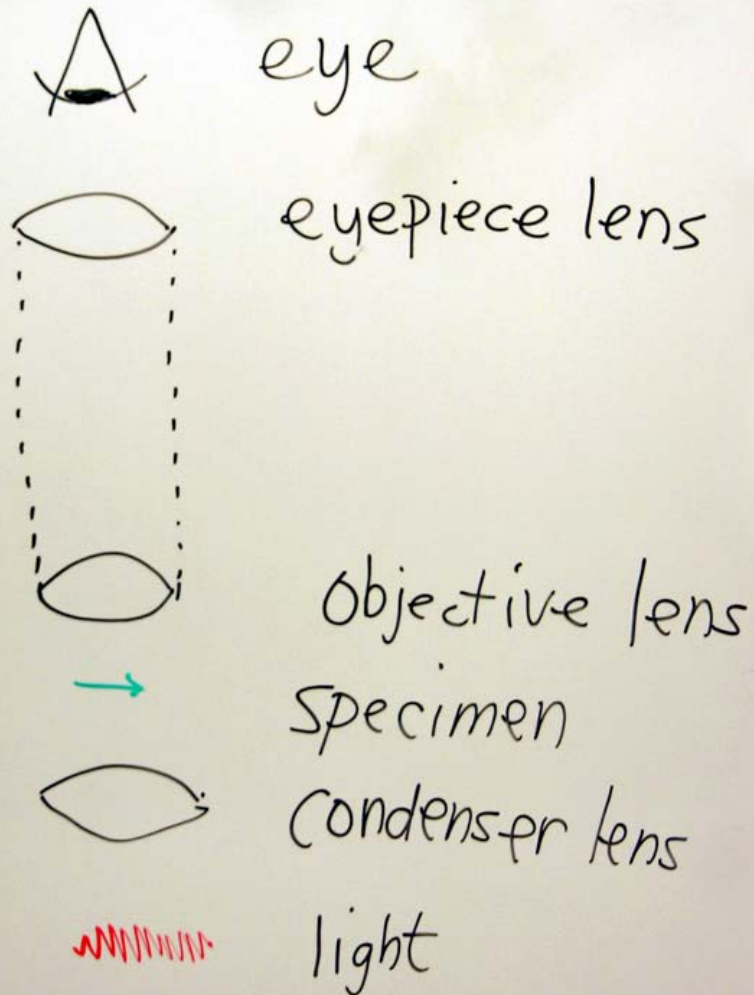


# Epithelium

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# Basic design of light microscope



# Types of epithelia

Simple  
(one layer  
of cells)

Squamous

Cuboidal

Columnar



Stratified  
(more than one  
layer of cells;  
named for top  
layer)

Rare  
(sweat gland duct)

Rare

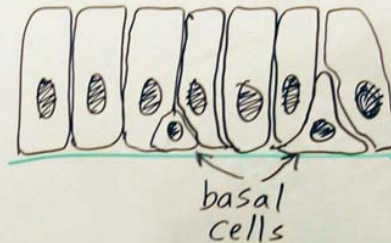
Ex

## Exceptions

### Pseudostratified Columnar epithelium

All cells are on basement membrane, but not all reach the surface.

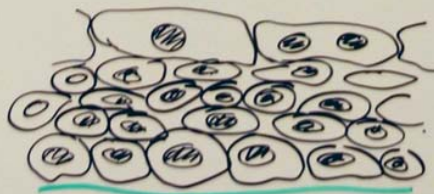
Examples: trachea, epididymis.



### Transitional epithelium

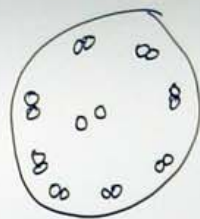
Modified for stretching.

Examples: ureter, bladder

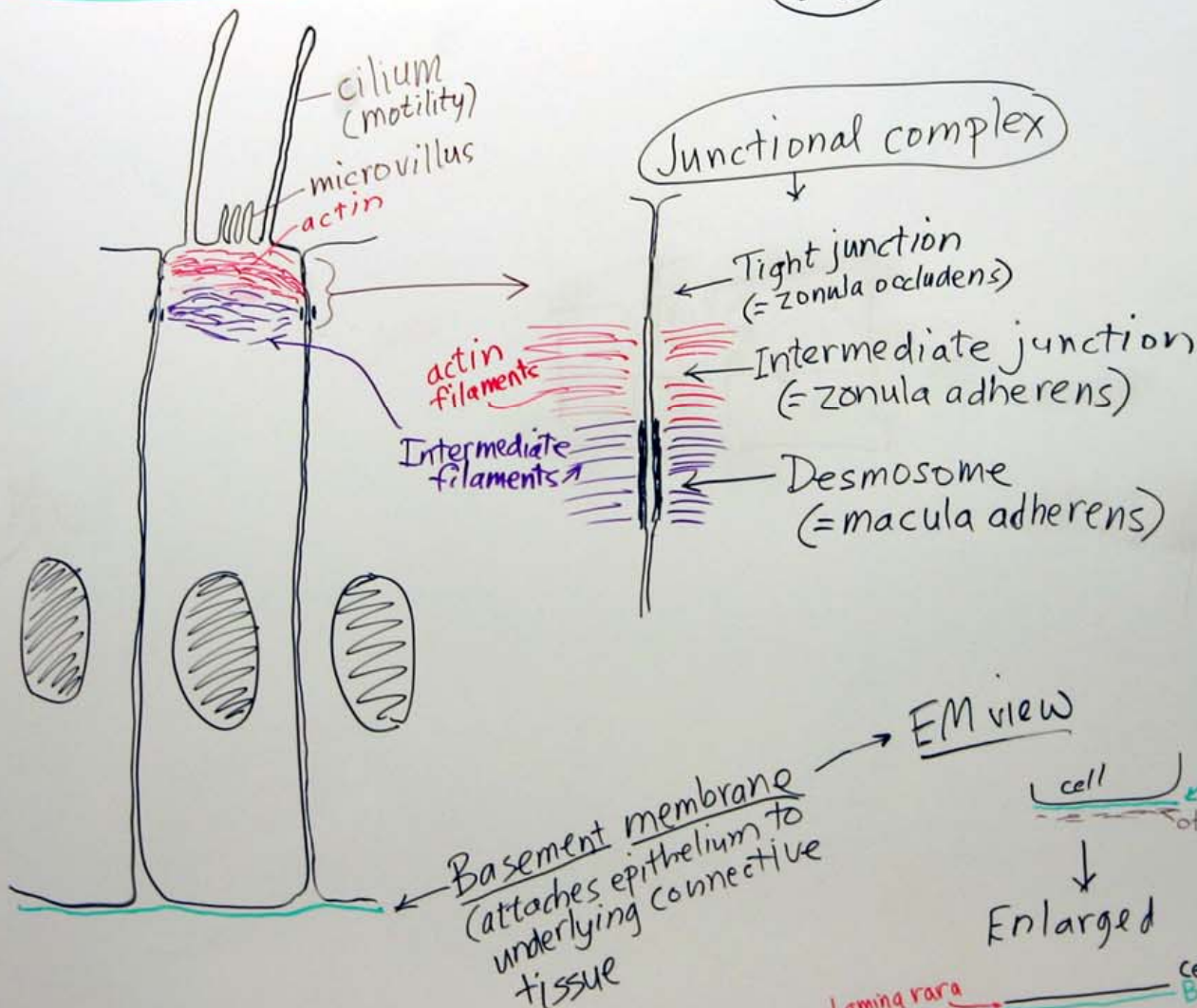




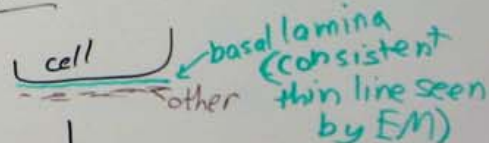
# Junctions, apical specializations, and basement membrane



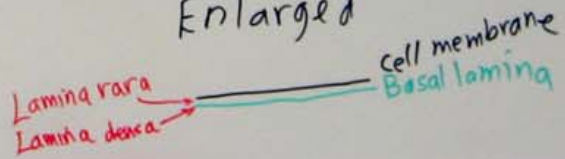
cilium cross section  
9+2 pattern of microtubules  
(9 doublets, 2 single)



EM view



Enlarged



# Terminology

"Basement membrane" = general layer seen during light microscope era

"Basal lamina" = specific thin layer seen with the electron microscope

Currently, the term "basement membrane" tends to mean both.

# Connective Tissue

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# Stains

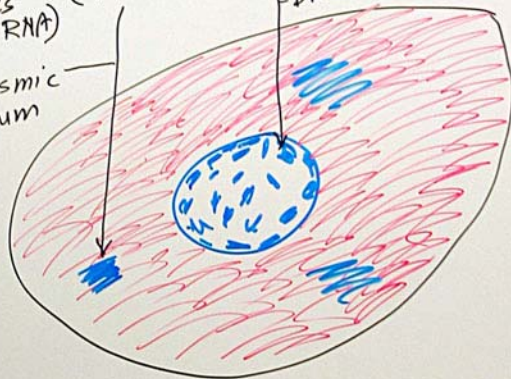
H+E = hematoxylin and eosin

Acidic pink dye stains proteins

Basic blue dye, stains nucleic acids (RNA and DNA)

Ribosomes (contain RNA) in rough endoplasmic reticulum (RER)

DNA in nucleus



Acid/base reaction:  
DNA and RNA are acidic, so "love" basic dye ("basophilic")

Protein is usually somewhat basic, so "love" acid dye ("acidophilic")

## Masson triple stain ("trichrome")

Useful in studying connective tissue because stains collagen and reticular fibers blue or green (depending on whether aniline blue or fast green is used in making up the stain)

### Stain for elastic fibers

- Elastic fibers are stained purple or black by aldehyde fuchsin or Weigert's stain.



# Cells of connective tissue

**Fibroblast** (makes collagen fibers, elastic fibers, ground substance, etc.)

Nucleus is large, pale and shaped like your hand (so appearance depends on orientation)

Cytoplasm usually not very obvious.

← collagen fiber

Collagens

- Type I (usual connective tissue packing)
- Type II (cartilage)
- Type III (reticular fibers, delicate packing, take silver stain)
- Type IV (in basal lamina/basement membrane)

← elastic fiber

(usually unstained, so not visible in conventional sections)

**Plasma cell**

A small cell

(Makes circulating antibodies; develops from B-lymphocytes)

halo = rough ER

Golgi complex

round, eccentric "cartwheel" nucleus

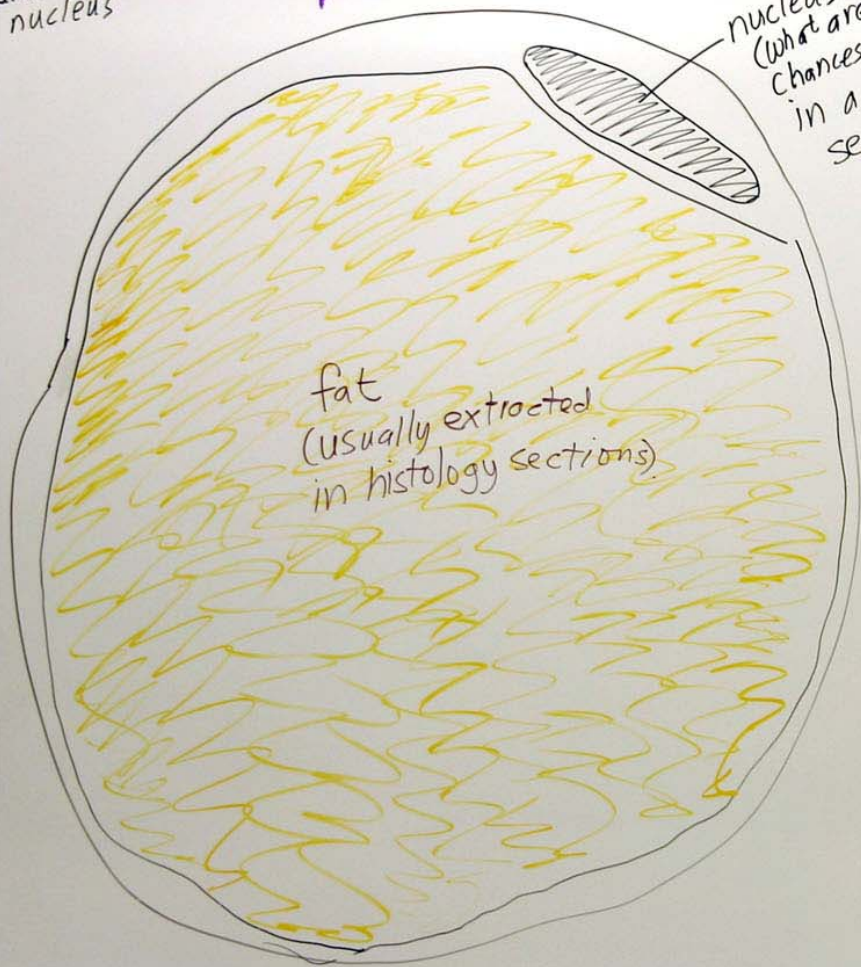


round, eccentric  
"cartwheel"  
nucleus

Fat cell = "adipocyte"

nucleus  
(what are your  
chances of seeing  
in a histological  
section?)

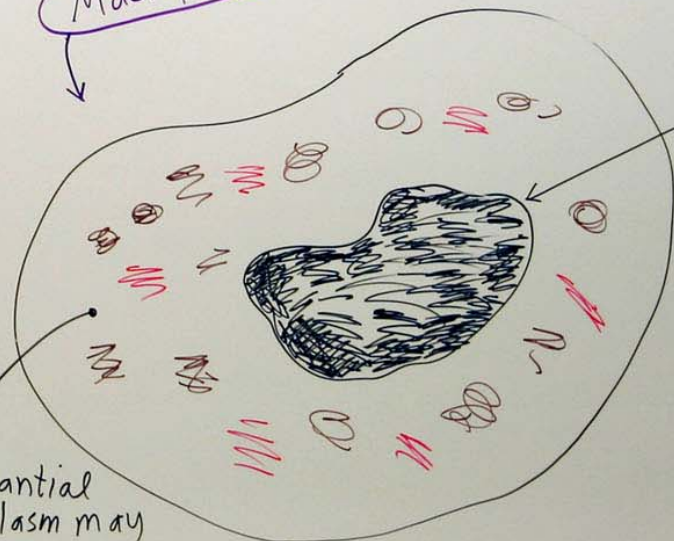
fat  
(usually extracted  
in histology sections)



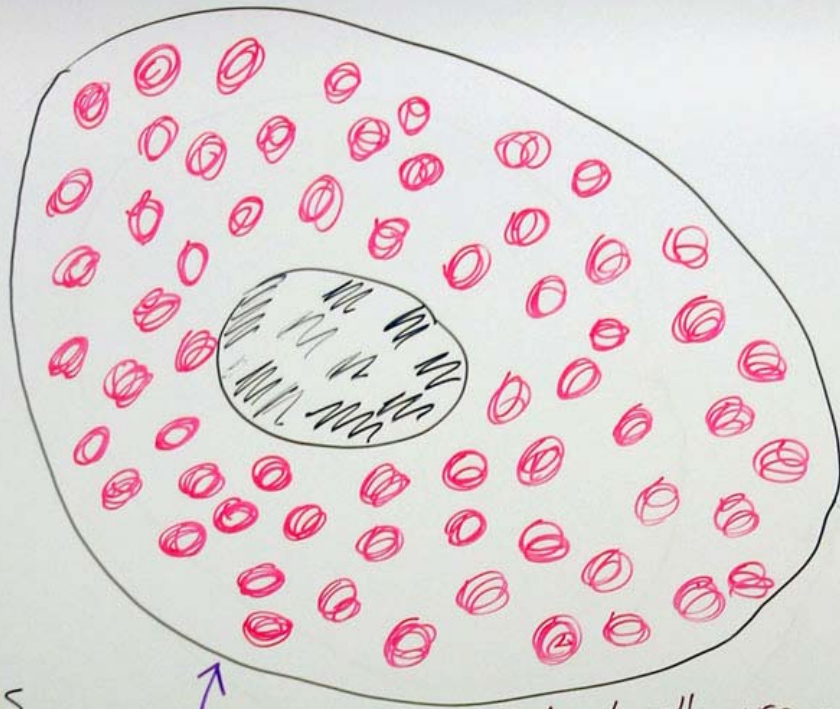
Macrophage (phagocytosis, etc.)

dense  
nucleus

Substantial  
cytoplasm may  
contain "residual bodies"  
= lysosomes.







se  
nucleus

### Mast cell

Cytoplasm full of granules that stain with special stains (such as Azure II or PAS).

Granules contain histamine, heparine, etc. Their release causes local increase in vascular permeability of small blood vessels, part of the inflammatory reaction.

Mast cells are not usually distinguishable in histological sections because their granules are extracted during slide preparation.

# Muscle

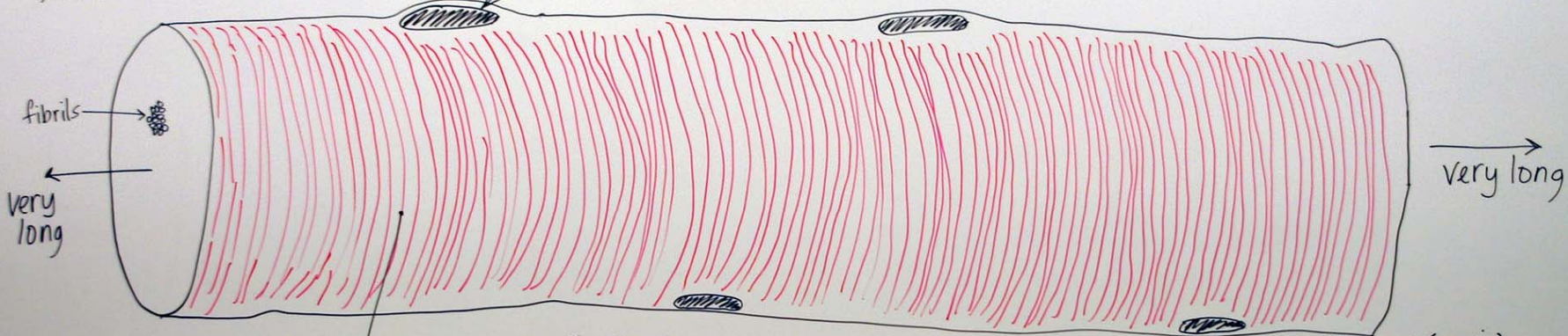
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# Skeletal muscle cell

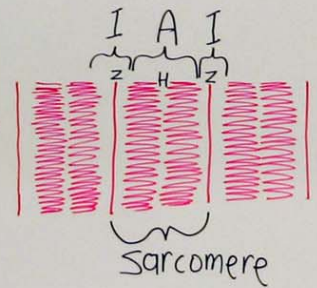
fiber = cell  
fibril  
filament: thick (myosin), thin (actin)

many nuclei (peripheral)

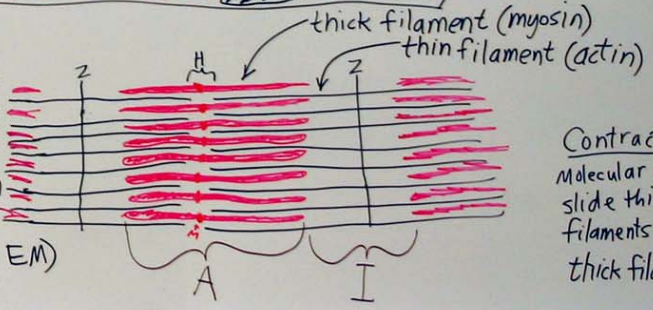


Muscle  
In Greek = Sarco-  
In Latin = Myo-

striated  
banding  
pattern



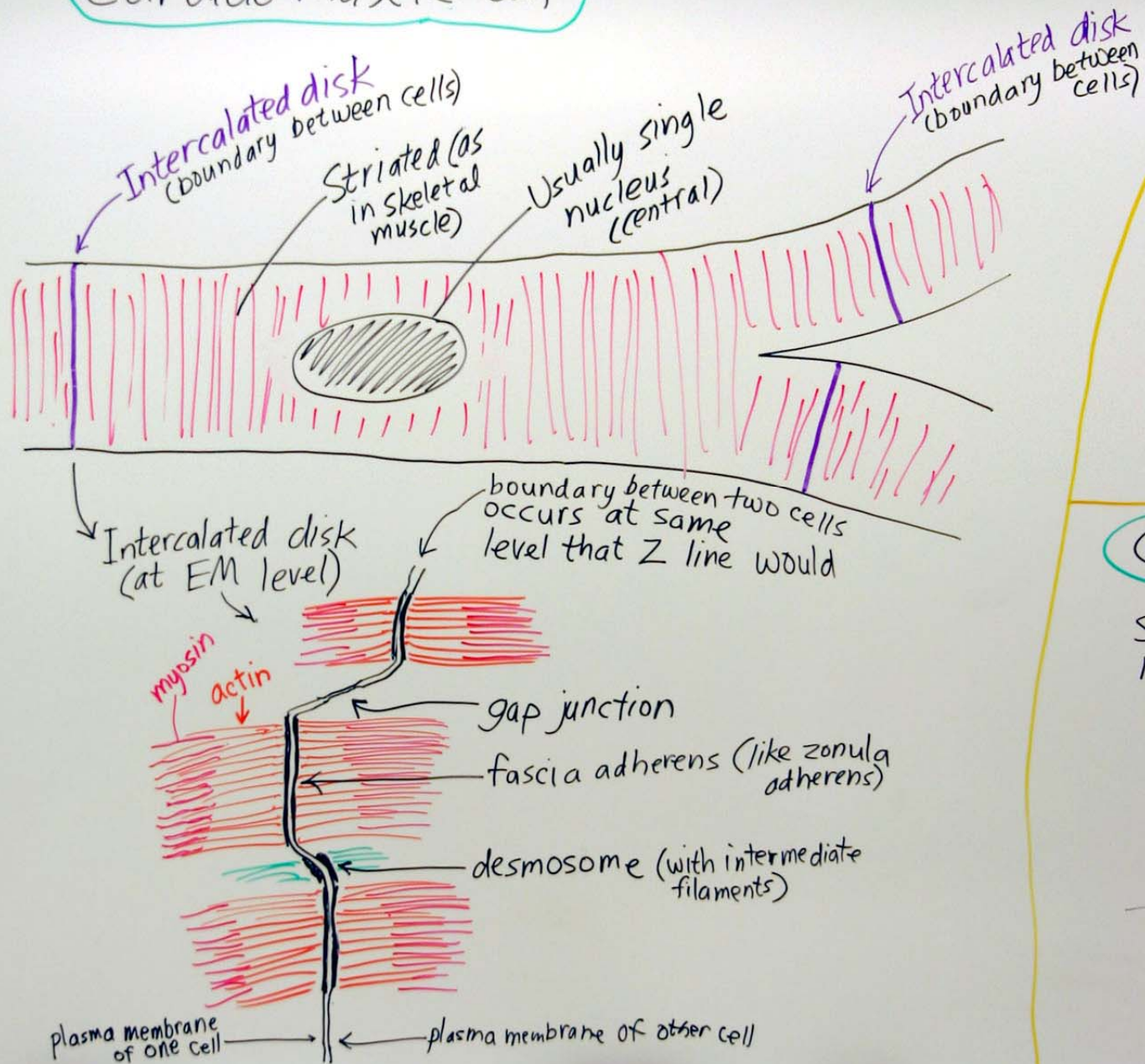
Molecular  
detail of  
banding  
pattern  
(can be  
seen by EM)



Contraction:  
molecular motors  
slide thin  
filaments along  
thick filaments.



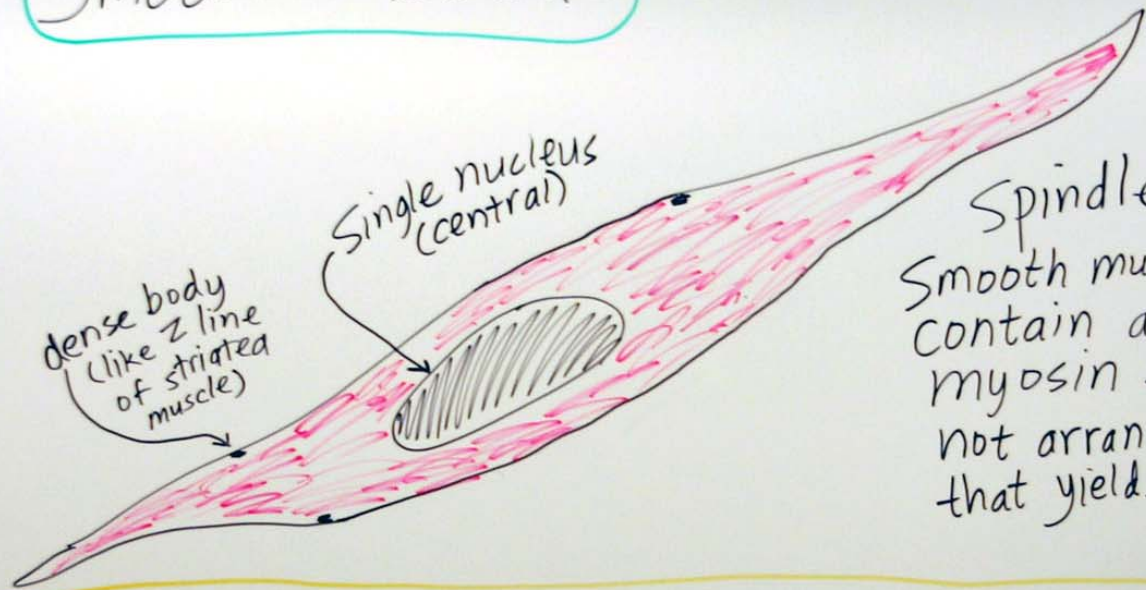
# Cardiac muscle cell



Cr  
Skel  
mus

disk  
between  
cells

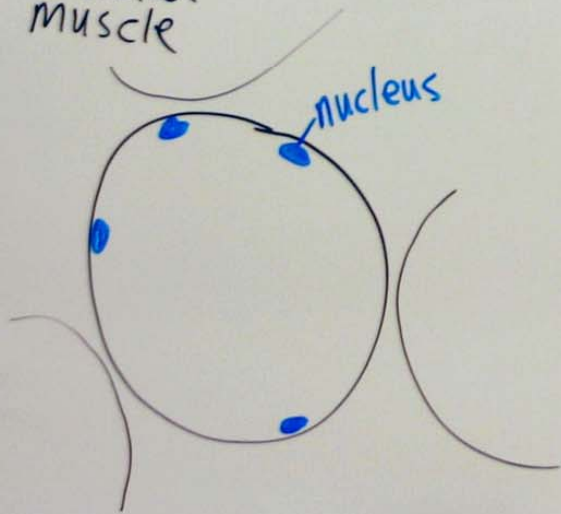
## Smooth muscle cell



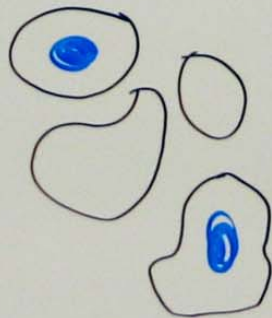
Spindle shape.  
Smooth muscle cells  
contain actin and  
myosin filaments, but  
not arranged in manner  
that yields striations.

## Cross sections

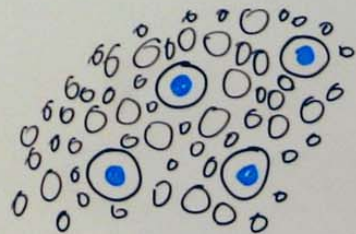
Skeletal  
muscle



Cardiac  
muscle



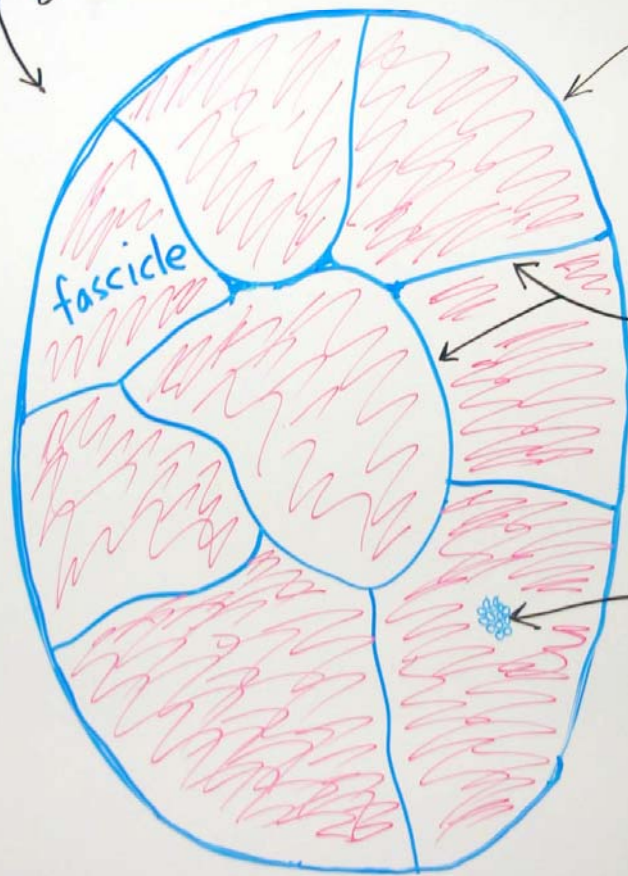
Smooth  
muscle





# Skeletal muscle connective tissue

Cross section  
of a skeletal muscle



**Epimysium**  
(= deep fascia  
of gross  
anatomy)  
dense irreg.  
connective  
tissue

**Perimysium**  
(c.t. between  
fascicles)

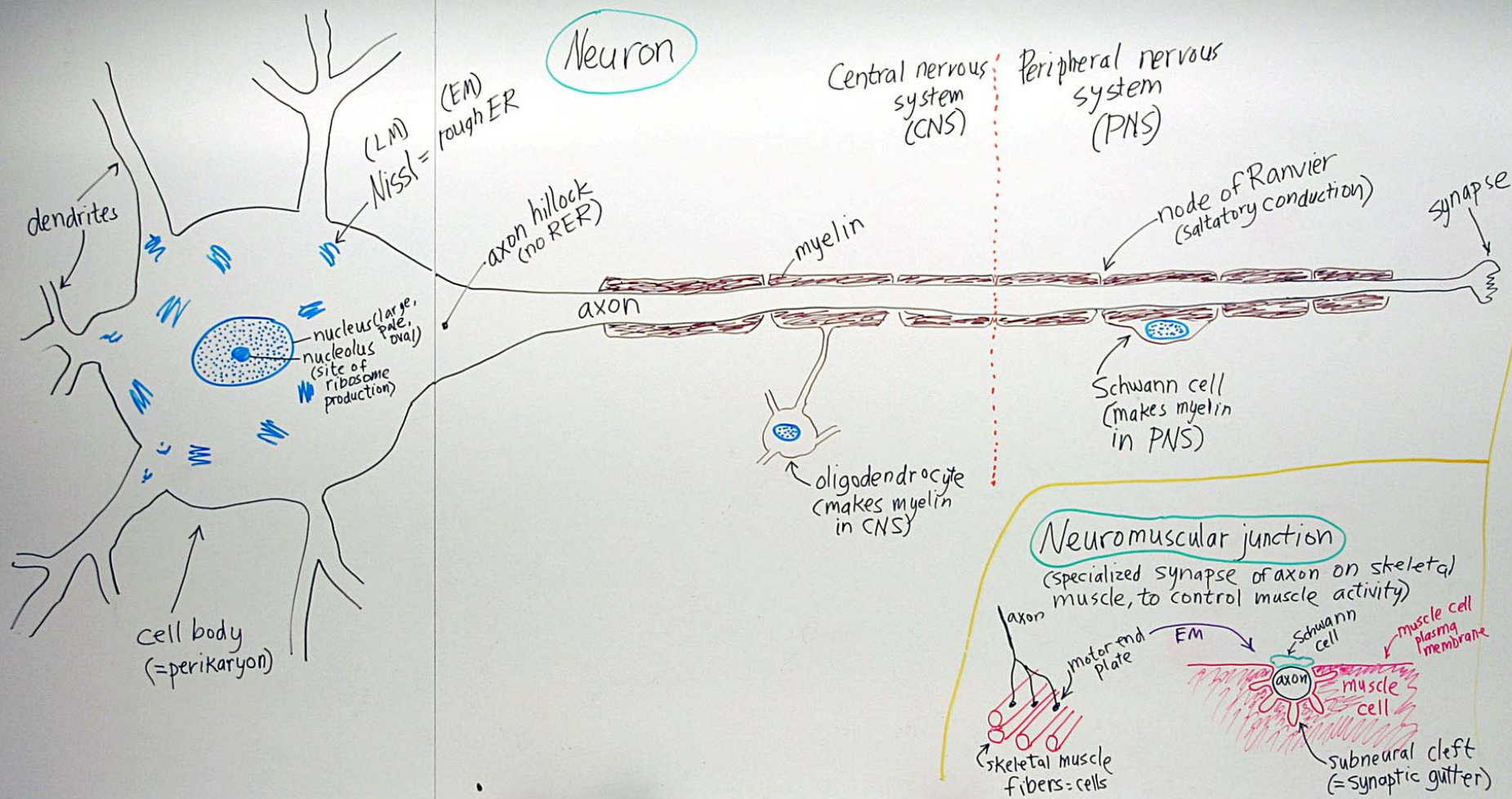
**Endomysium**  
(delicate c.t.  
between muscle  
cells = fibers;  
reticular fibers  
= type III collagen)



# Peripheral Nervous System

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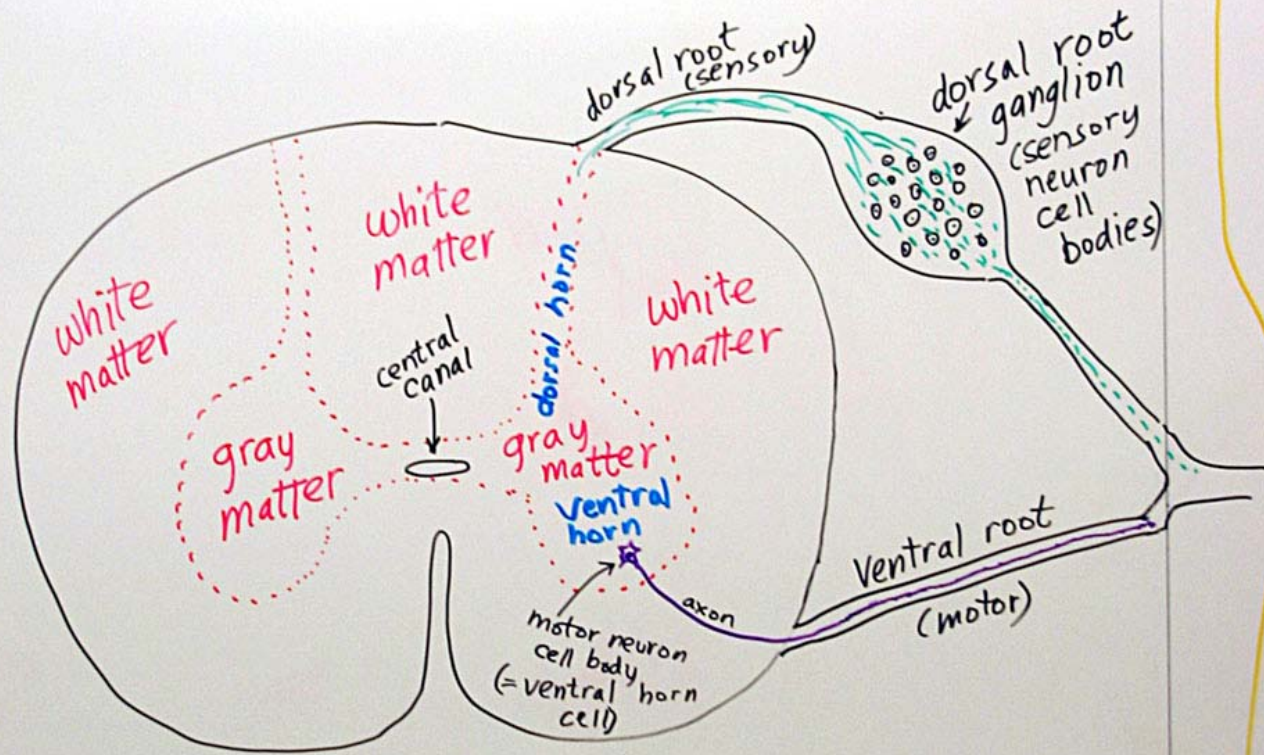
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# Spinal cord

(Cross section)



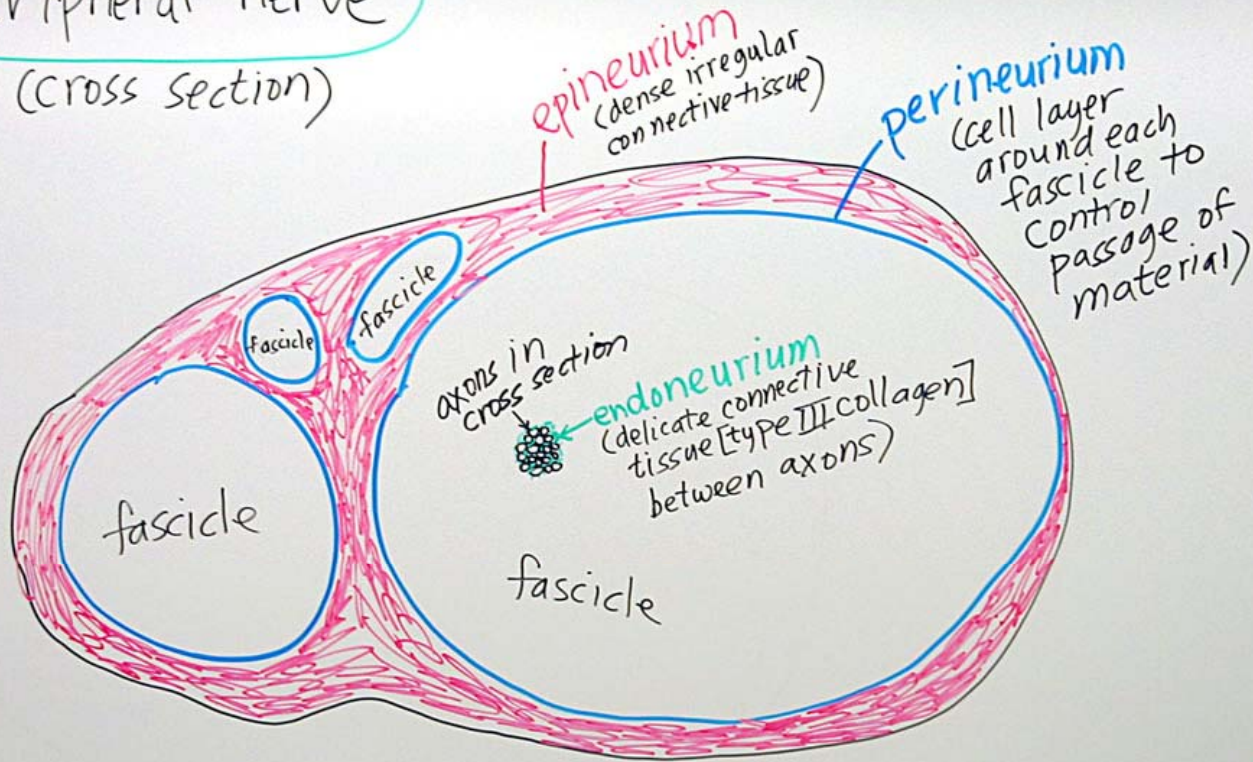
Gray matter = neuron cell bodies, dendrites, axons, glia, blood vessels

White matter = axon tracts, glia, blood vessels, no neuron cell bodies

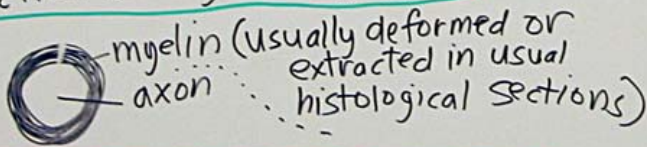


# Peripheral nerve

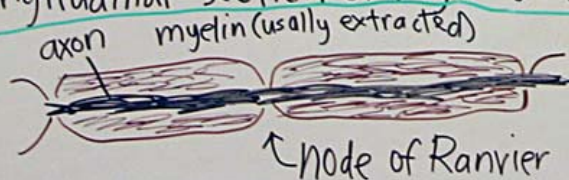
(cross section)



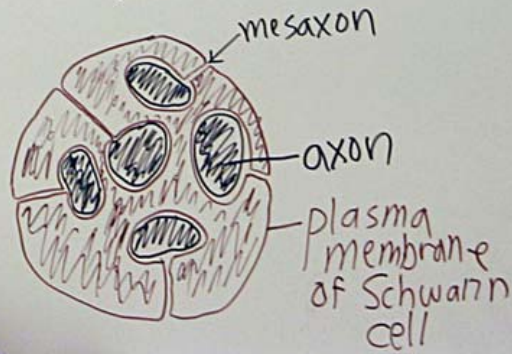
## Cross section of myelinated axon



## Longitudinal section of myelinated axon



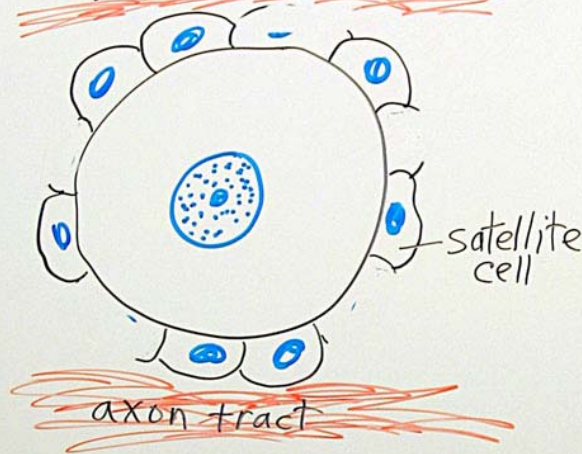
## Cross section of unmyelinated axons in invaginations of a Schwann cell (as seen by EM)



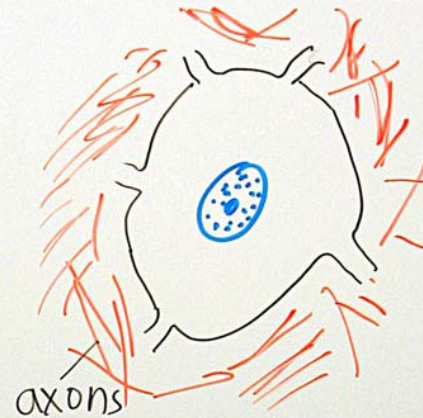


# Compare neuron cell bodies of dorsal root ganglion and Autonomic ganglion

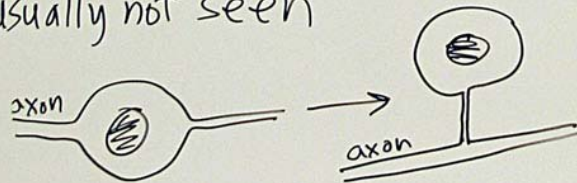
Dorsal root ganglion



Autonomic ganglion



Neuron cell body is pseudounipolar, so processes usually not seen



axon tracts run parallel

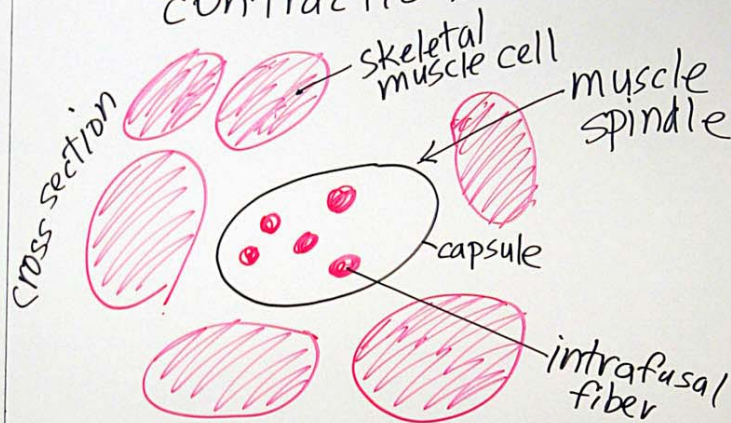
Satellite cells usually obvious

Neuron cell body is multipolar so often see processes  
Axon tracts in various directions

Satellite cells less numerous

## Neuromuscular spindle

Stretch receptor to tell you the extent of muscle contraction.



Small specialized muscle cells (intrafusal fibers) surrounded by regular skeletal muscle cells (extrafusal fibers).

Both sensory and motor innervation. Two kinds intrafusal fibers (nuclear bag fibers, nuclear chain fibers).

Can't usually distinguish in routine histology slides.

# Skin & Mammary Gland

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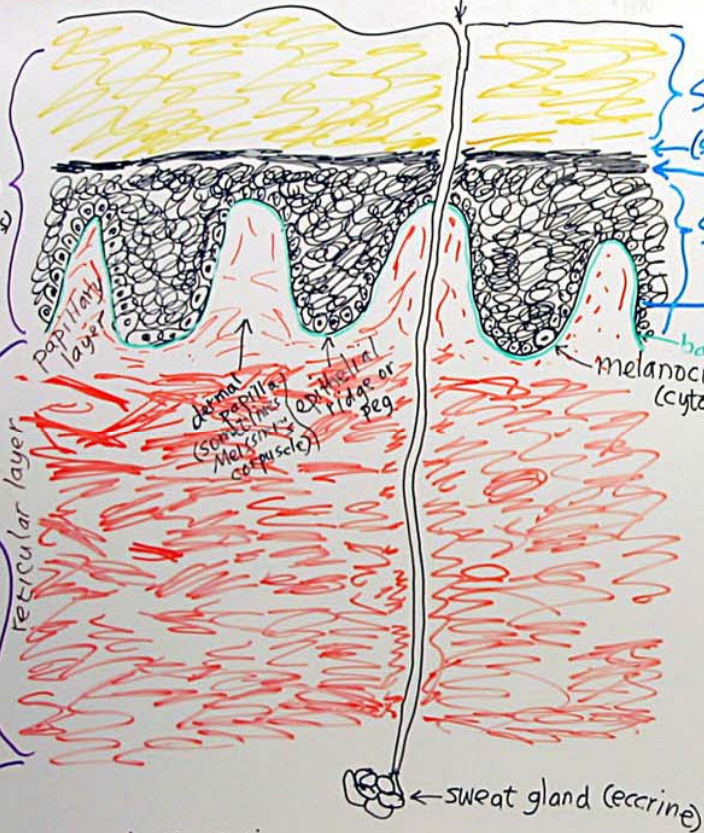
# Thick skin (palms, soles of feet)

epidermis (epithelium)  
(keratinocytes)

dermis (connective tissue)

hypodermis (fat, etc.)  
(=superficial fascia or subcutaneous)

Sweat duct



stratum corneum - (cells dead, flat, cornified)

(stratum lucidum)

stratum granulosum - (Kerato-hyaline granules, membrane coating granules, etc.)  
(ceramide)

stratum spinosum - (keratin tonofibrils, intercellular desmosomes = "bridges")

stratum basale - (basal layer of cells, cell division)  
(=stratum germinativum)

basement membrane  
melanocyte (cytoplasm appears empty) →

← dense irregular connective tissue

## Thin skin

(Surface of body, other than palms and soles of feet)

Stratum corneum thin

Stratum granulosum sparse or absent

Sweat

Eccrine s

→ also in stratum spinosum:

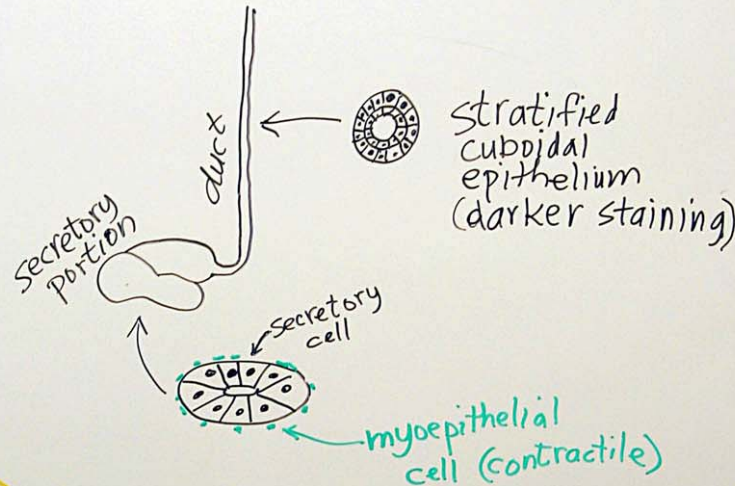
- (Langerhans cells = antigen processing cells, for immune function)

- Merkel's cells (perhaps secretory or endocrine, contain small, dense granules)



# Sweat glands

Eccrine sweat glands (most of body surface)

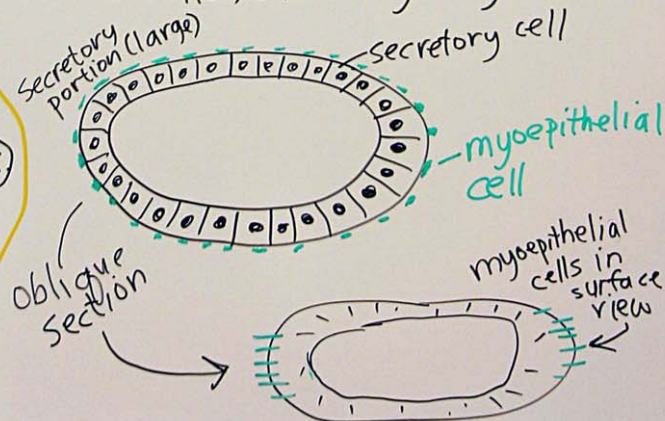


pinosum:

s cells = antigen  
g cells, for  
function)

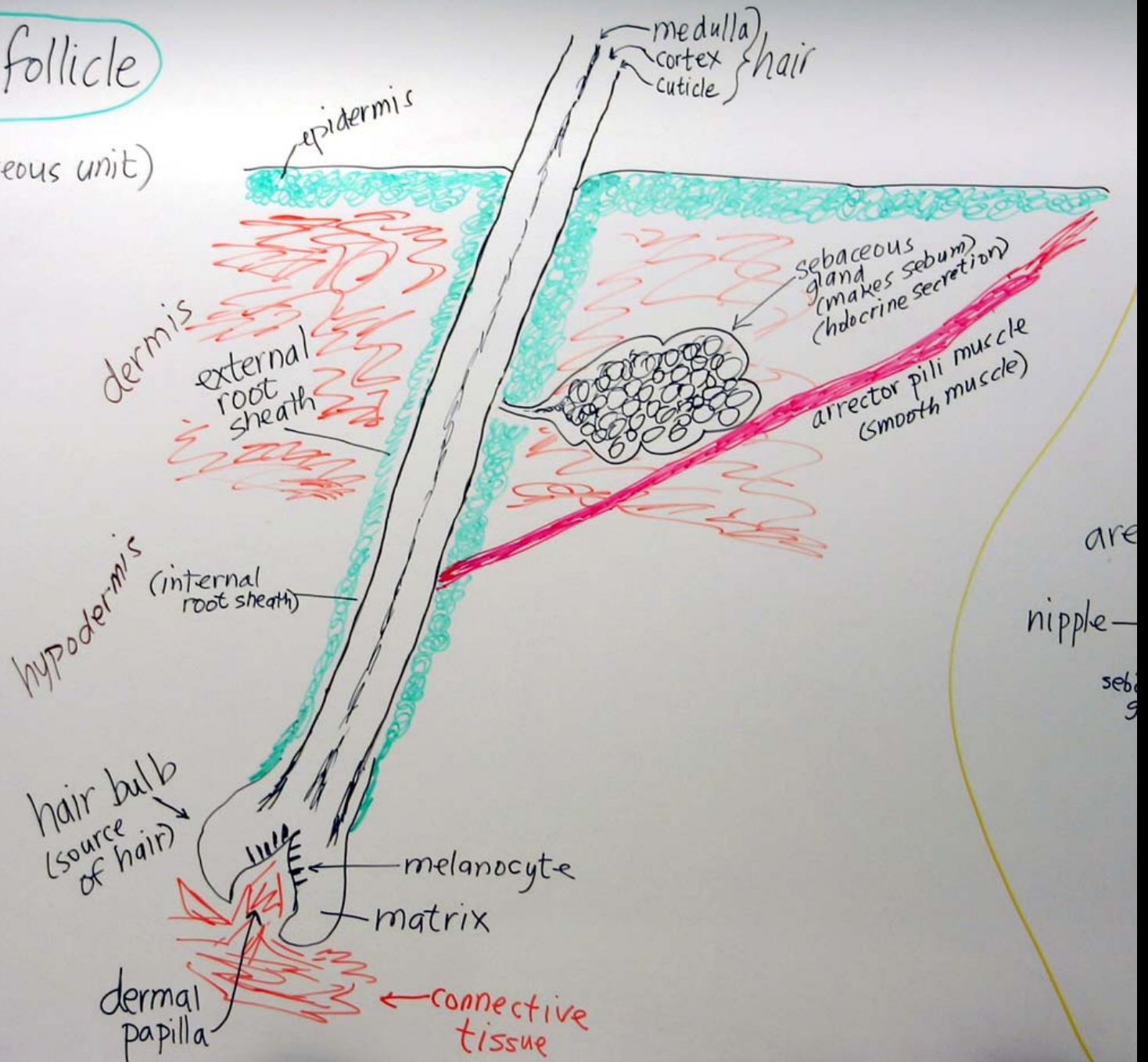
cells  
s secretory  
ocrine, contain  
dense granules)

## Apocrine sweat glands (axilla, anal region)



# Hair follicle

(Pilosebaceous unit)

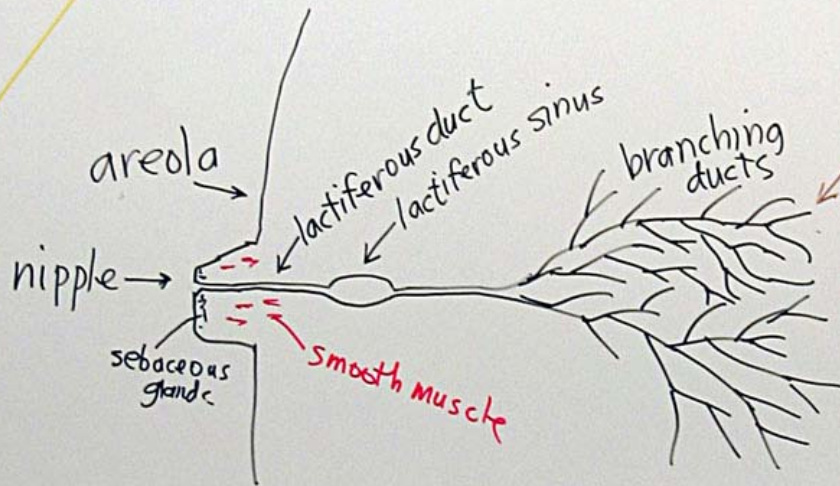




# Mammary gland (breast)

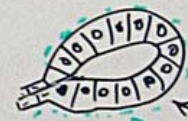
15-30 lobes, each a separate lactiferous duct and branches. Each lobe opens independently at the nipple.

muscle  
(muscle)



endings (secretory portions = alveoli)

duct  
myoepithelial cells  
nulliparous (no children)



pregnancy

alveolus  
myoepithelial cells



lactation

milk  
lipid droplet

# Cartilage and Bone

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# Cartilage and bone

(Next time will be bone development)

Cells

Hyaline cartilage

Cartilage  
Matrix

(collagen type II,  
proteoglycans,  
aggrecans,  
glycosaminoglycans,  
chondroitin  
sulfate, etc.)

No blood  
vessels

Chondrocytes (cells shrunk and  
distorted in histological  
sections = preservation  
artefact)

territorial  
matrix

lacuna  
(compartment  
cell is in)

Interterritorial  
matrix

Bone

(collagen I,  
hydroxyapatite,  
calcium phosphate  
etc.)

lacuna (compartment cell is in)

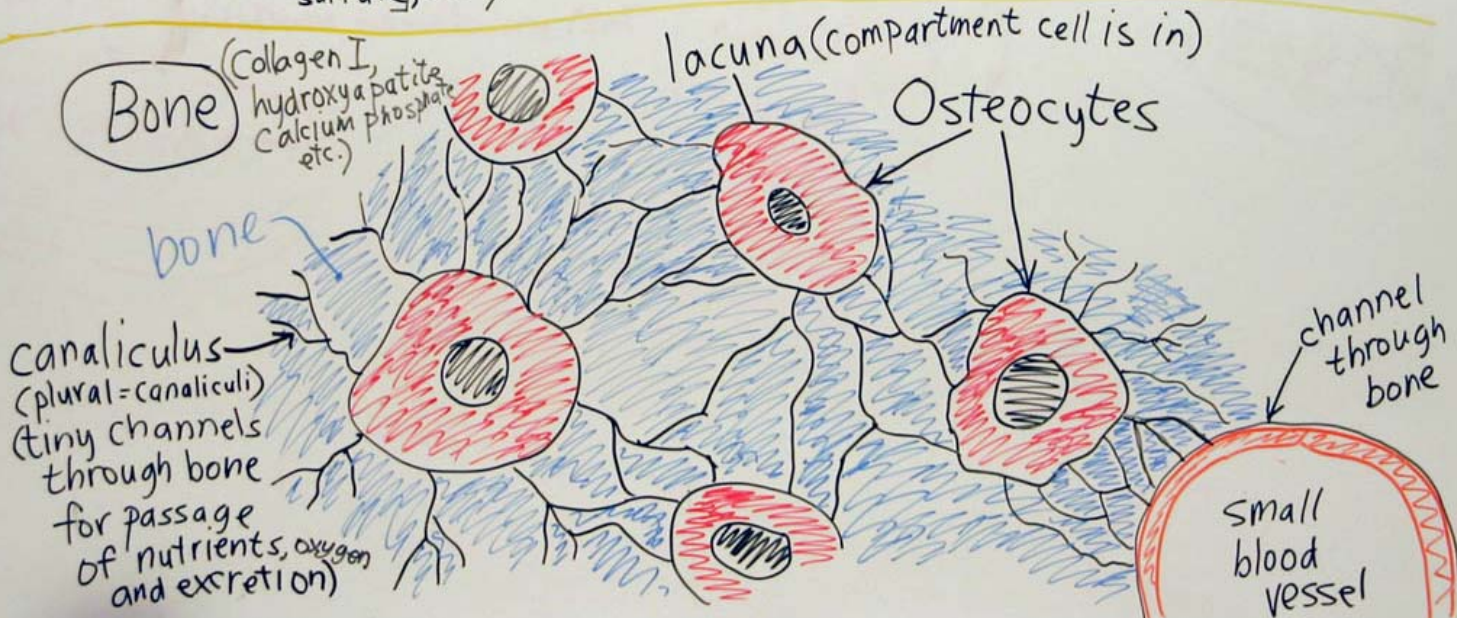
Osteocytes

bone

canaliculus  
(plural = canaliculi)  
(tiny channels  
through bone  
for passage  
of nutrients, oxygen  
and excretion)

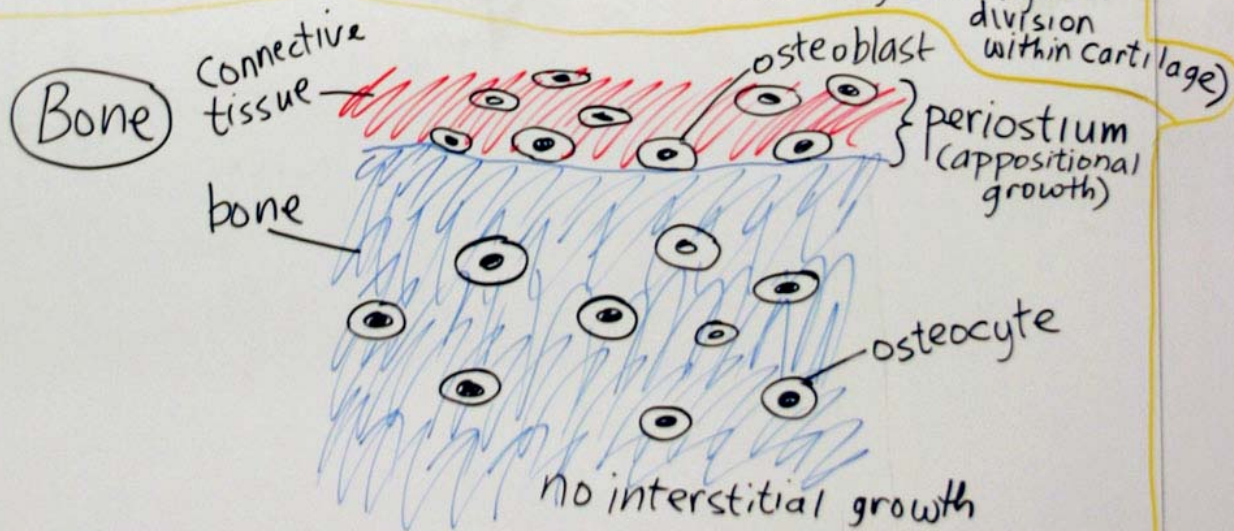
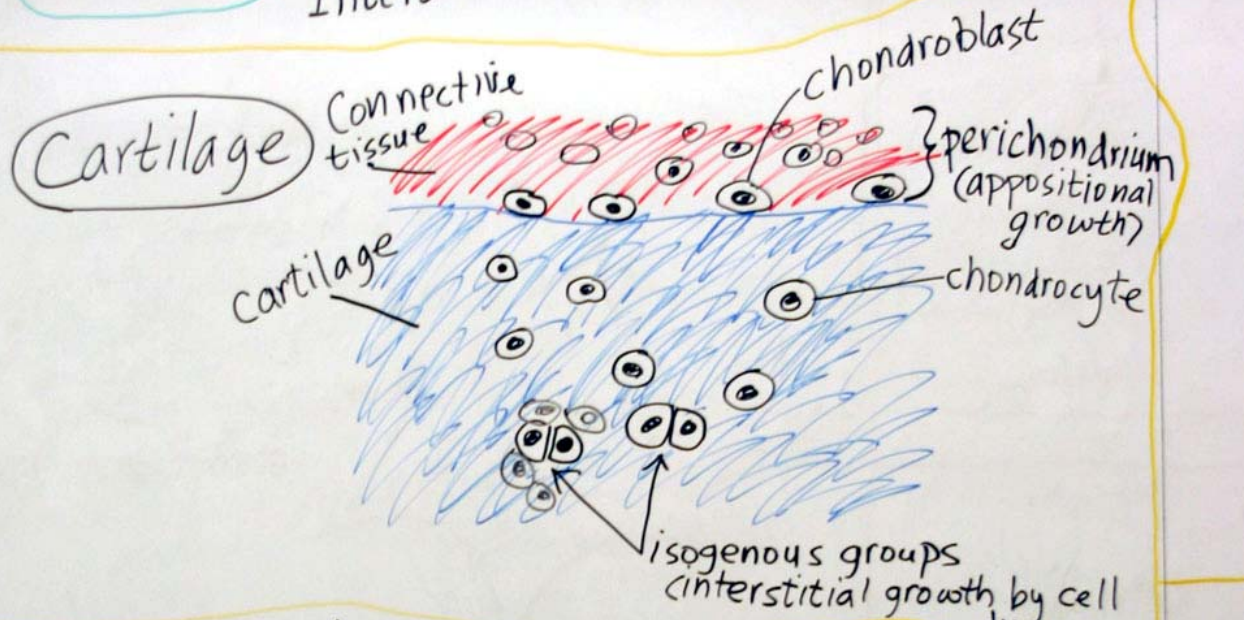
channel  
through  
bone

small  
blood  
vessel

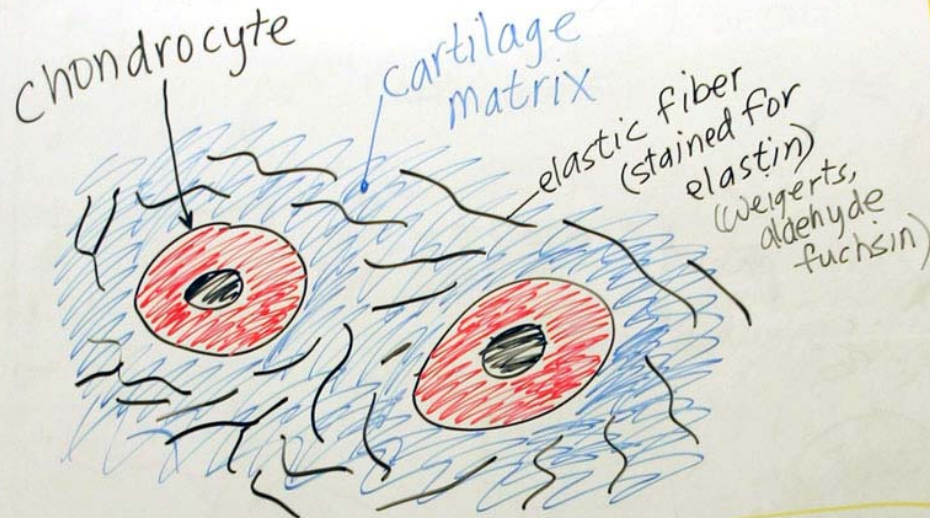




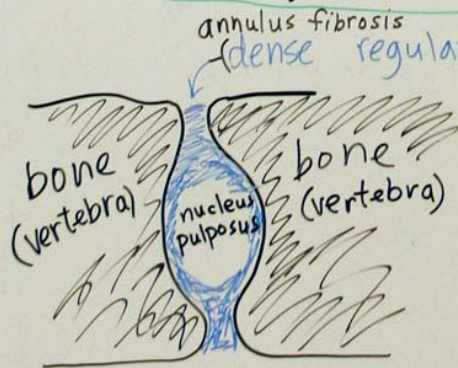
Growth Appositional (at surface)  
Interstitial (within matrix)



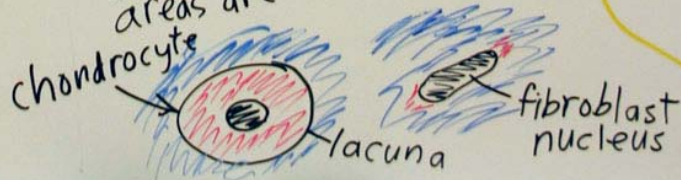
## Elastic cartilage



## Fibrocartilage slide (slide 45)



In areas of dense reg. c.t., look for areas where the cells are in lacunae, and thus are chondrocytes. These areas are fibrocartilage.

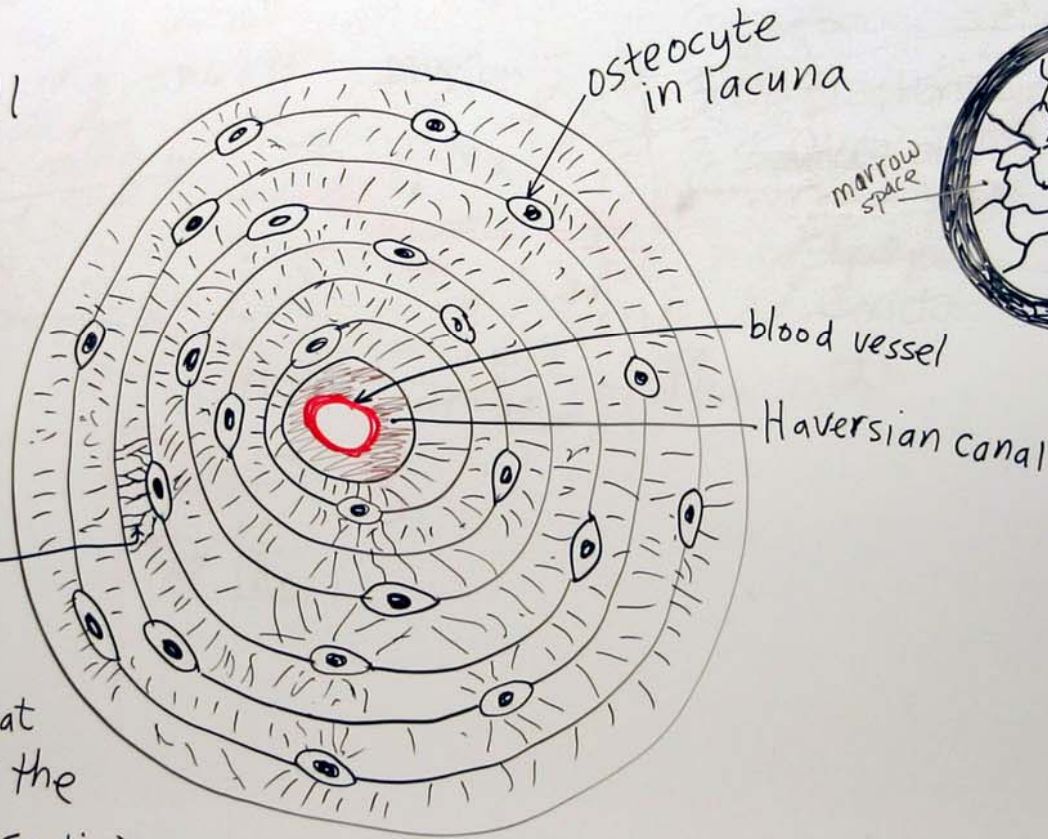




# Compact bone (osteons = Haversian systems)

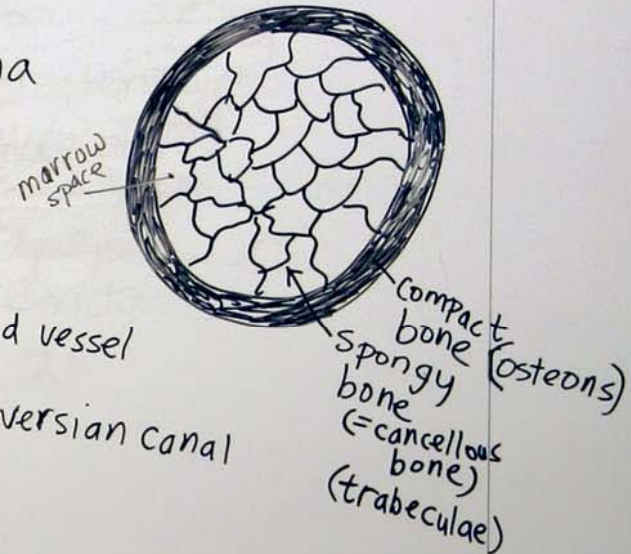
## Cross section of an osteon

(next time we will  
consider how  
osteons develop)



canaliculi  
(many are  
to and from  
osteocytes that  
are out of the  
plane of section)

## Cross section of a long bone



age.

fibroblast  
nucleus



# Bone formation

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# Bone formation

## Embryonic bone formation

### Intramembraneous

Bone forms in situ (in connective tissue)  
(e.g., cranial bones) (=mesenchyme)

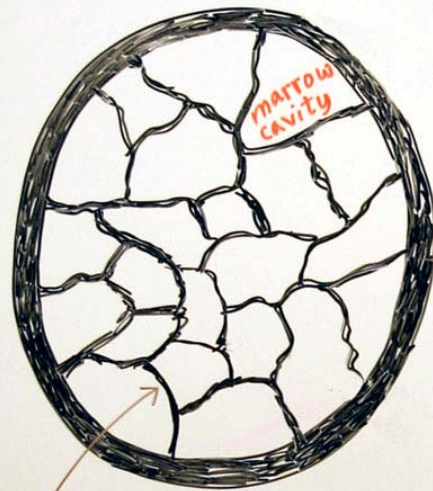
### Endochondral

Cartilage model laid down.  
Bone replaces cartilage.  
(e.g., long bone)

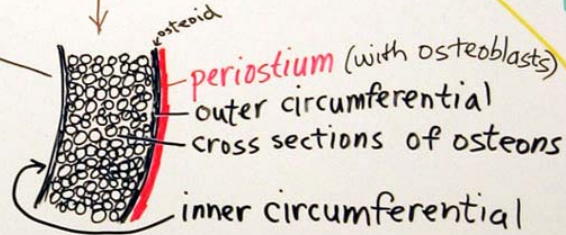
### Bone growth (appositional growth)

In general, bone is laid down in lamellae (layers) by osteoblasts at a bone surface (periosteum, endosteum, osteon) or at a cartilage surface (epiphyseal plate or other endochondrial bone formation).

# Cross section of a long bone



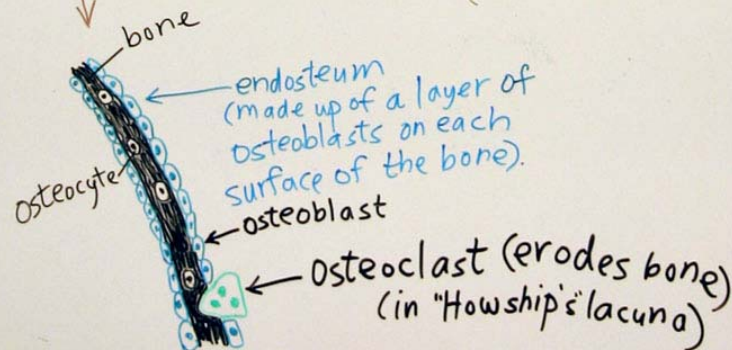
Cortical or Compact bone



bone

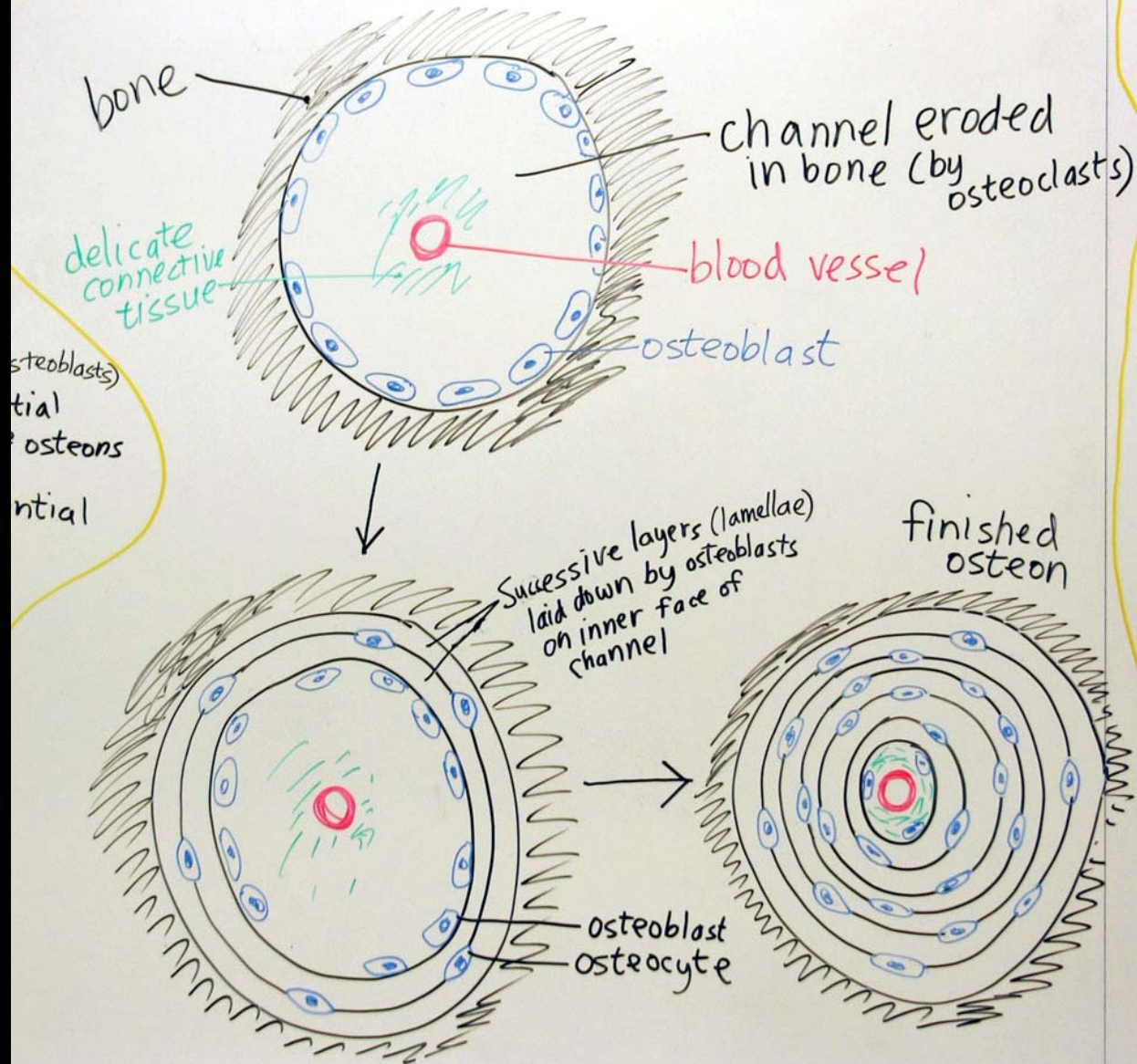
delicate connective tissue

trabeculum (plural=trabeculae) of spongy (or cancellous) bone

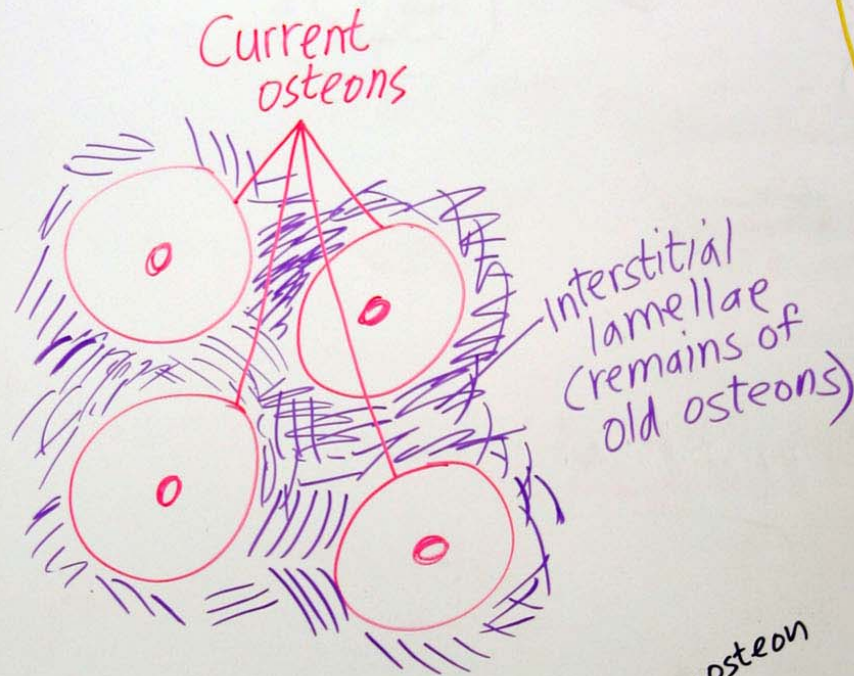




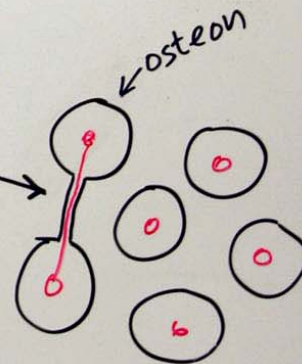
# Formation of osteons (= Haversian systems)



# Reworking of compact bone



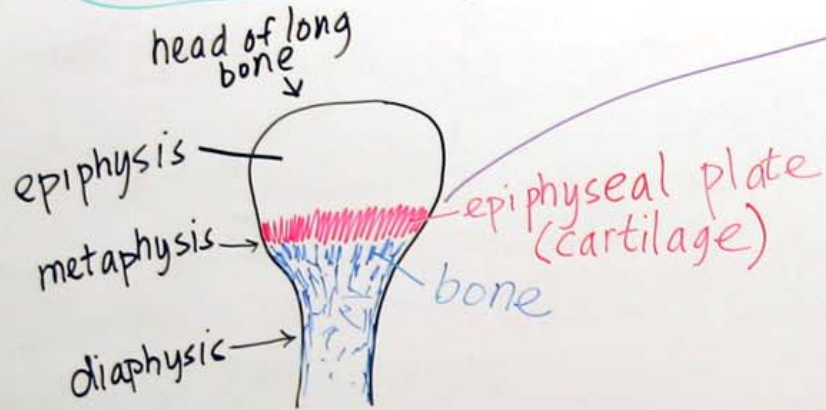
Volkmann's canal  
(blood vessels in cross channels connecting osteons)



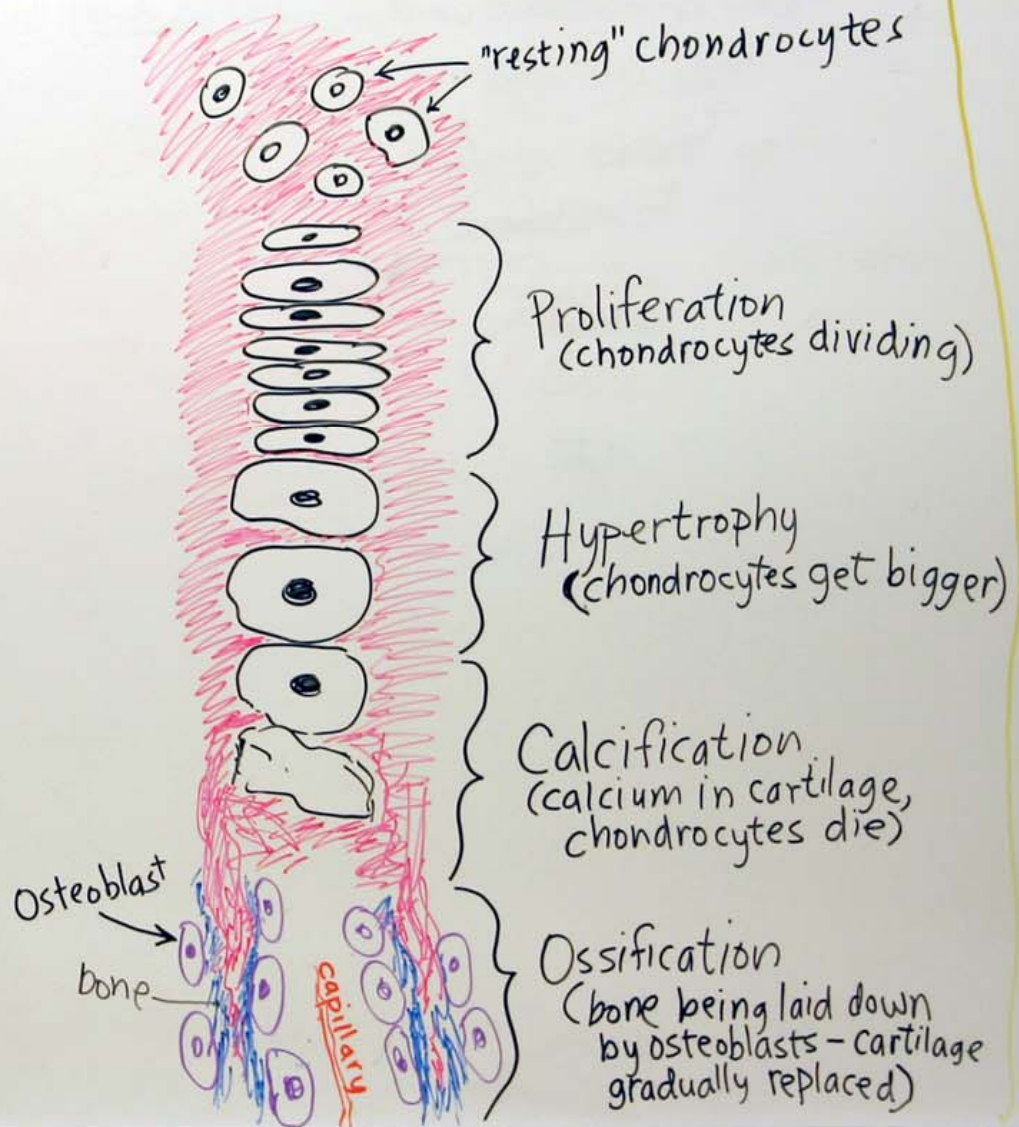


# Lengthening of long bones

(example of endochondral bone formation)



## Zones of epiphyseal plate



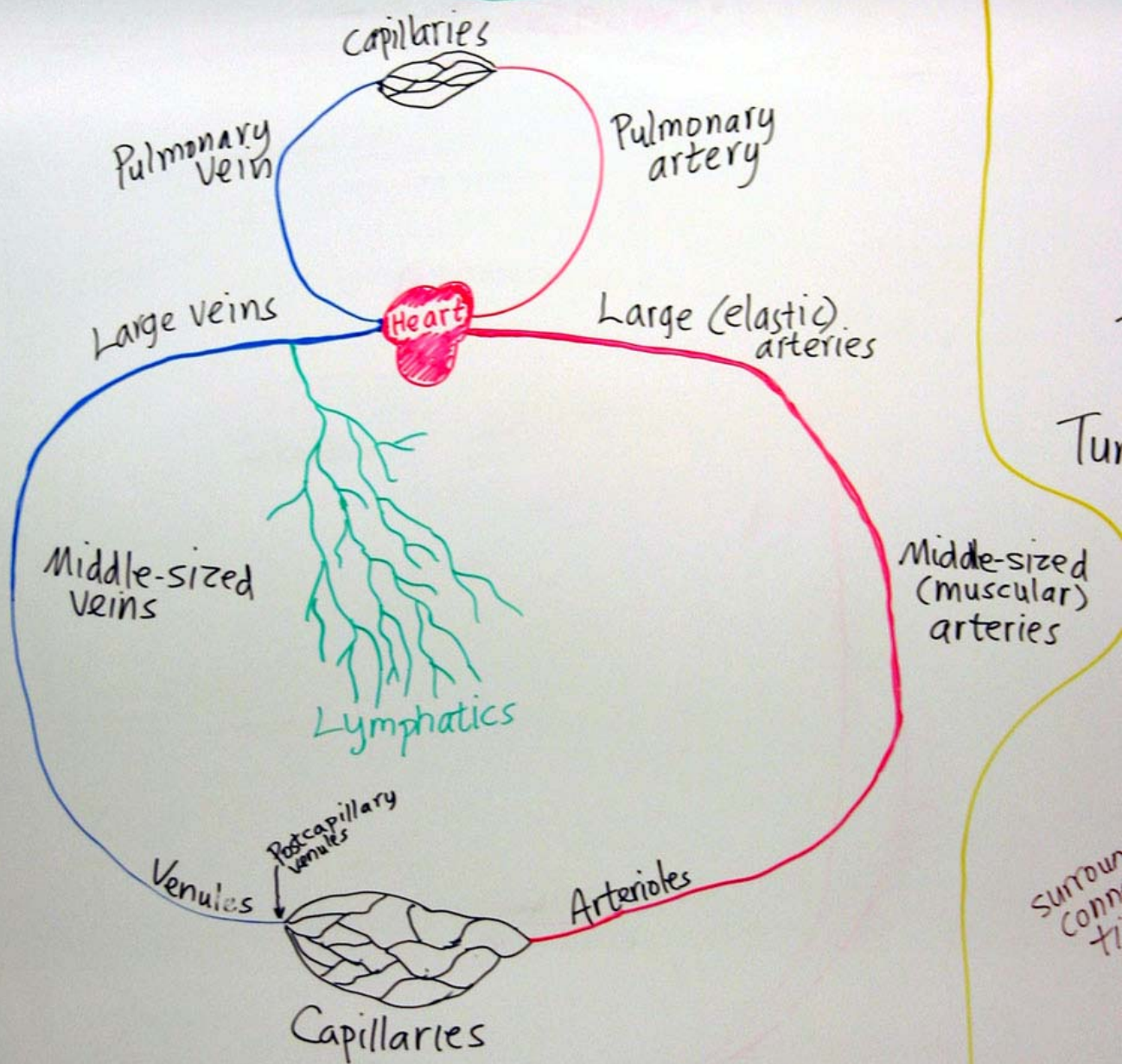


# Cardiovascular

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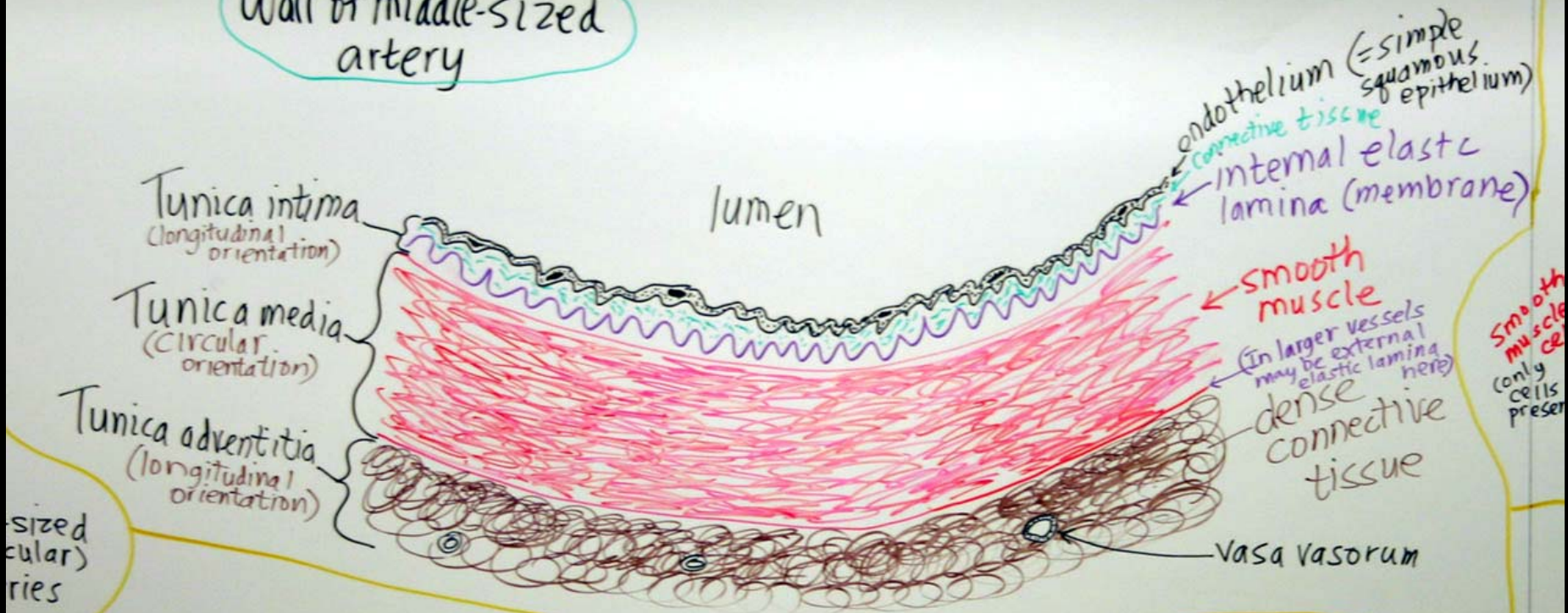
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# Cardiovascular (Circulatory) System

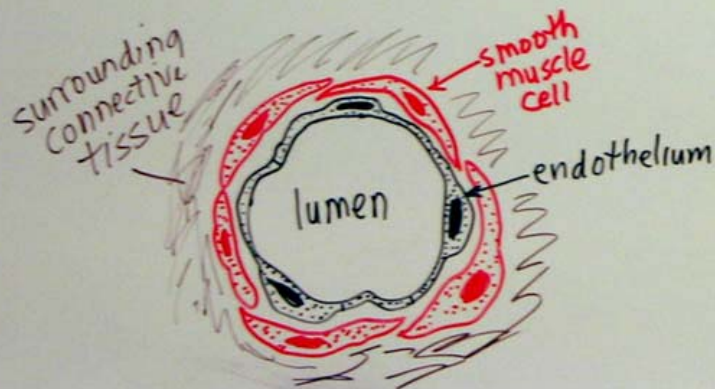




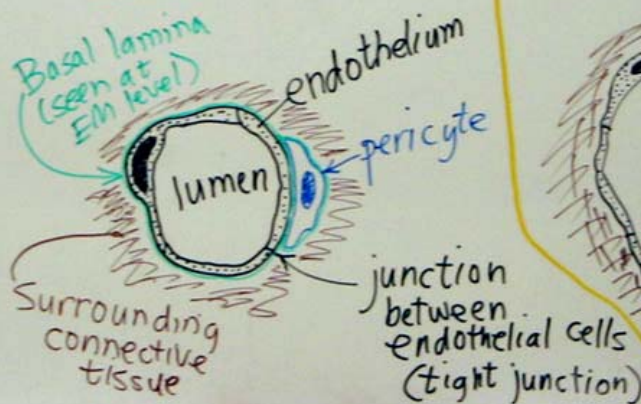
# Wall of middle-sized artery



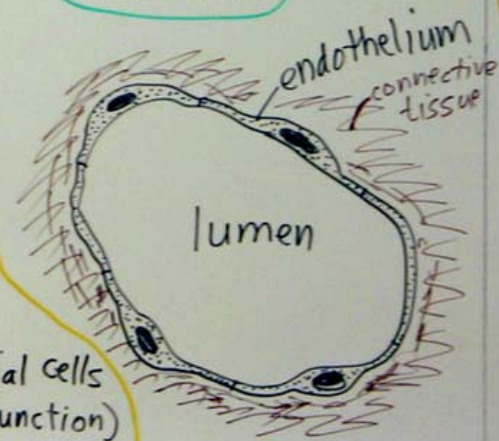
## Arteriole



## Capillary

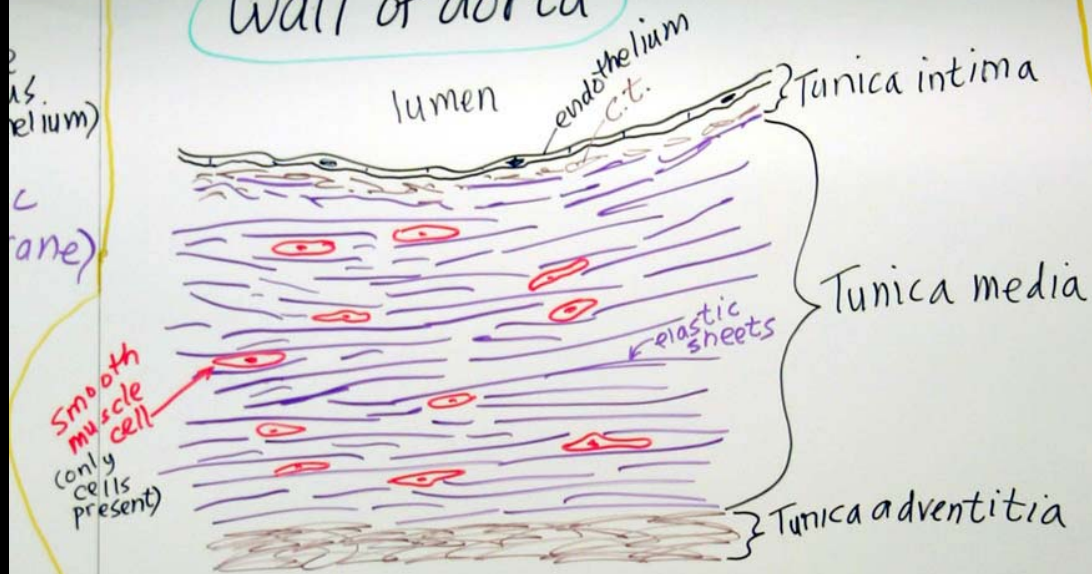


## Venule

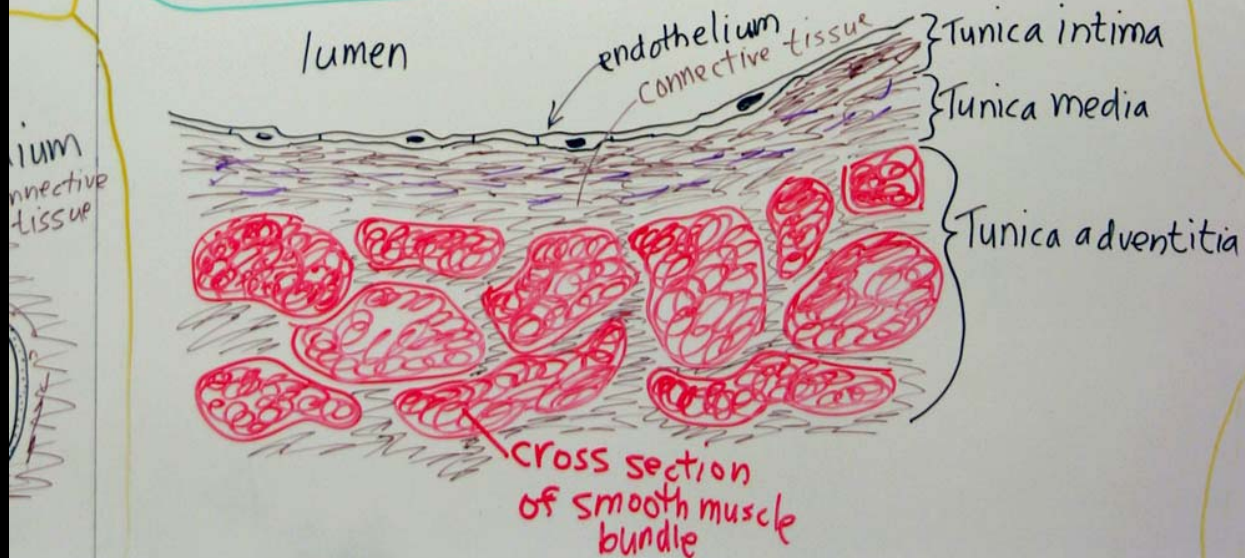




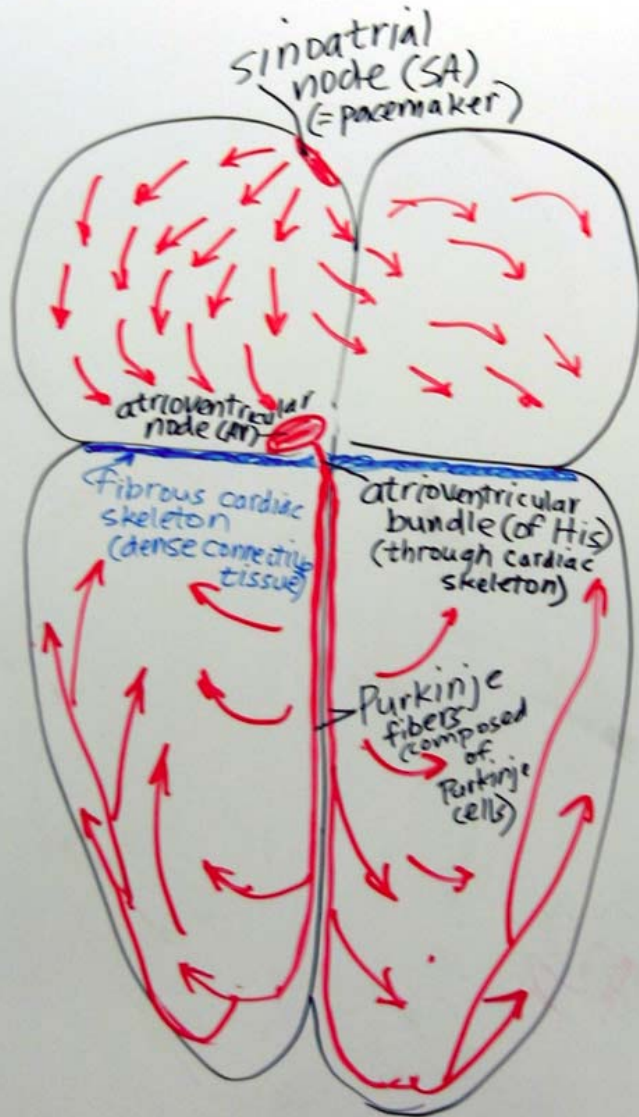
## Wall of aorta



## Wall of inferior vena cava



# Cardiac conduction system



SA and AV nodes, as well as AV bundle and Purkinje fibers, are all composed of cardiac muscle cells that are specialized for conduction

ntitia

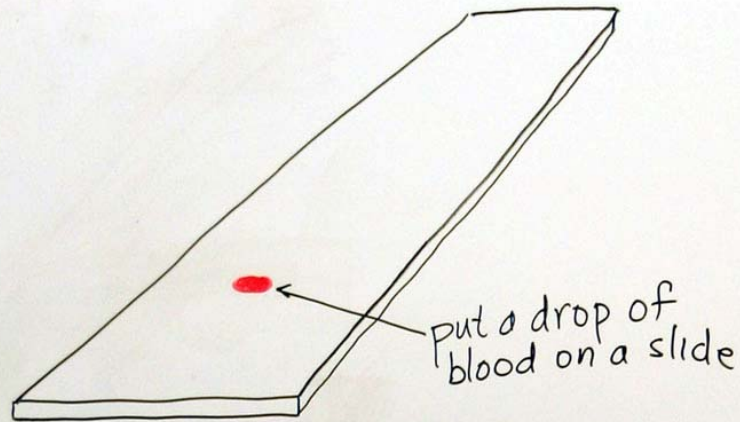
# **Blood and Bone Marrow**

Histology Laboratory Drawings

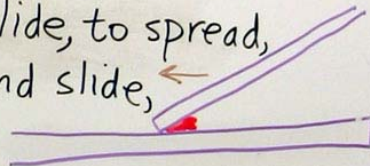
A. Kent Christensen



# Making a blood smear



Touch the drop with another slide, to spread, then gently withdraw the second slide, producing a thin blood smear.

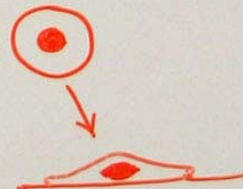


Air dry, then fix in alcohol.

Stain with Wright blood stain, Giemsa, or other stain

Apply coverslip.

**White blood cells:** Remember that the cells you see in a smear are not sectioned. You are seeing the whole cells, dried down on the glass like fried eggs.





# BLOOD CELLS

RBC = erythrocyte = red cell  
WBC = leukocyte = white cell

Greek for:

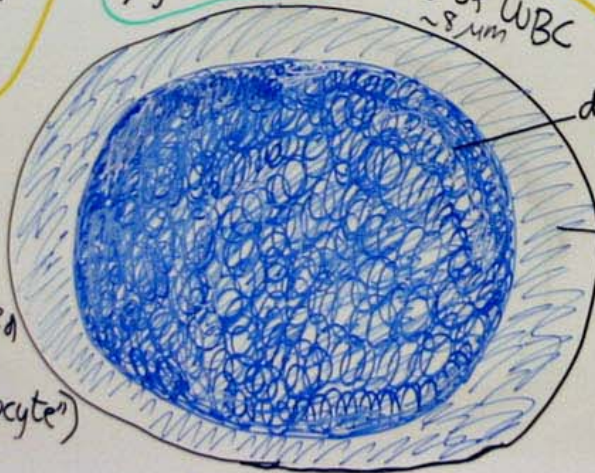
Red blood cell (RBC)  
= erythrocyte

Biconcave  
disk, so  
light  
center



~8  $\mu$ m diameter  
(compare size  
of WBCs)

cells  
often  
larger  
("medium-sized  
lymphocyte",  
"Large lymphocyte")



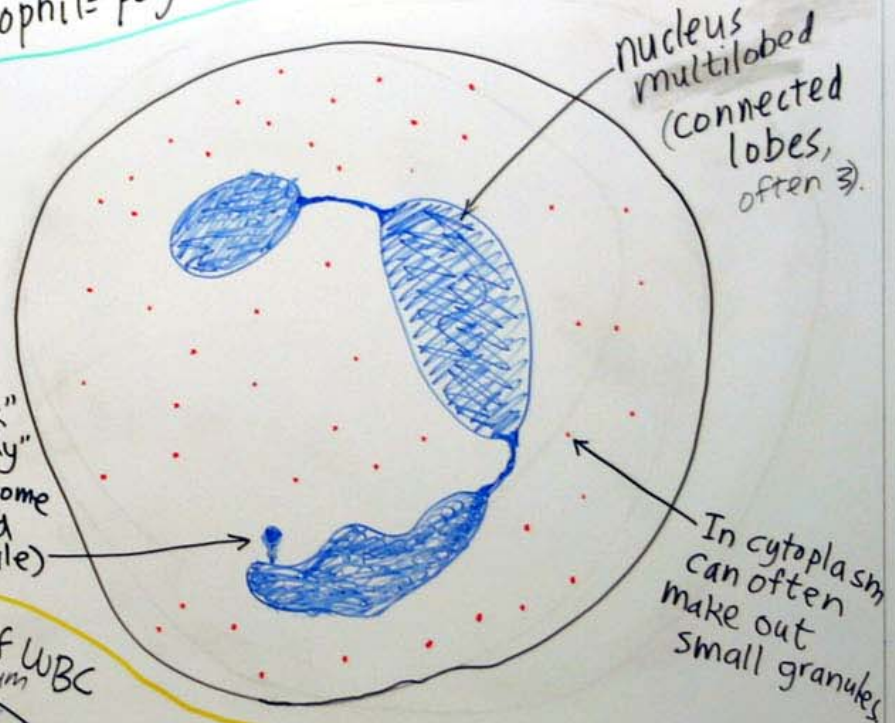
Lymphocyte ~25% of WBC  
~8  $\mu$ m

dense,  
round nucleus

sparse cytoplasm  
("robin egg blue")

You can't tell whether  
B or T lymphocyte

Neutrophil = polymorphonuclear leukocyte (PMN)



nucleus  
multilobed  
(connected  
lobes,  
often 3)

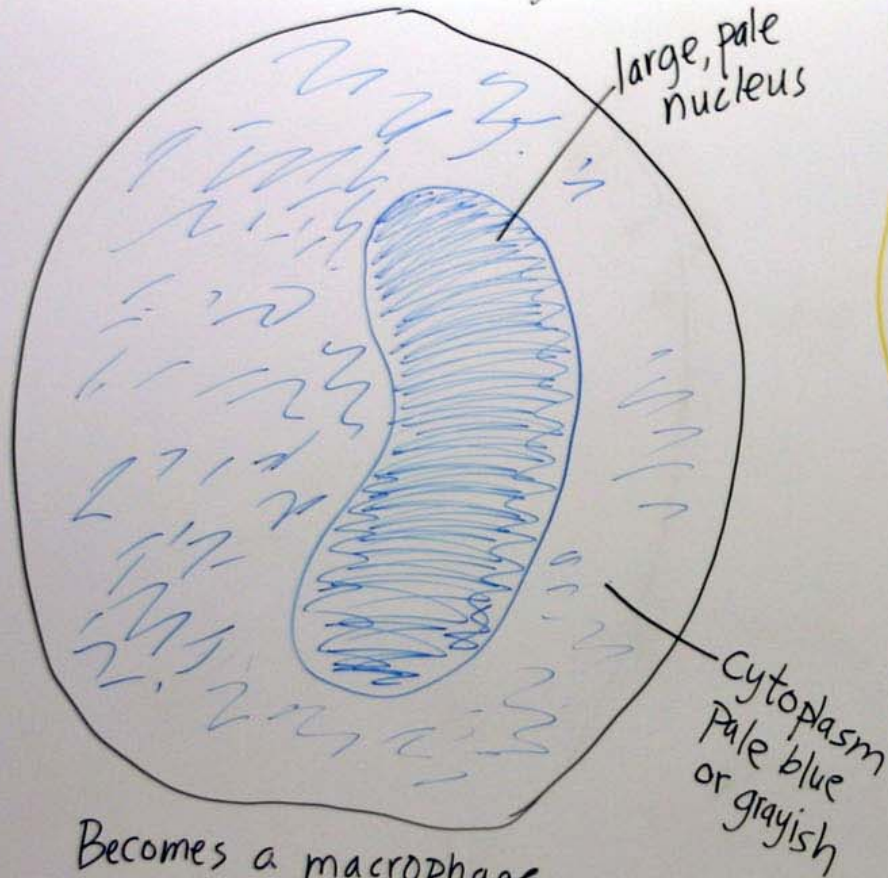
"Drumstick"  
= "Barr body"  
(X chromosome  
inactivated  
in female)

In cytoplasm  
can often  
make out  
small granules



## Monocyte

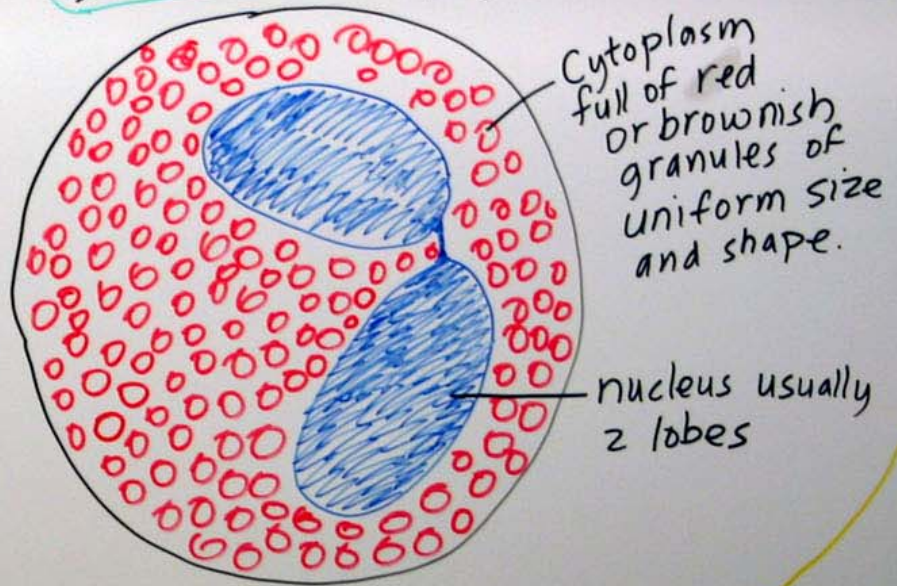
About 7% of WBC  
~16  $\mu\text{m}$



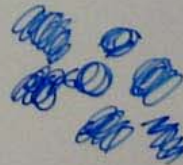
Becomes a macrophage  
in tissue

## Eosinophil

~4% of WBC  
~10-12  $\mu\text{m}$



Platelets (thrombocytes)  
(involved in blood clotting)



Is this  
granul  
in the  
nuc  
(Thin  
f



ish  
of  
n size  
ape.

usually

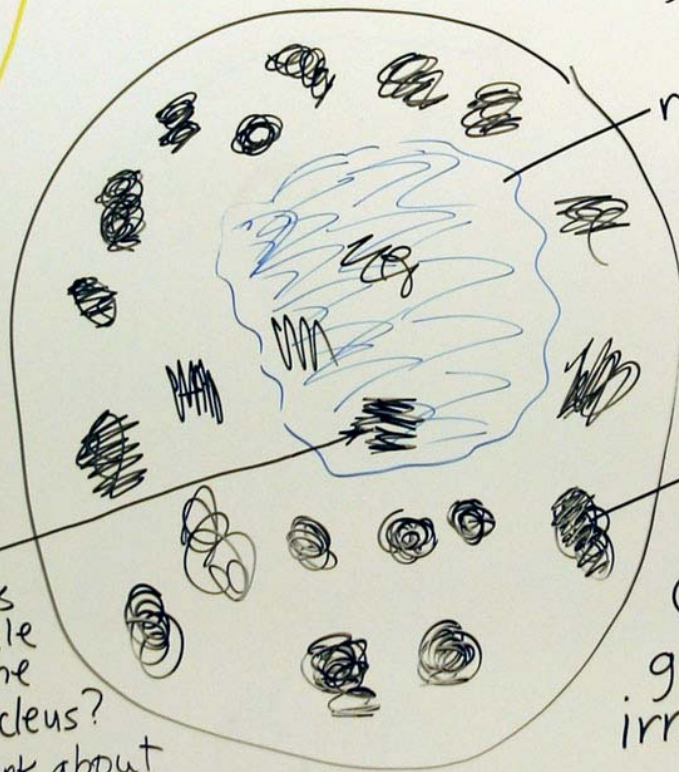
Basophil

<1% of WBC  
~8-10  $\mu$ m.

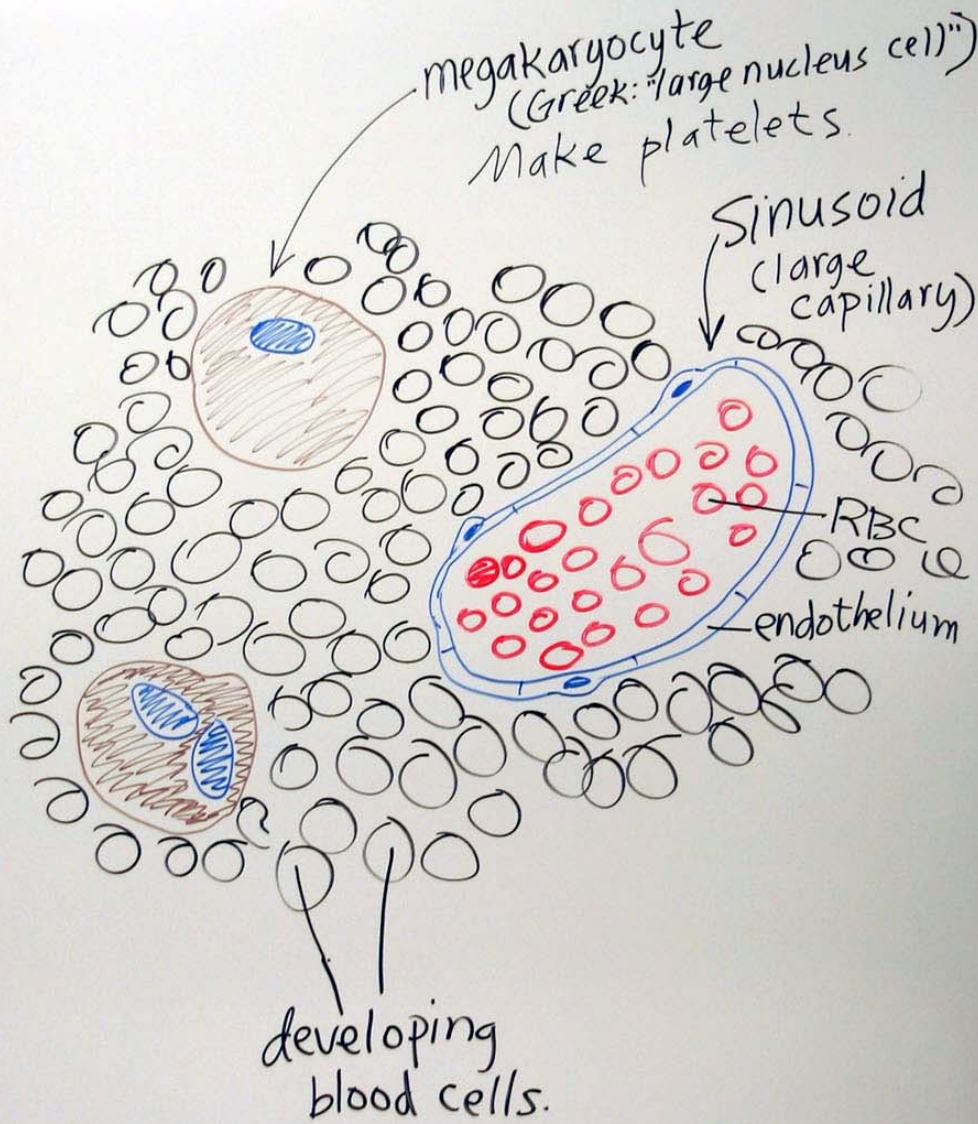
nucleus  
usually not  
clearly seen

Is this  
granule  
in the  
nucleus?  
(Think about  
fried egg).

In cytoplasm  
are large black  
(or dark purple)  
granules of  
irregular size and  
shape (contain  
histamine, etc., like  
those of mast cells)



# BONE MARROW SECTION (Slide 48)



# Respiratory

Histology Lab Drawings

A. Kent Christensen

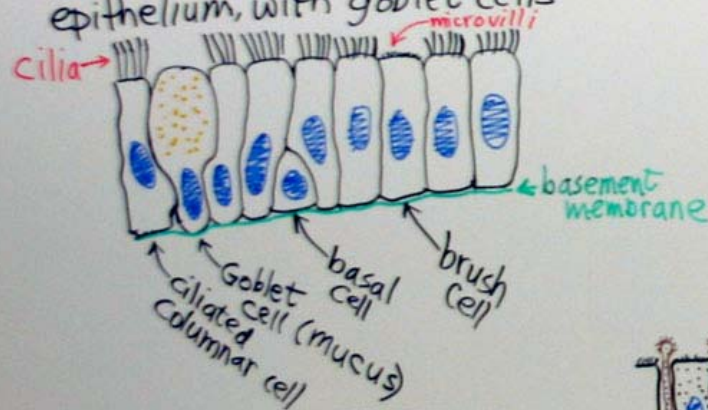


# RESPIRATORY SYSTEM

See diagram on page 84 of the lab guide showing how far components extend down the respiratory tract.

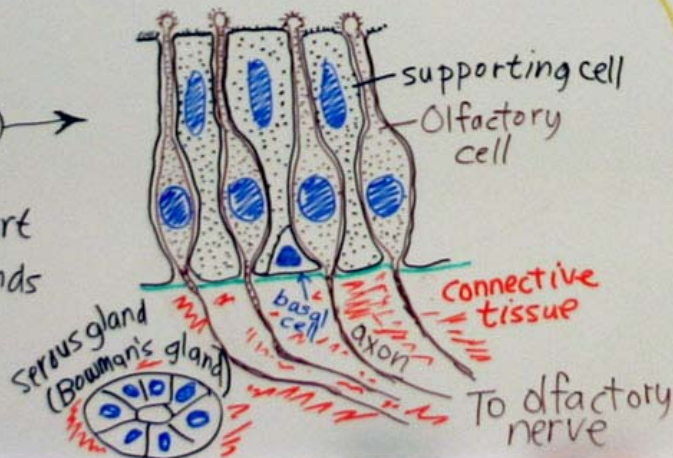
## Respiratory epithelium

= pseudostratified columnar epithelium, with goblet cells.



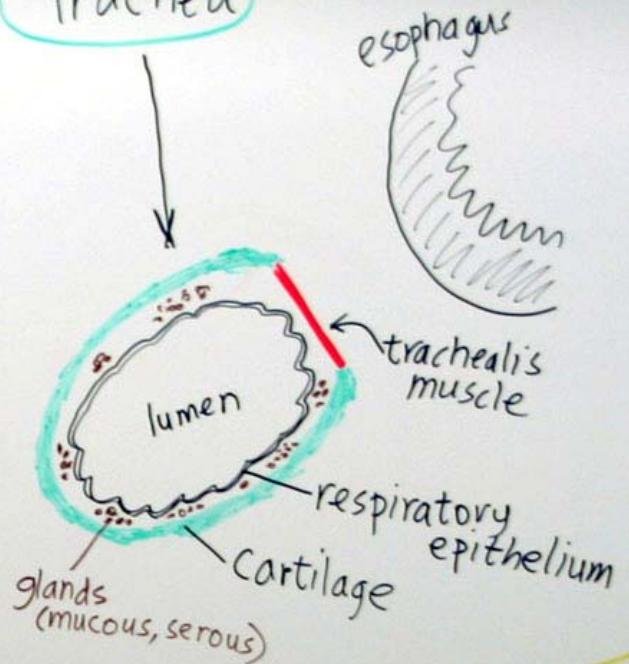
## Olfactory epithelium

Sense of smell. Thicker, no goblet cells. Superior part of nasal cavity. Serous glands underneath.



"Mucosa" = lining epithelium plus underlying connective tissue (lamina propria)

## Trachea



## Lung vasculature

**Pulmonary artery** (always near bronchus or bronchiole)

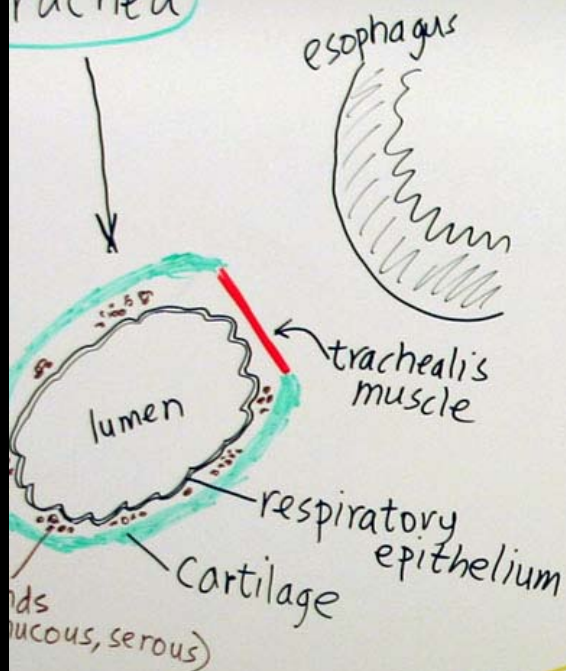
**Bronchial artery** (small, thick wall; always near bronchus or bronchiole; oxygenated blood)

**Pulmonary vein** (far from bronchus or bronchioles)

There are also bronchial veins, but you

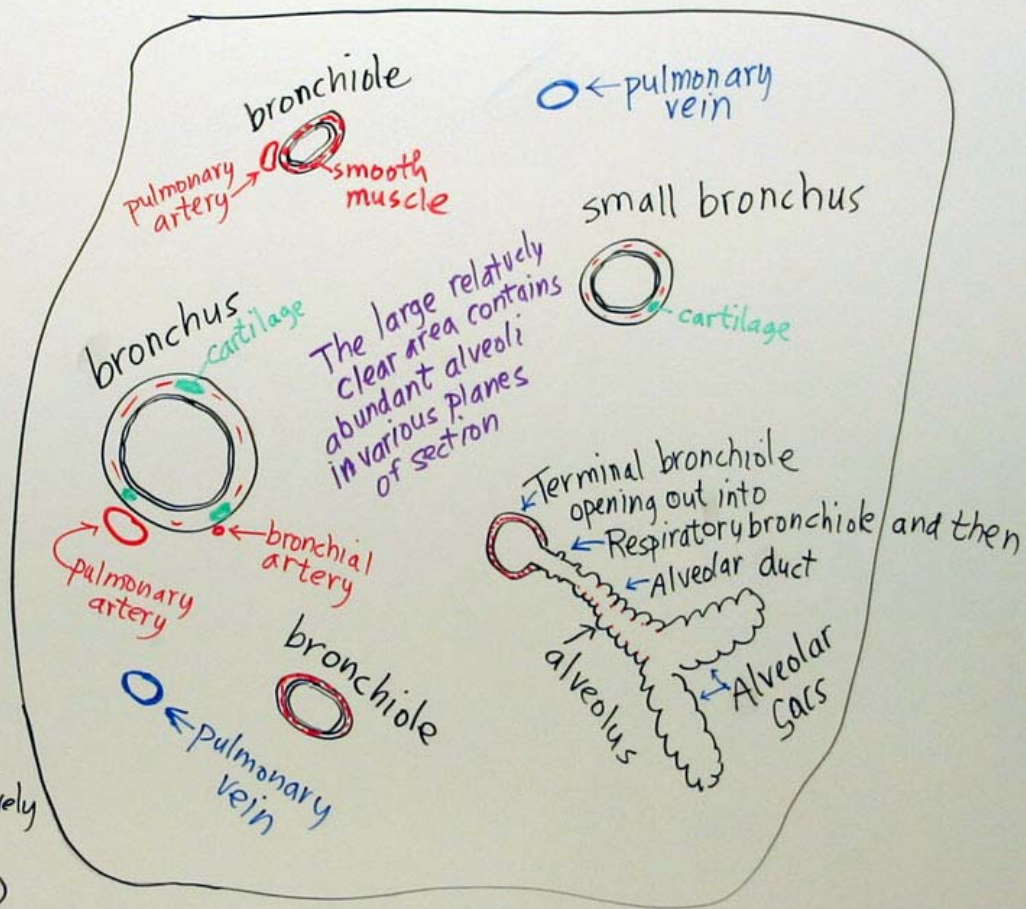


# Trachea



# Lung

Low power LM of lung



## Lung vasculature

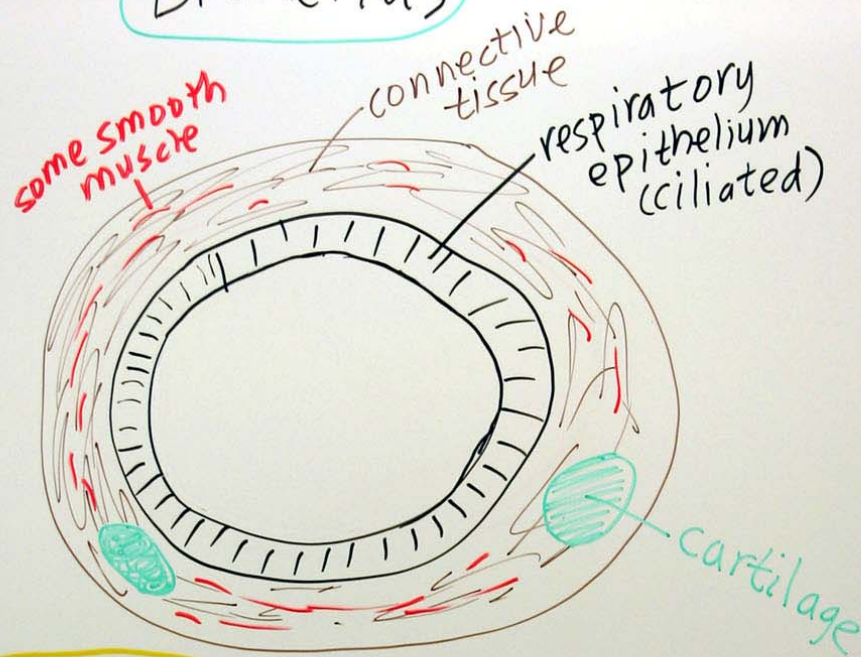
**Pulmonary artery** (always near bronchus or bronchiole)

**Bronchial artery** (small, relatively thick wall; always near bronchus or bronchiole; oxygenated blood)

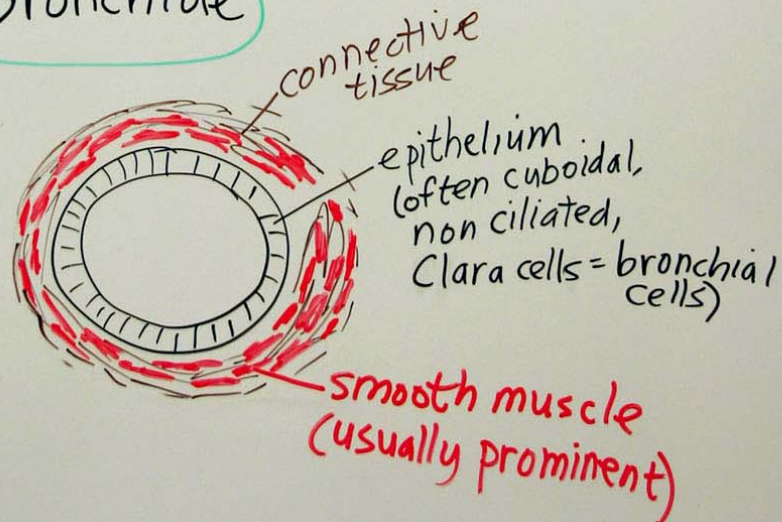
**Pulmonary vein** (far from bronchi or bronchioles).

There are also bronchial veins, but you are not likely to see them.

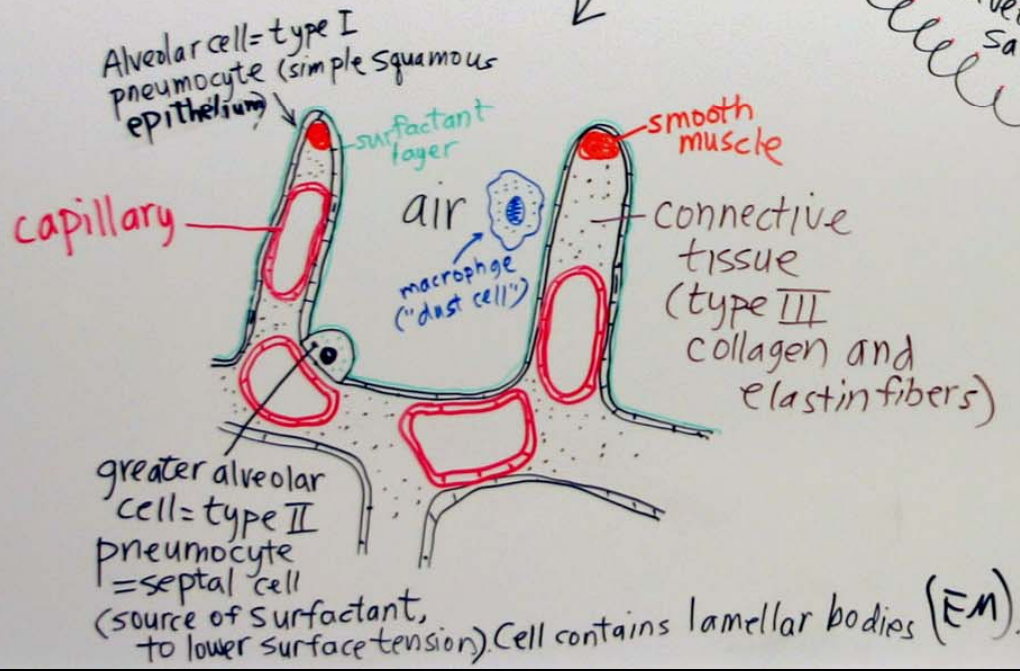
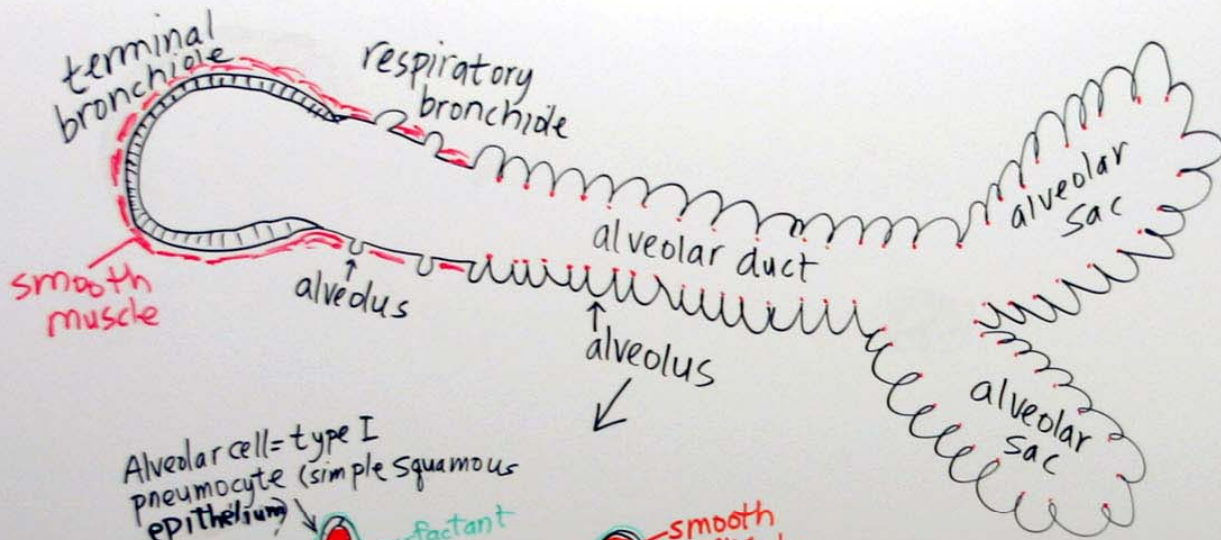
## Bronchus



## Bronchiole







### Blood-air barrier

- ① Surfactant
- ② Alveolar cell
- ③ Fused basal laminae of alveolar cell and capillary
- ④ Capillary endothelial cell

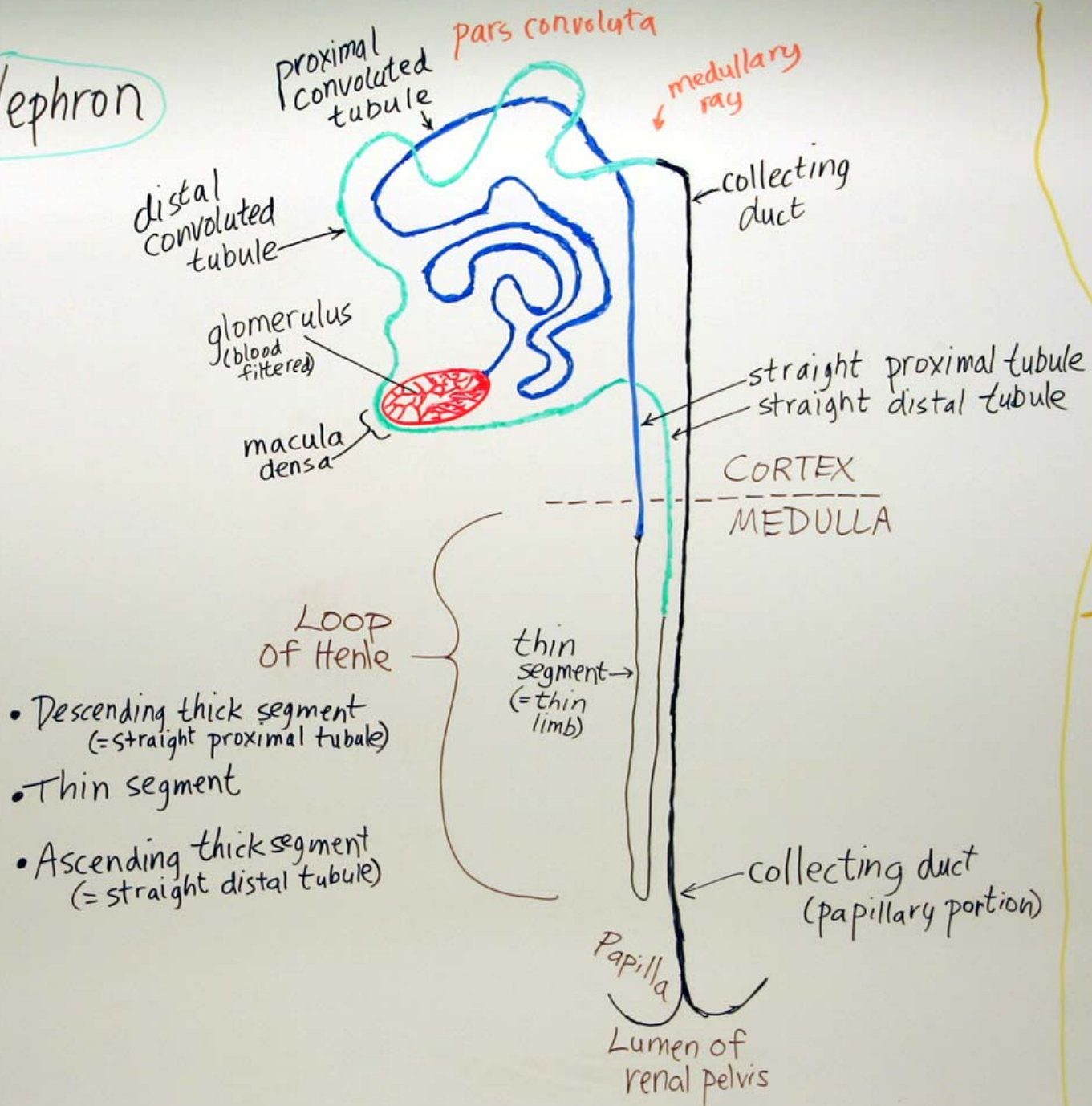
# Urinary System

Histology Lab Drawings

A. Kent Christensen



# Nephron



# Tubules

proximal tubule

boundary between cells usually not clearly seen



cytoplasm (usually pink = eosinophilic)

brush border (= microvilli) (often not well preserved)

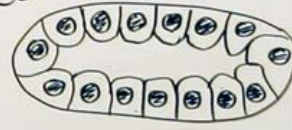
distal tubule

Smaller tubule, cell margins indistinct



collecting duct

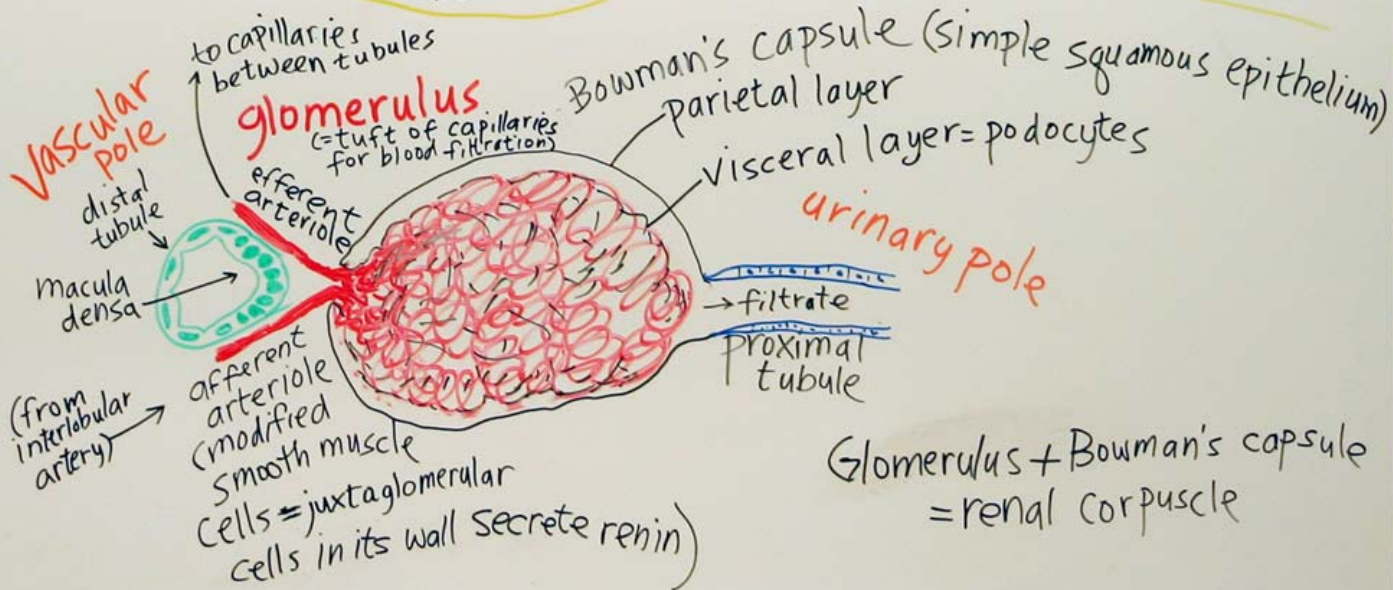
(about same size as distal tubule, cells more distinct, round nuclei)



Thin segment



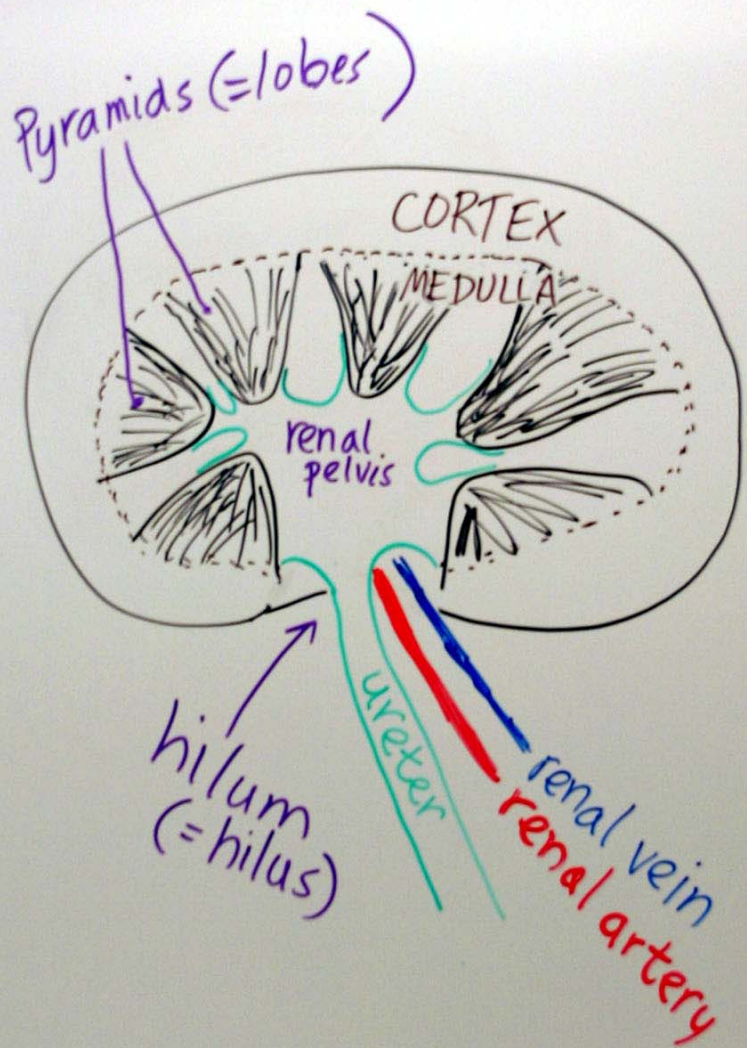
(looks like a capillary, but no RBCs).



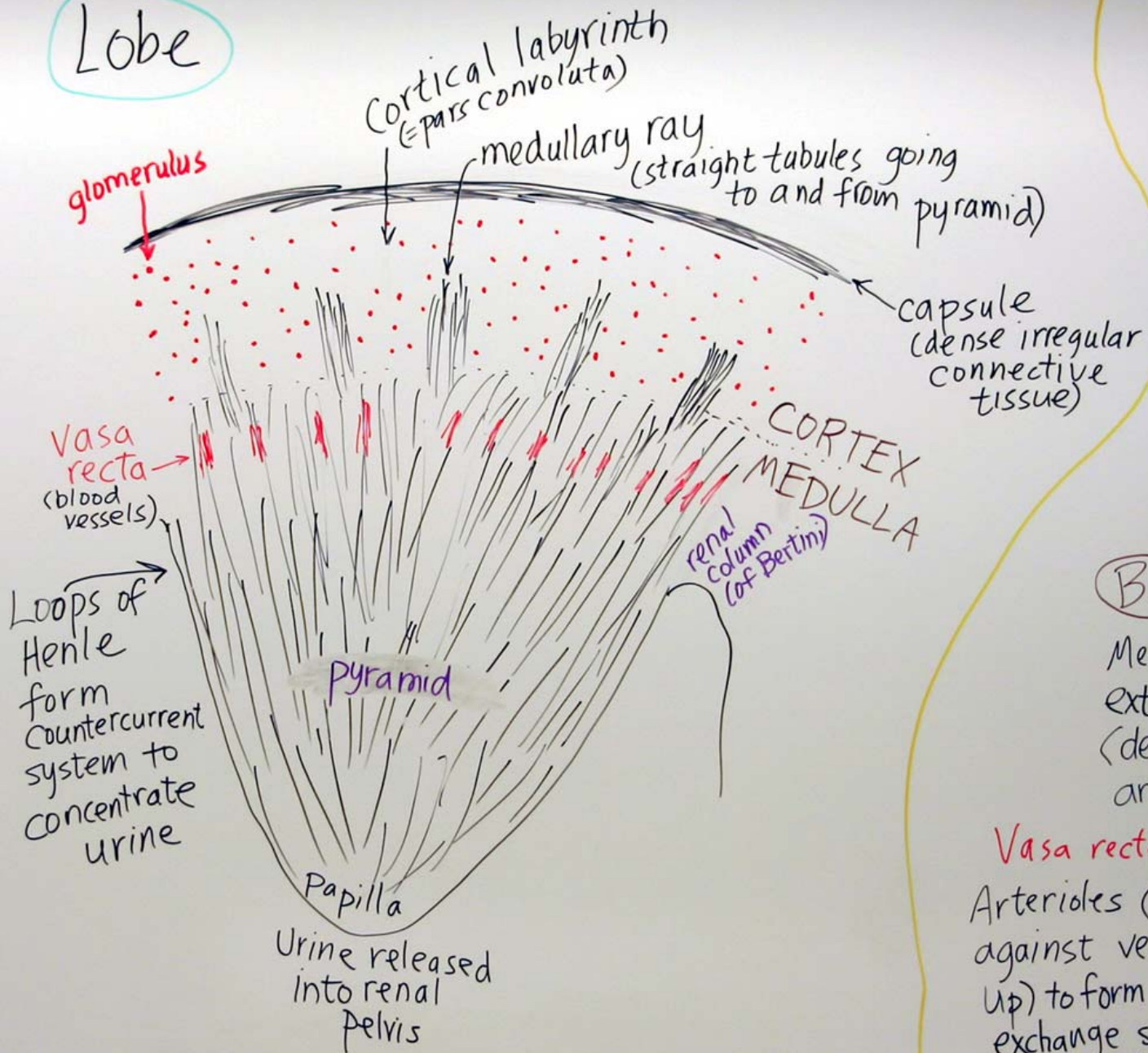
Glomerulus + Bowman's capsule = renal corpuscle



# Kidney



# Lobe



Blood

Medulla  
extends  
(derived  
arteries)

Vasa recta (Arterioles (blood) against venules (blood) to form an exchange system by blood flow)

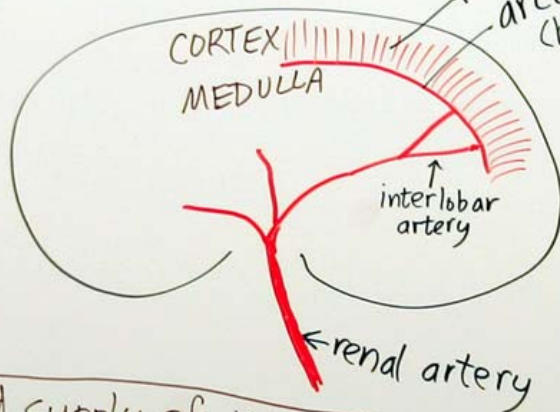


# Renal Vasculature

## Blood supply of Cortex (Arteries shown (veins parallel))

ing  
pyramid)

apsule  
dense irregular  
connective  
tissue)



interlobular arteries (supply glomeruli)  
arcuate artery  
(between cortex and medulla)

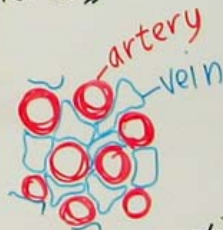
Medullary rays are considered to be the center of lobules in the cortex. Interlobular arteries are in the Pars convoluta between the medullary rays (which is why they are "interlobular")

## Blood supply of medulla

Medulla is supplied by small vessels extending down from the cortex (derived mostly from efferent arterioles of juxtamedullary glomeruli)

Vasa recta (see Lobe drawing)

Arterioles (blood going down) lie against venules (blood coming up) to form a countercurrent exchange system to minimize salt loss by blood from the gradient



Cross section of Vasa recta

# Oral Cavity

Histology Lab Drawings

A. Kent Christensen



# GI-1: ORAL CAVITY

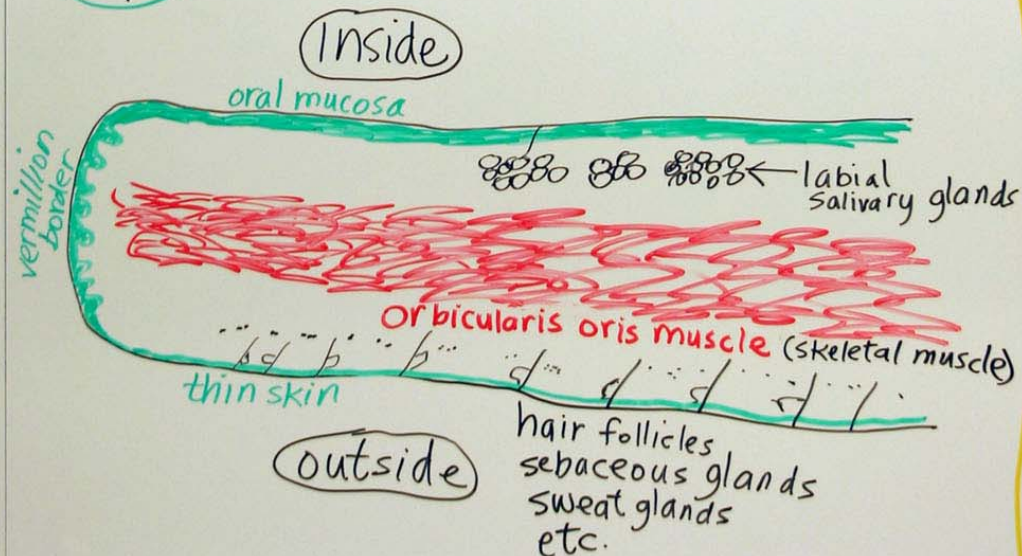
## Oral mucosa

(1) Epithelium (stratified squamous non-keratinized, unless in place where abrasion, then keratinized.)

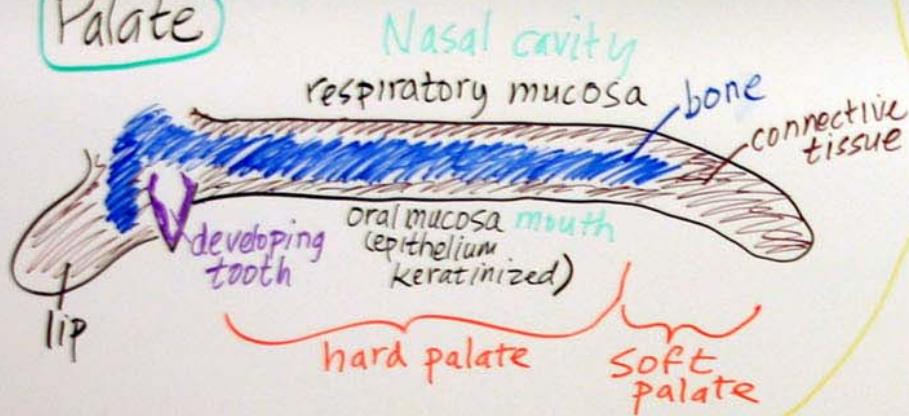
(2) Lamina propria (connective tissue underlying the epithelium)

Submucosa (layer of connective tissue under the mucosa — boundary between lamina propria and submucosa may not be well-defined.)

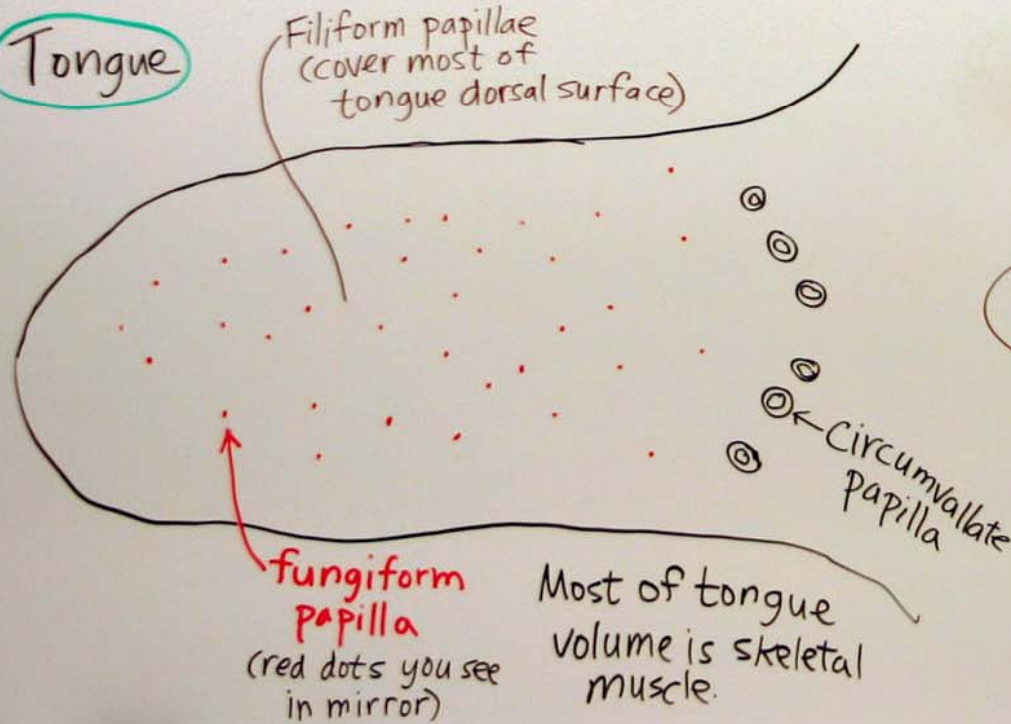
## Lip



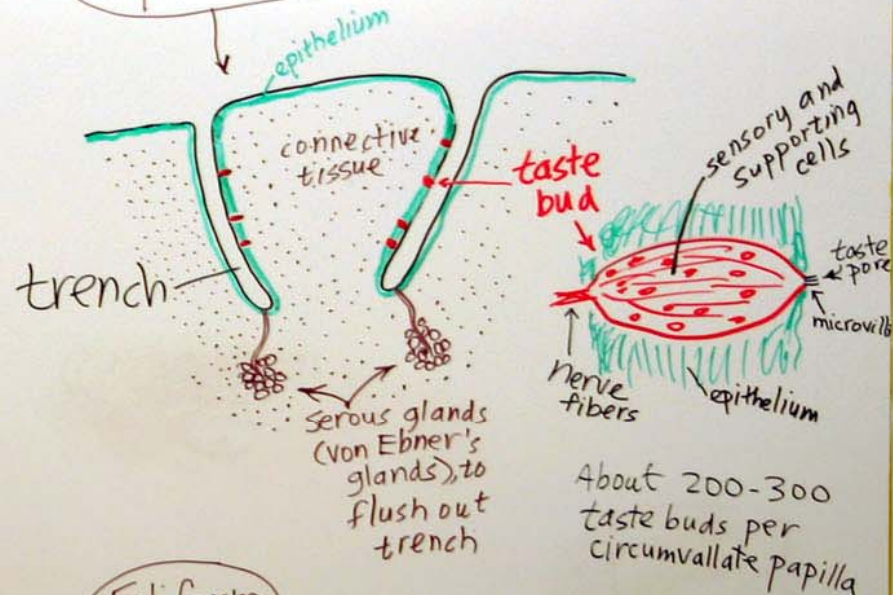
# Palate



# Tongue



# Circumvallate papilla



About 200-300 taste buds per circumvallate papilla

# Filiform papillae



# Fungiform papilla

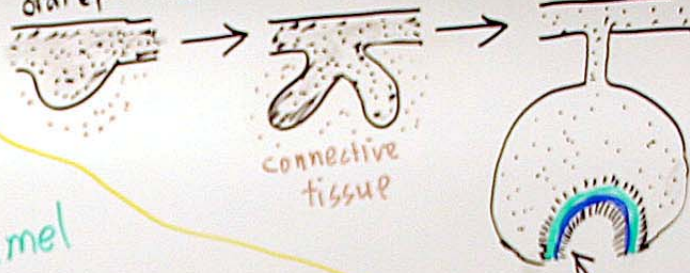
(occasional taste buds)



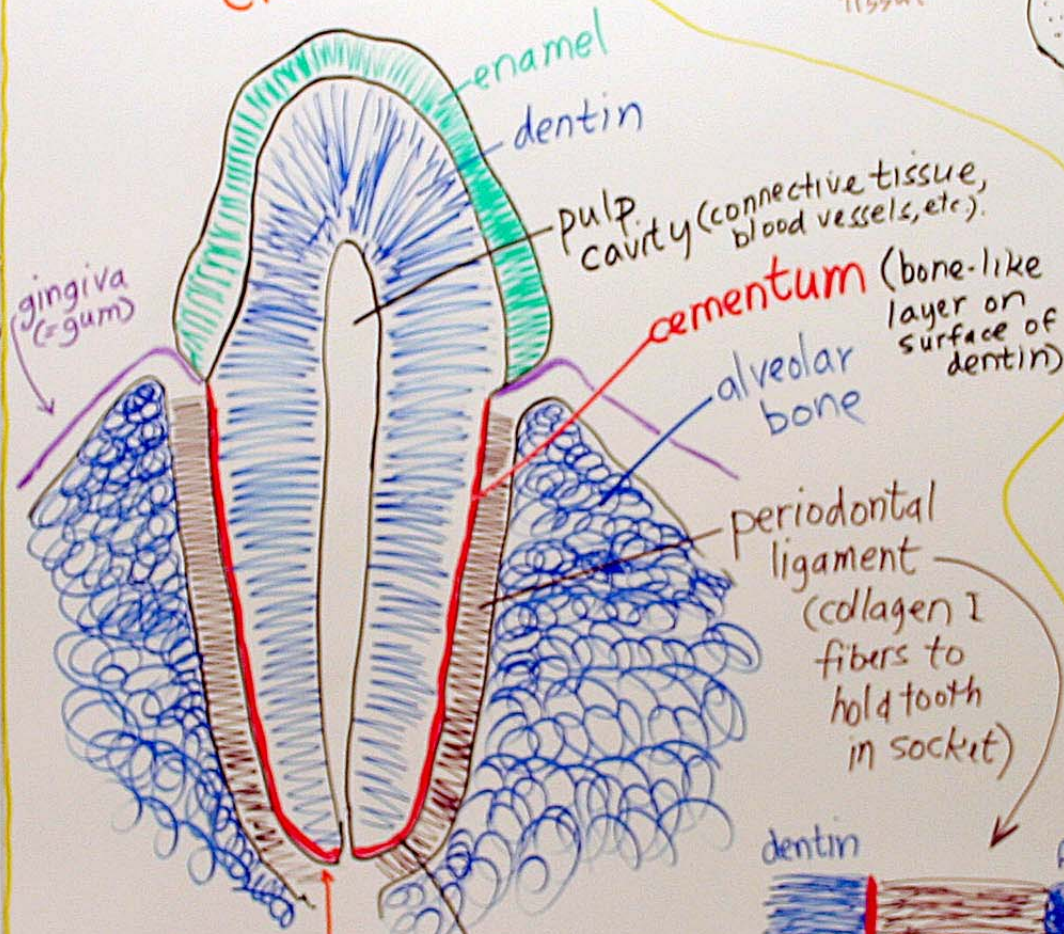


# Tooth and alveolus (=socket)

Tooth development  
oral epithelium

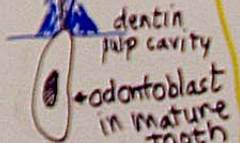
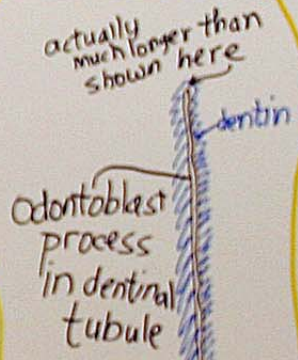
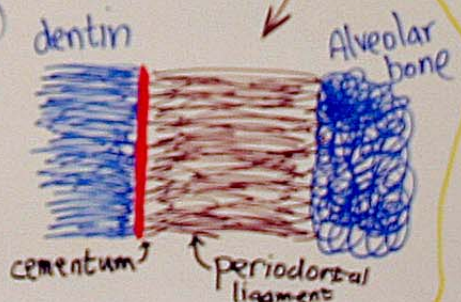


CROWN



ROOT

Cementum is cellular in this area



Major

Se

mu

In sect



# Salivary glands

Serous gland → fluid rich in proteins  
Mucous gland → mucus

Major

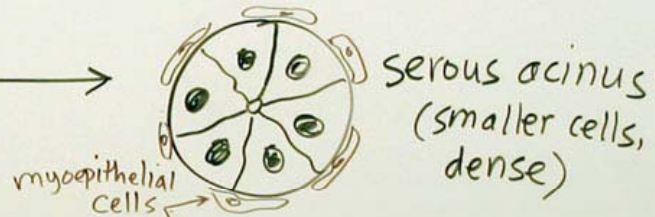
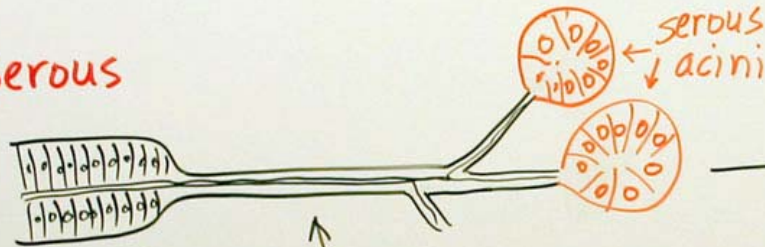
Parotid (all serous)

Submandibular (mixed serous and mucous)

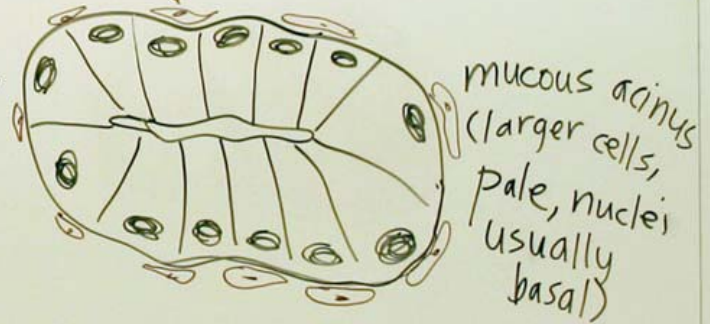
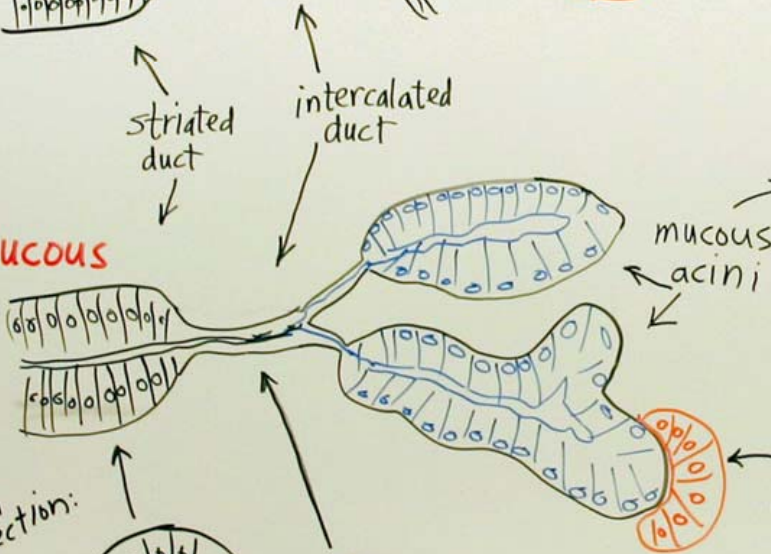
Sublingual (mostly mucous)

In section:

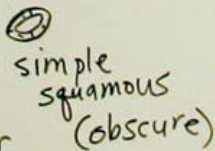
Serous



Mucous



In section:

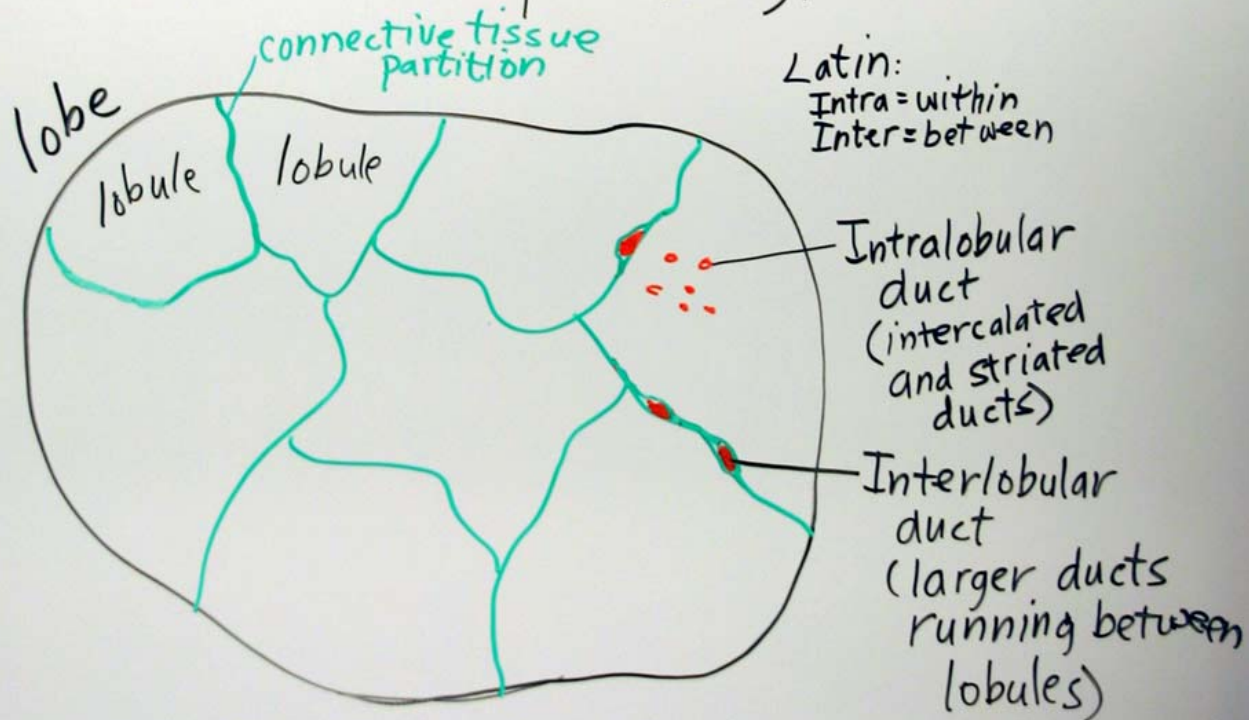


dentin  
pulp cavity  
odontoblast  
in mature  
tooth



# Salivary gland lobes and lobules

A salivary gland is divided into lobes, which are further divided into lobules (separated by connective tissue partitions).



# Esophagus & Stomach

Histology Lab Drawings

A. Kent Christensen



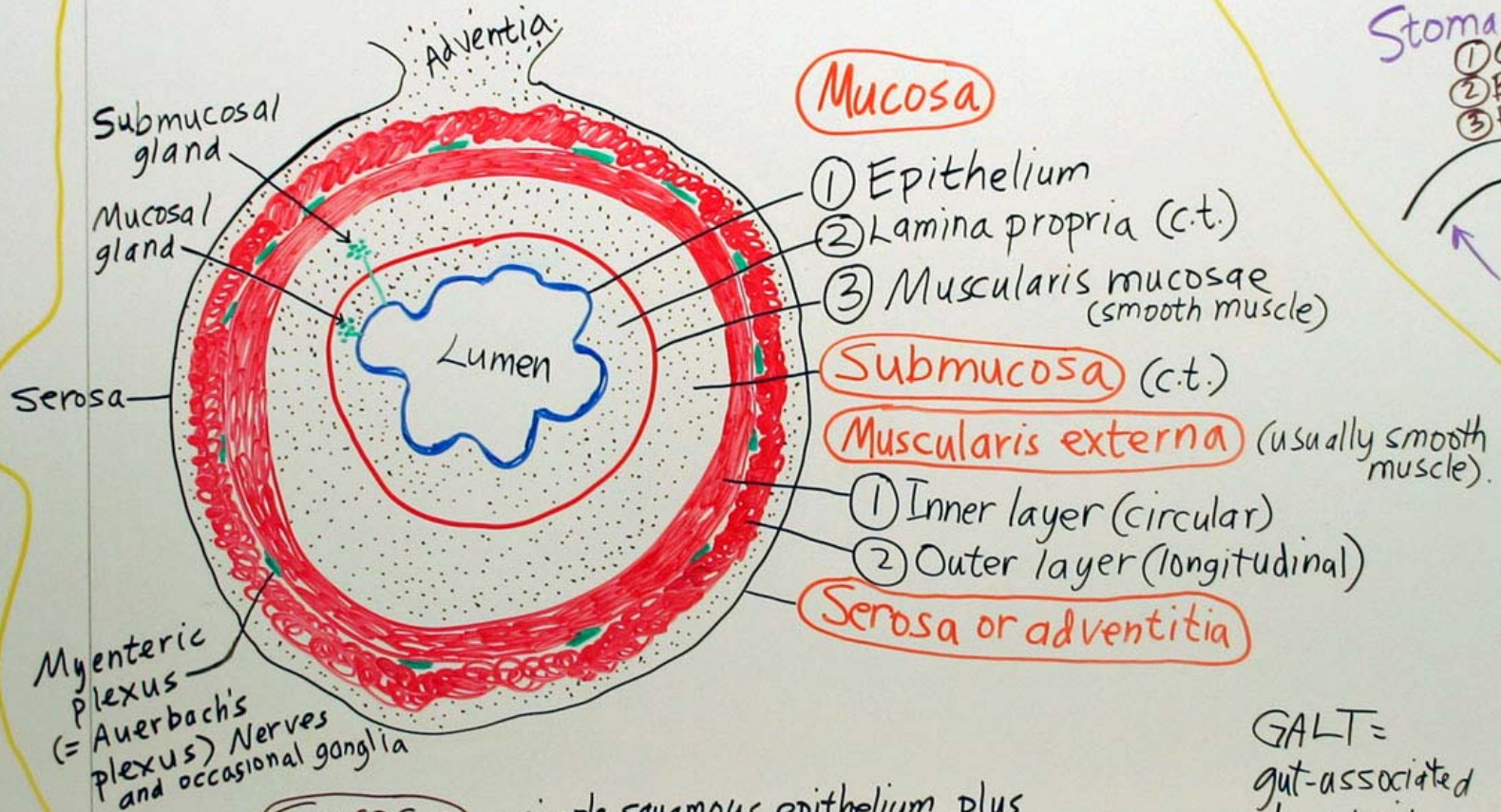
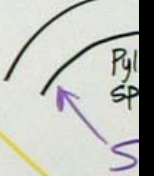
# Standard gut wall

Anatomy

Esoph

Stomach

- ① Cardia
- ② Body
- ③ Pylorus



**Serosa** = simple squamous epithelium plus underlying connective tissue. It faces a body cavity.

**Adventitia** = Connective tissue joining the organ to the body wall or other structure.

GALT = gut-associated lymphoid tissue



# Anatomy

Esophagus

Muscularis externa

- ① Skeletal muscle
- ② Mixed
- ③ Smooth muscle

Diaphragm

Stomach

- ① Cardia
- ② Body/fundus
- ③ Pylorus

Fundus

Body (corpus)

Pyloric sphincter

Small intestine (duodenum)

Wall of esophagus

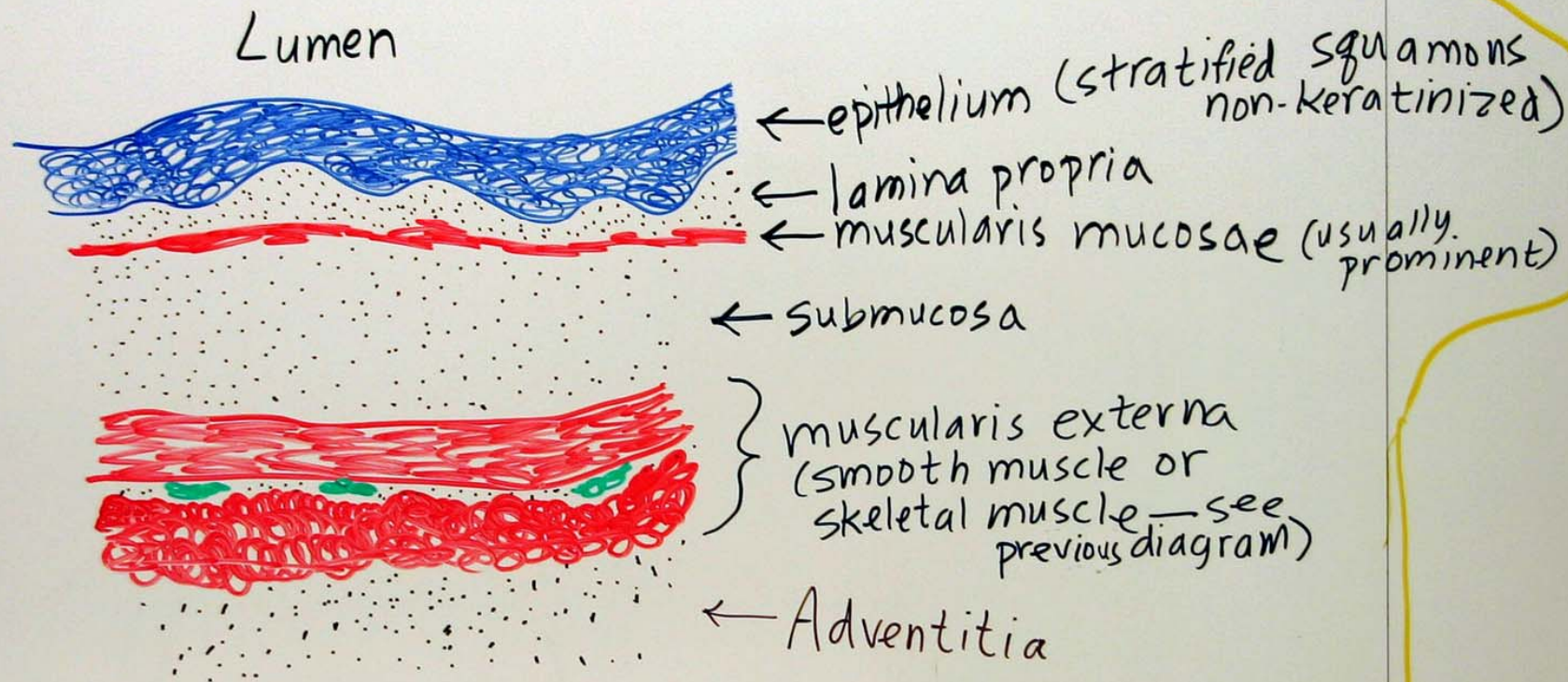
Lumen

...  
skeletal muscle)

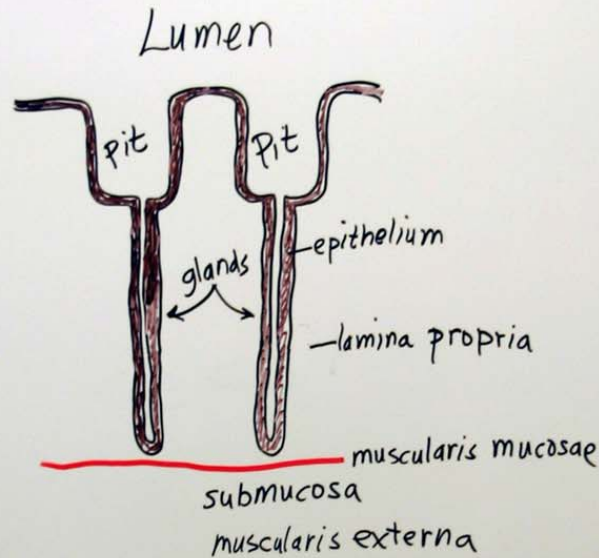




# Wall of esophagus



# Schematic diagram of stomach mucosa



## Glands

### Cardiac and pyloric areas of stomach

Glands lined mainly by mucus-secreting cells.

### Body/fundus part of stomach

Glands lined by:

- Mucus-secreting cells.

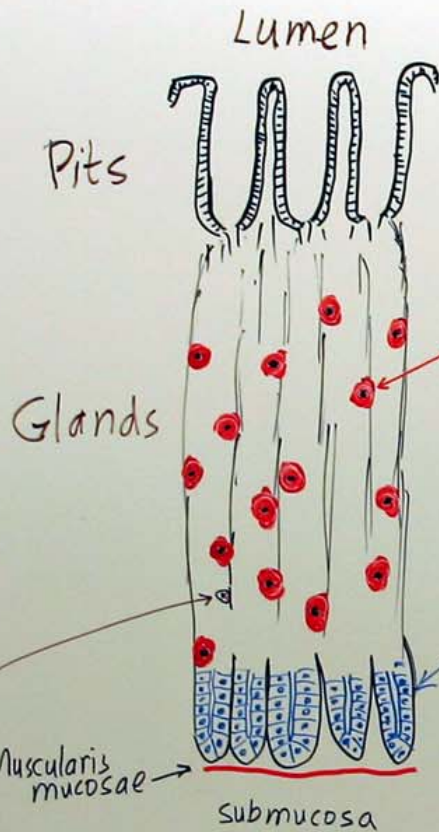
- Parietal cells ( $\rightarrow$  HCl acid)

- Chief cells ( $\rightarrow$  pepsinogen  $\rightarrow$  pepsin)

- Occasional enteroendocrine cells



# Mucosa of body/fundus of stomach



Parietal cell

HCL, intrinsic factor



large cell  
very eosinophilic

E.M.  
(intracellular  
canaliculi)

Chief cell

pepsinogen  
→ pepsin  
(digestive enzyme,  
pH optimum ~2)

secretory  
granules

rough ER  
(at EM level)

Typical protein-secreting  
cell. Cytoplasm basophilic (blue)  
because of extensive RER  
(abundant ribosomes)

Enteroendocrine cell

small cells seen occasionally  
in epithelium of gland. Secretory  
granules oriented toward base of  
cell (hormones, such as gastrin, secreted from base  
to capillaries, rather than to lumen).

basement  
membrane

apex



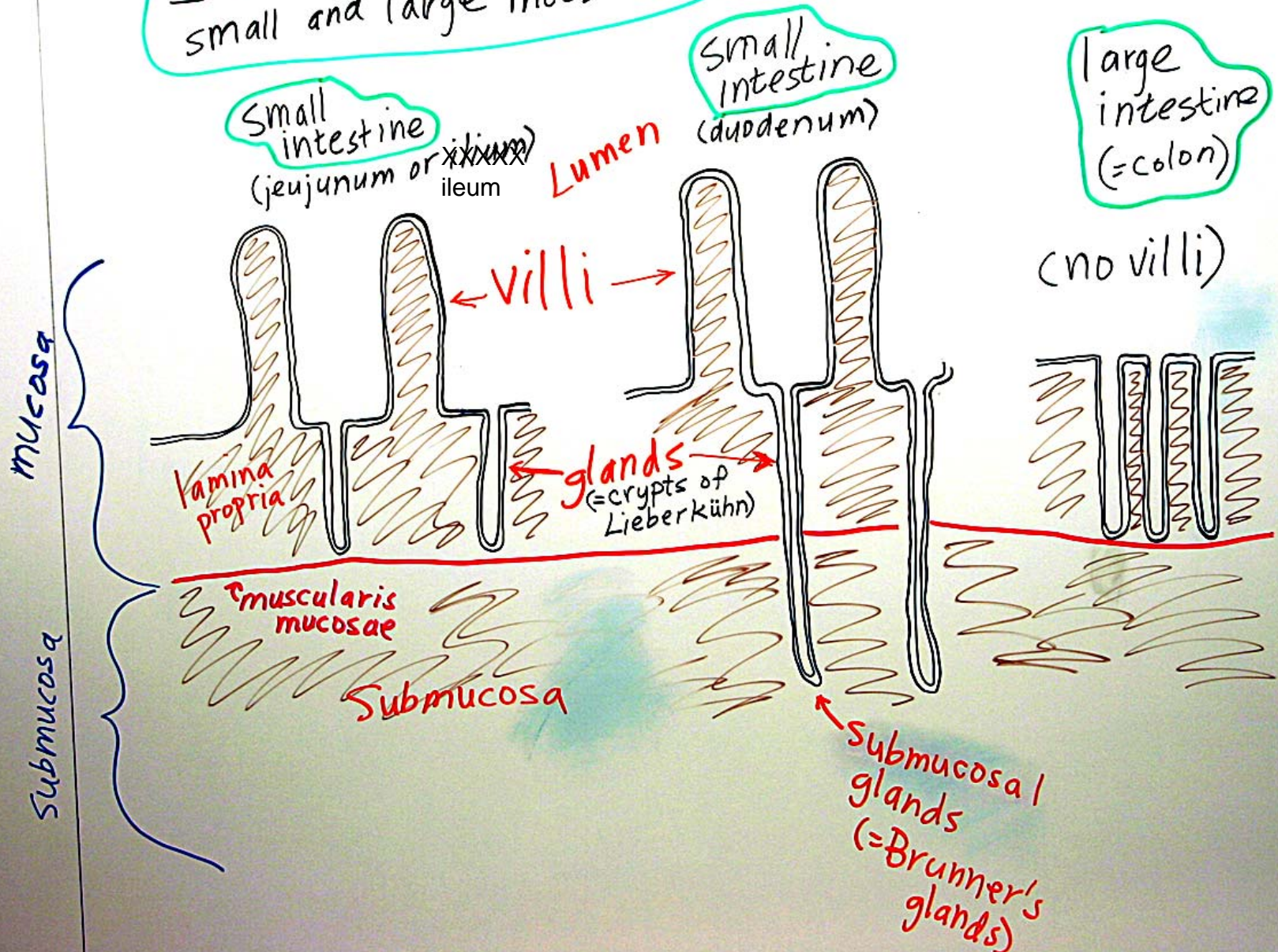
# Intestines

Histology Lab Drawings

A. Kent Christensen

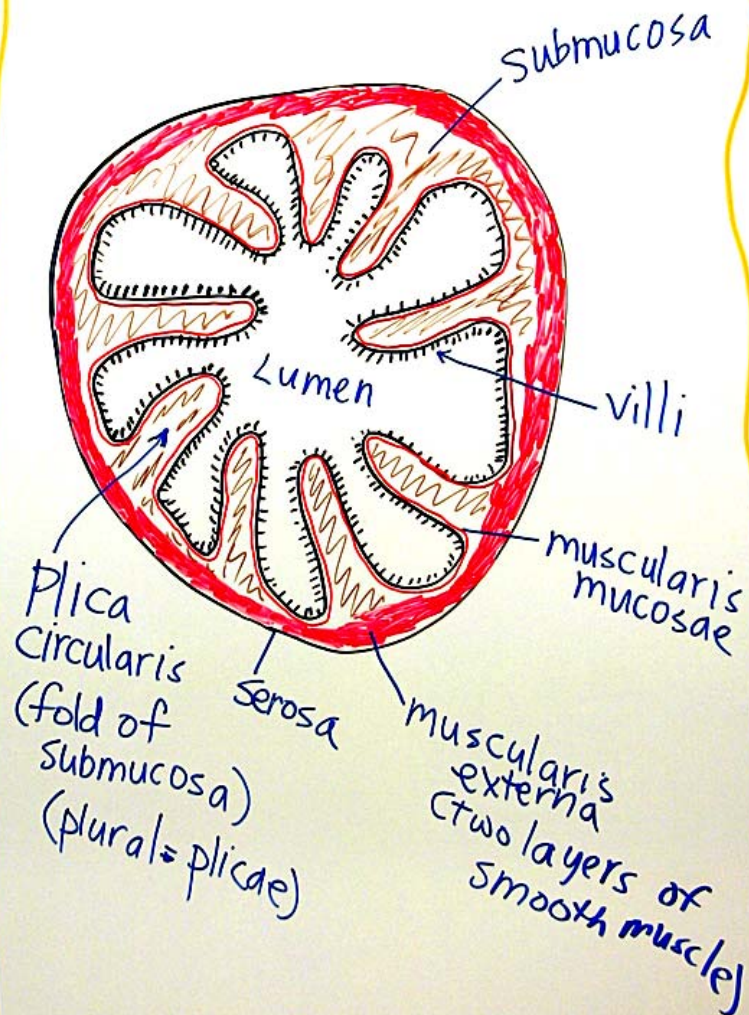


# Schematic comparison of small and large intestine



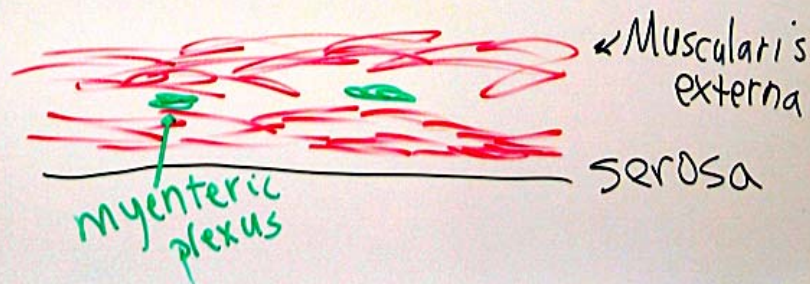
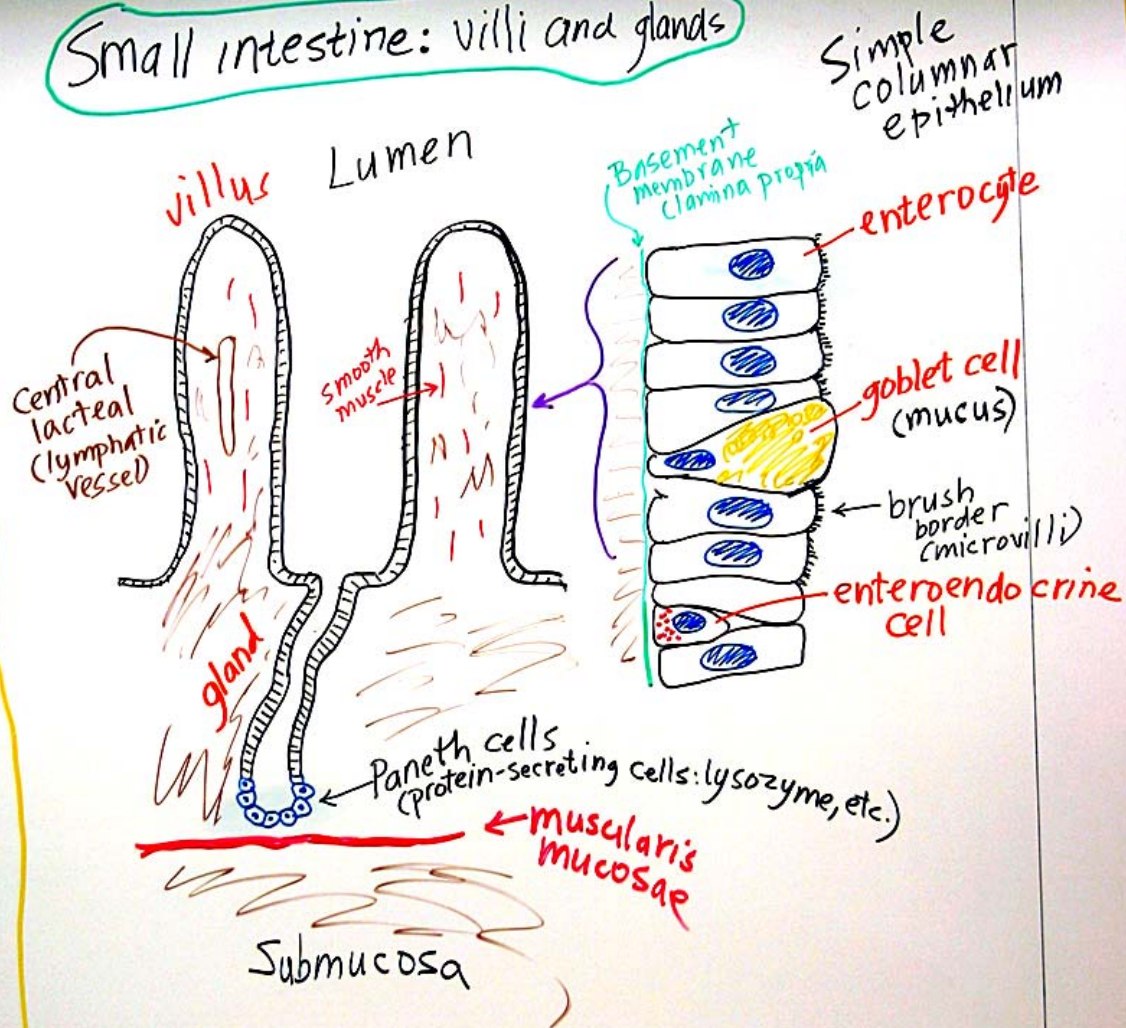


# Small Intestine general plan





# Small intestine: villi and glands



# Large intestine = colon

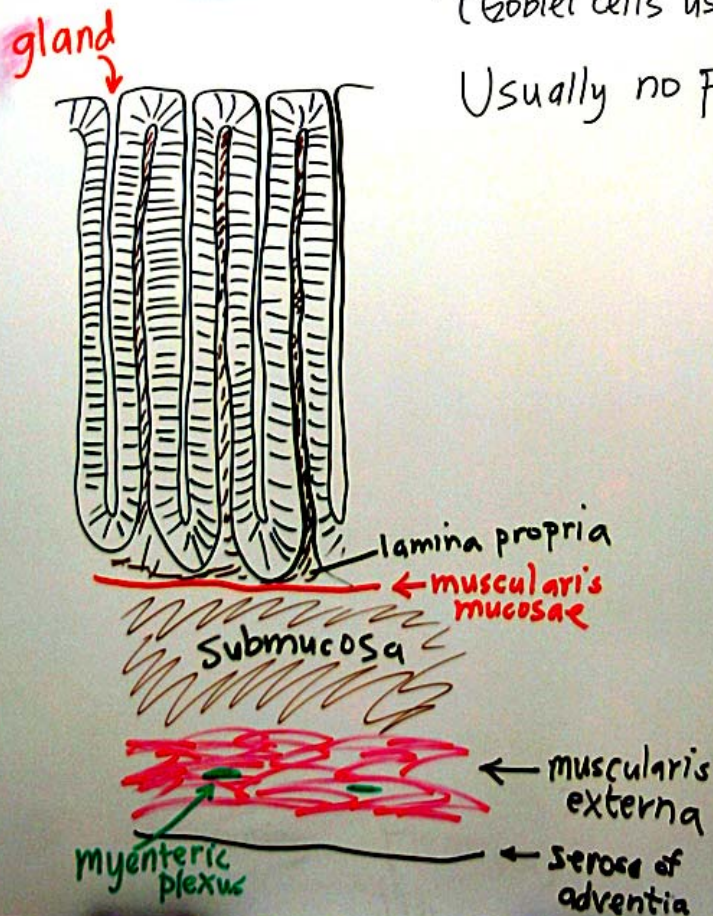
No plicae

No villi

"Test-tube glands"

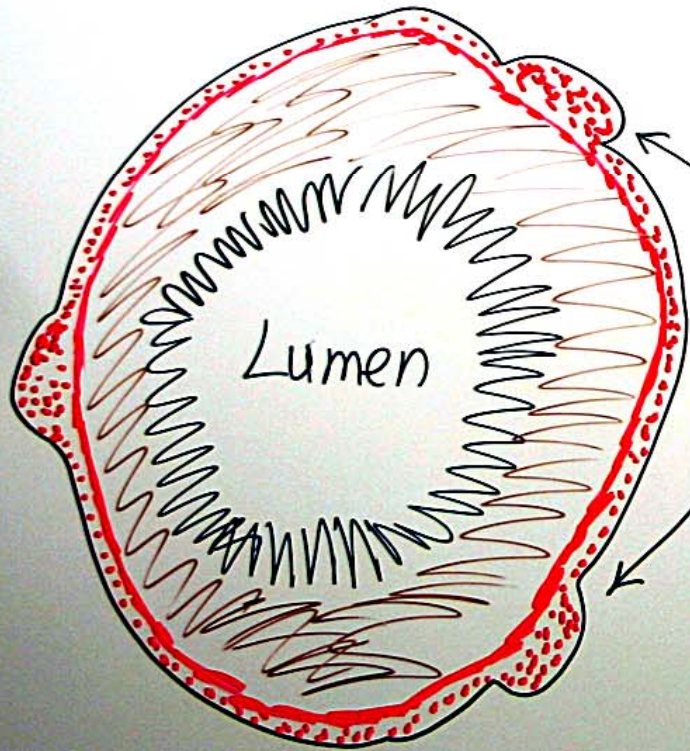
Simple columnar epithelium  
(Goblet cells usually predominate).

Usually no Paneth cells.





Cross section of colon,  
showing ~~tenia coli~~  
tenia



Tenia coli  
(thickening of outer [longitudinal]  
layer of muscularis externa).

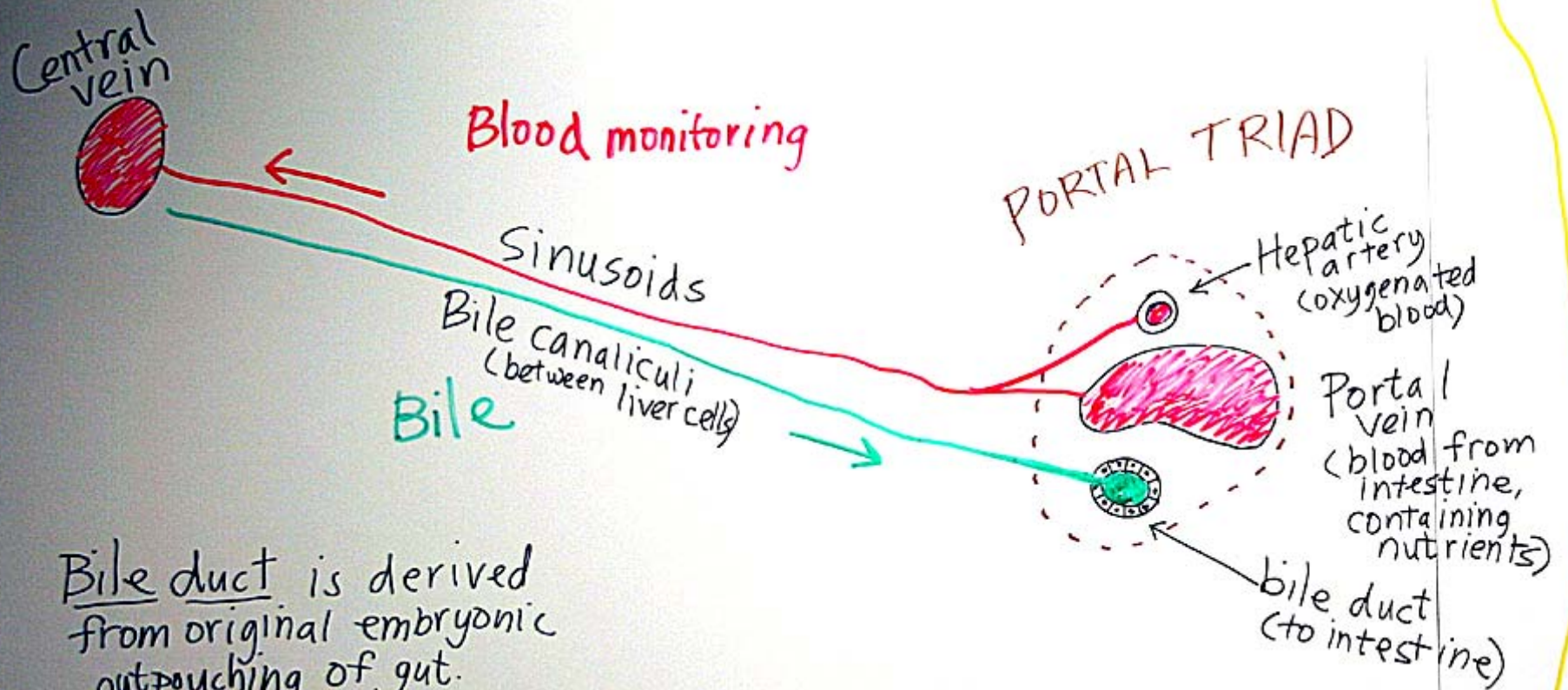
# **Liver & Pancreas**

**Histology Lab Drawings**

**A. Kent Christensen**



# Liver—general idea



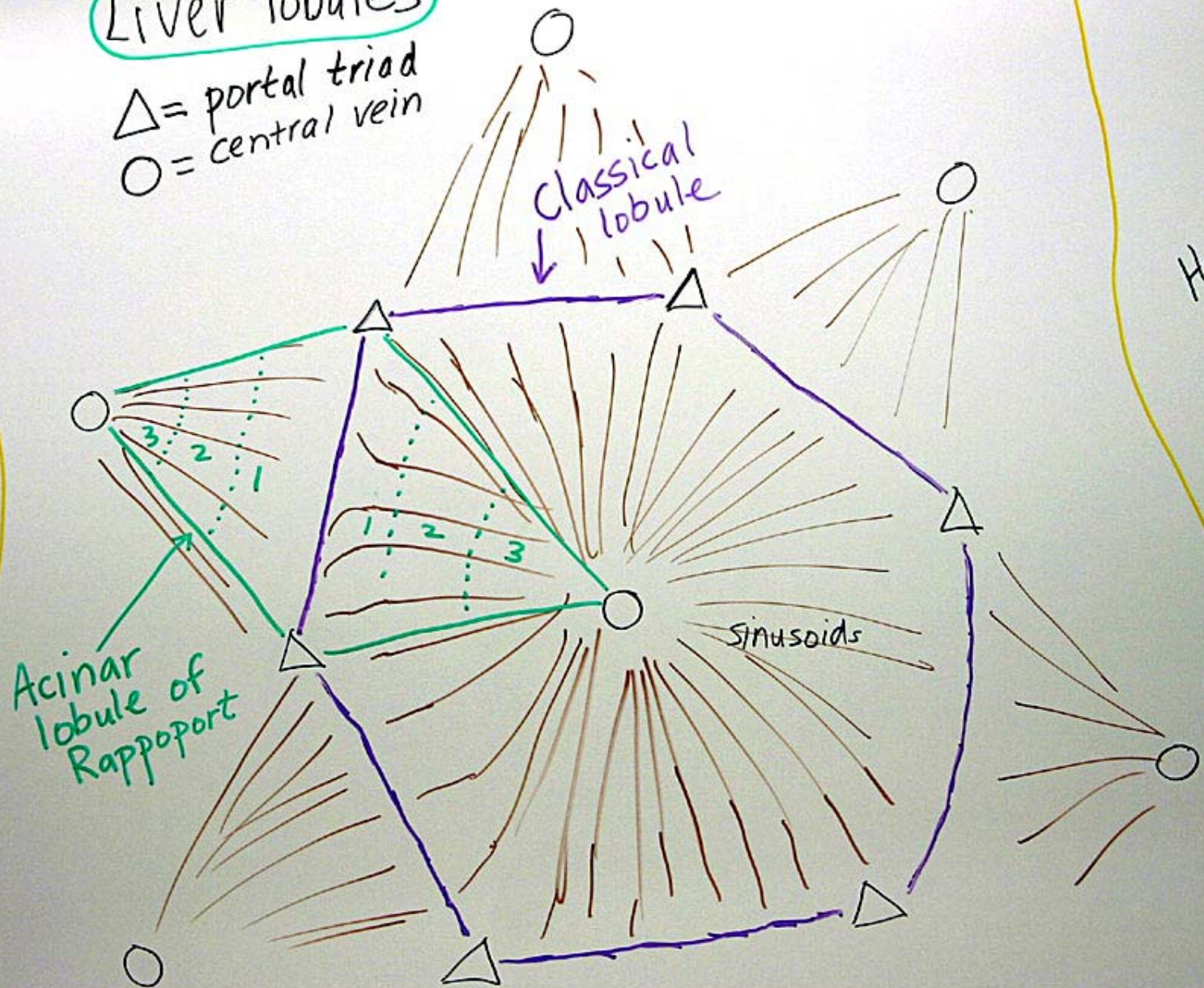
Bile duct is derived from original embryonic outpouching of gut.

Blood monitoring is a later larger scale function



# Liver lobules

$\Delta$  = portal triad  
 $\bigcirc$  = central vein

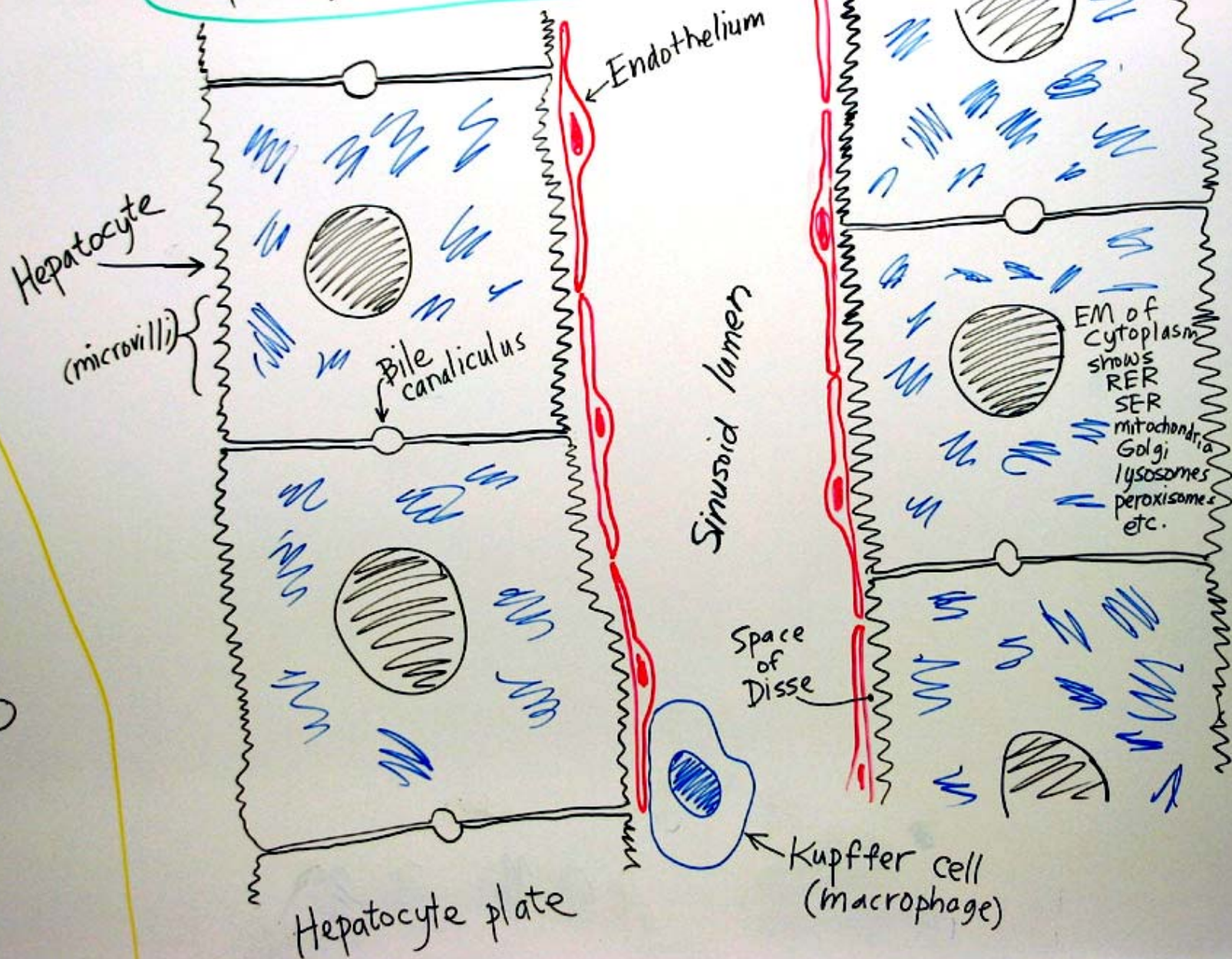


Hepat

(n



# Hepatocytes and sinusoids





## Arrangement of Bile canaliculi in liver hepatocyte plate

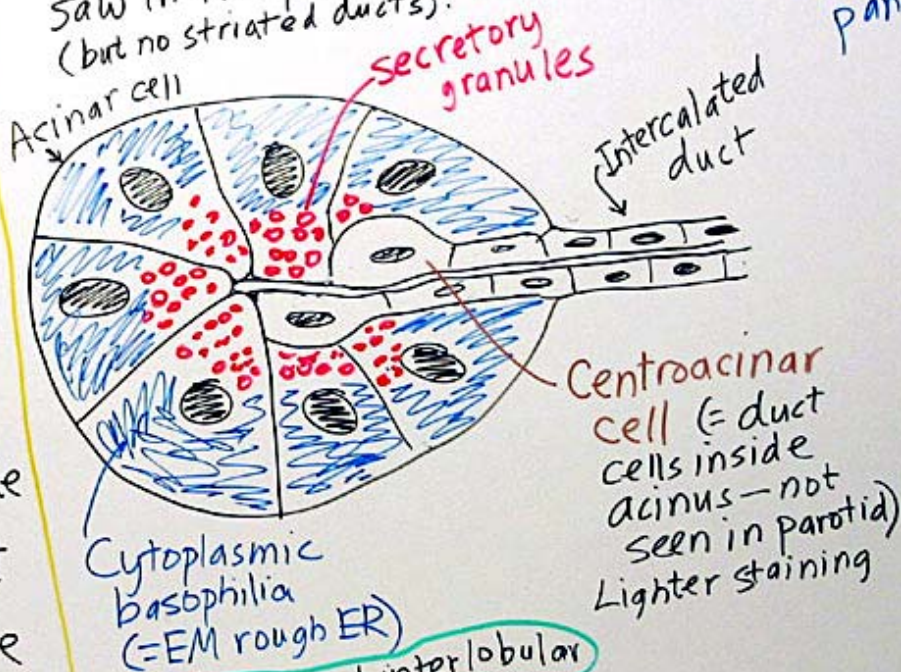
Chicken wire  
from farm



Imagine chicken  
wire with a hepatocyte  
in each hole. That  
would be comparable  
to a hepatocyte plate  
with bile canaliculi  
in place of the wire.

## Exocrine pancreas acini and ducts

High capacity protein synthesis  
(digestive enzymes). The acini  
and ducts resemble those you  
saw in the parotid gland  
(but no striated ducts).



## Intra- and interlobular ducts

As in parotid, the exocrine  
pancreas has lobules. The  
only intralobular duct in  
pancreas is the intercalated duct  
(no striated ducts in pancreas).  
Interlobular ducts are large,  
as in parotid.

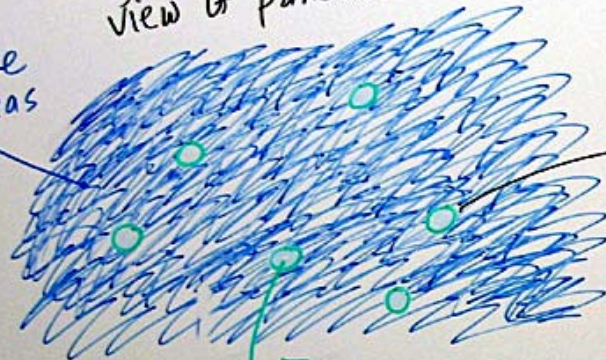
Exocrine  
pancreas



# Endocrine pancreas

Very low power LM  
view of pancreas

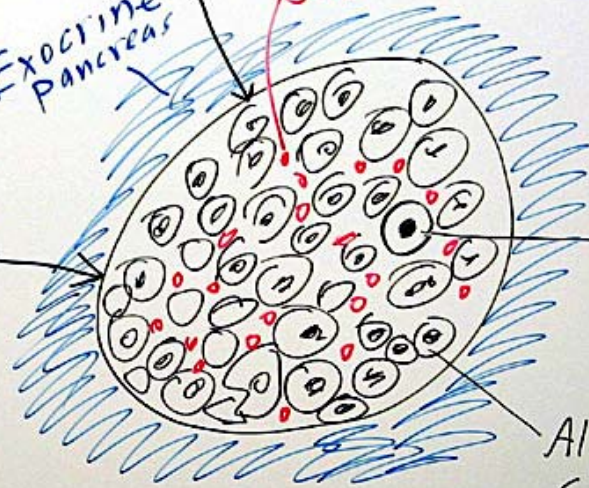
Exocrine  
pancreas



Endocrine pancreas  
(usually lighter staining  
than ~~endocrine~~ exocrine pancreas)

Islet of Langerhans = endocrine pancreas  
(mass of cells, very vascular)  
capillary (abundant)

Exocrine  
pancreas



Beta (or B) cell  
(→ insulin). Larger  
cells, usually more  
central

Alpha (or A) cell  
(→ glucagon)  
Smaller cells, usually  
located more  
peripherally

Delta (or D) cell  
(→ somatostatin)  
Hard to distinguish

nar  
duct  
ide  
- not  
in parotid)  
aining

# Endocrine

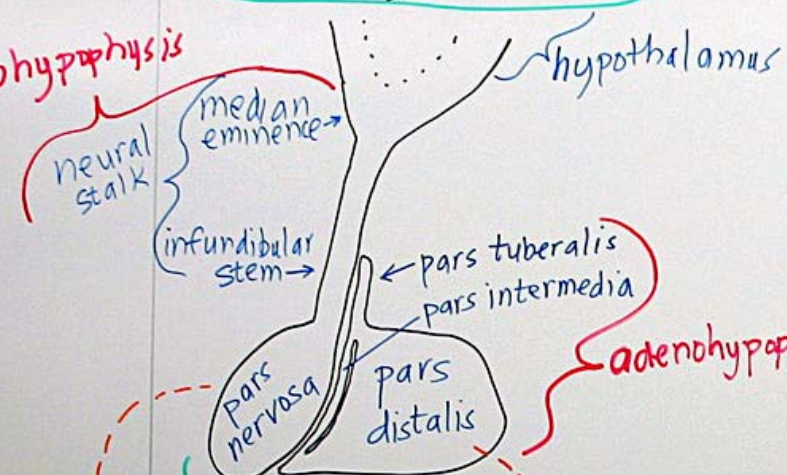
Histology Lab Drawings

A. Kent Christensen



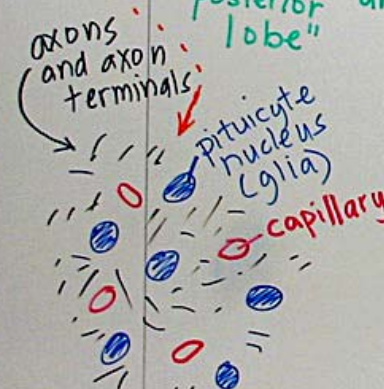
# Pituitary (= Hypophysis)

Neurohypophysis

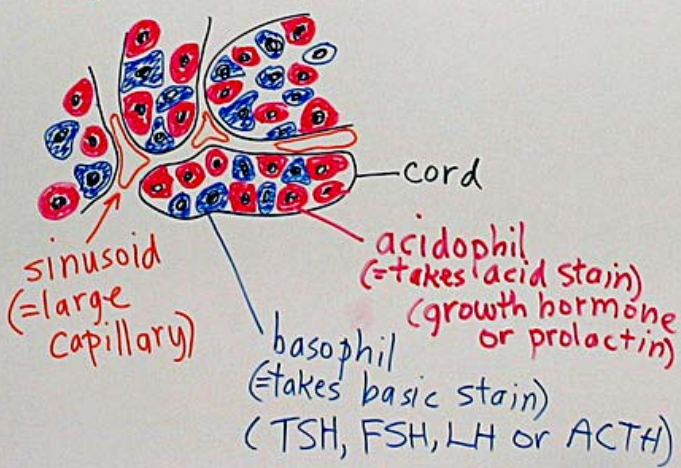


adenohypophysis

"posterior lobe" "anterior lobe"

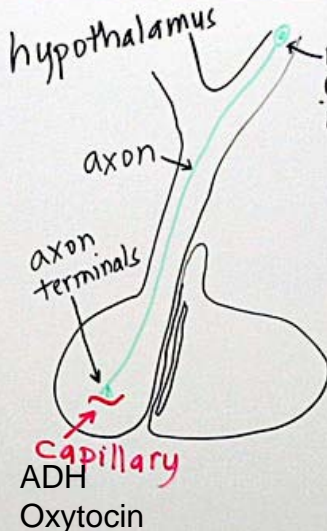


The pars nervosa is white matter (= no neuron cell bodies)

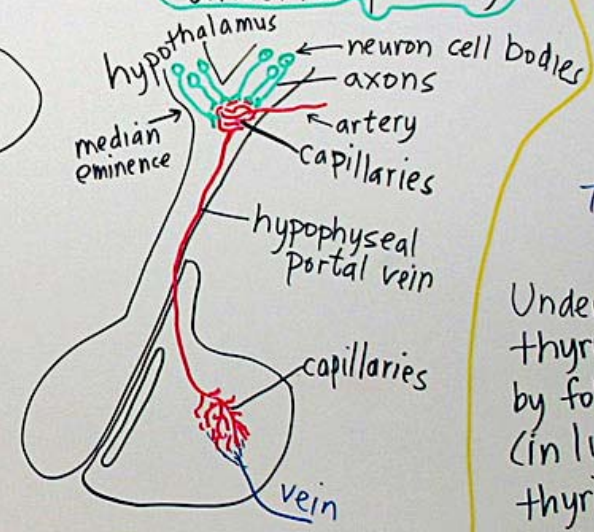


## Posterior pituitary

Neuroendocrine (= neurosecretion)



## Regulation of anterior pituitary



Releasing hormones (and inhibiting hormones)

TRH  
GnRH  
CRH  
etc.

Thy (sp) Sim cul epi

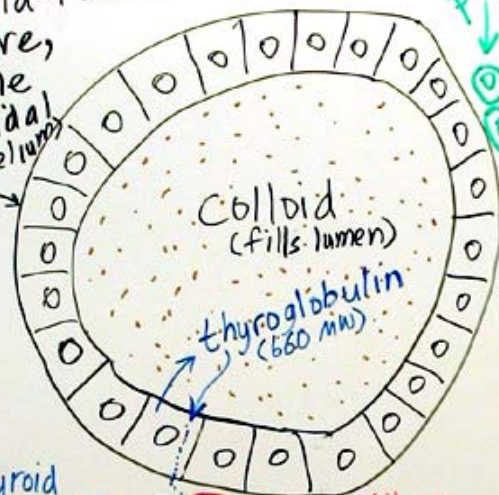
Under thyro by fol (in ly thyro which C



# Thyroid gland

Thyroid follicle →  
(sphere,  
simple  
cuboidal  
epithelium)

parafollicular cells  
(= C-cells)  
(secrete  
calcitonin)  
(causes  
serum calcium ↓)

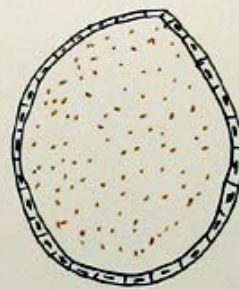


Thyroid  
hormones  
(T<sub>4</sub>, T<sub>3</sub>)

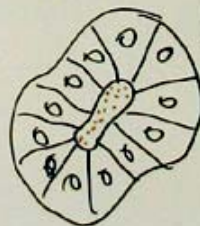
capillary

Under TSH stimulation,  
thyroglobulin taken up  
by follicular cells, digested  
(in lysosomes), yielding  
thyroid hormone (T<sub>4</sub>, T<sub>3</sub>),  
which diffuses into  
capillaries.

## Thyroid follicle state of activity



Low activity  
(hypoactive)  
Low epithelium,  
much colloid  
(because not being  
taken up and  
broken down)



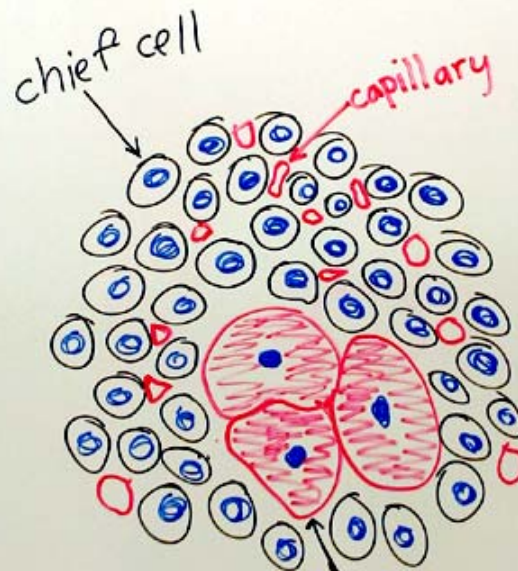
High activity  
(hyperactive)  
High epithelium,  
little colloid  
(because being  
processed rapidly)



## Parathyroid gland

Mass of chief cells  
(arranged in cords).

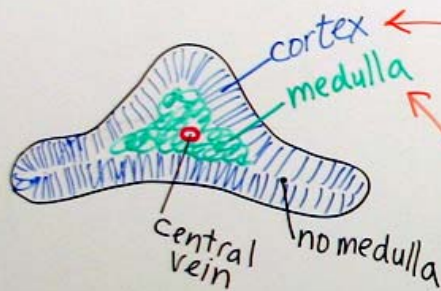
→ parathyroid hormone (PTH).  
(causes serum calcium  $\uparrow$ )



Occasional oxyphil clusters  
(cells large, eosinophilic,  
with small, dark nuclei)  
Function unknown.  
(by EM, cytoplasm full of  
mitochondria)

# Adrenal gland

Human adrenal



capsule

Zona glomerulosa  
(palisades, but often not obvious)

aldosterone  
(controlled by angiotensin II)

a mineralocorticoid  
a mineraloid steroid hormone

capillaries

Zona fasciculata  
(cells pale because of abundant extracted lipid droplets in cytoplasm)

Cortisol  
(controlled by pituitary ~~xxxxx~~ ACTH)

a glucocorticoid  
steroid hormone

Zona reticularis → some cortisol and androgens.

MEDULLA → epinephrine (adrenalin)  
nor-epinephrine (nor-adrenalin)  
(each cell makes one or the other, not both)

controlled by axons from preganglionic sympathetic neurons

cells homologous with postganglionic sympathetic neurons (from neural crest)

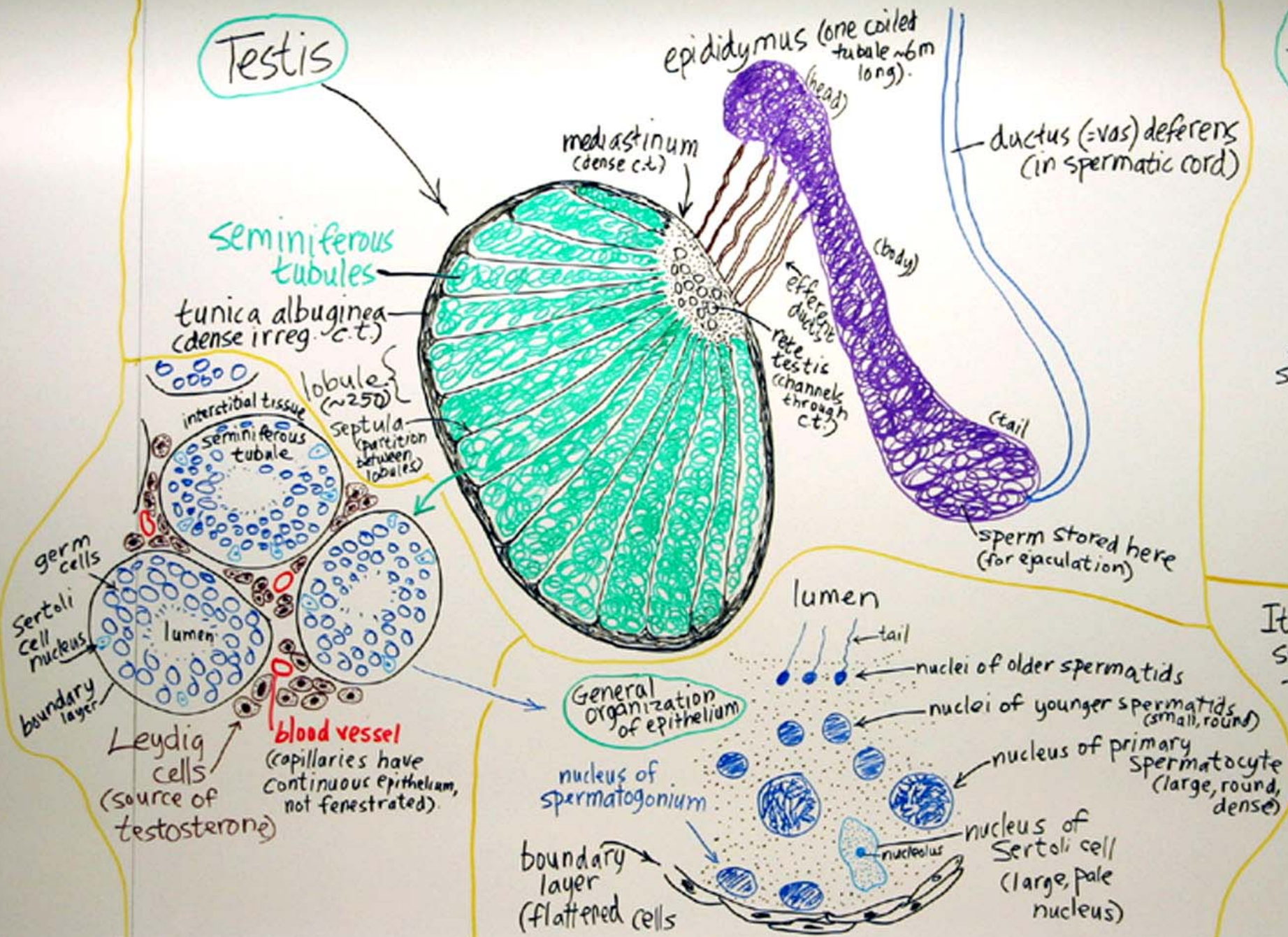


# Male Reproductive System

Histology Lab Drawings

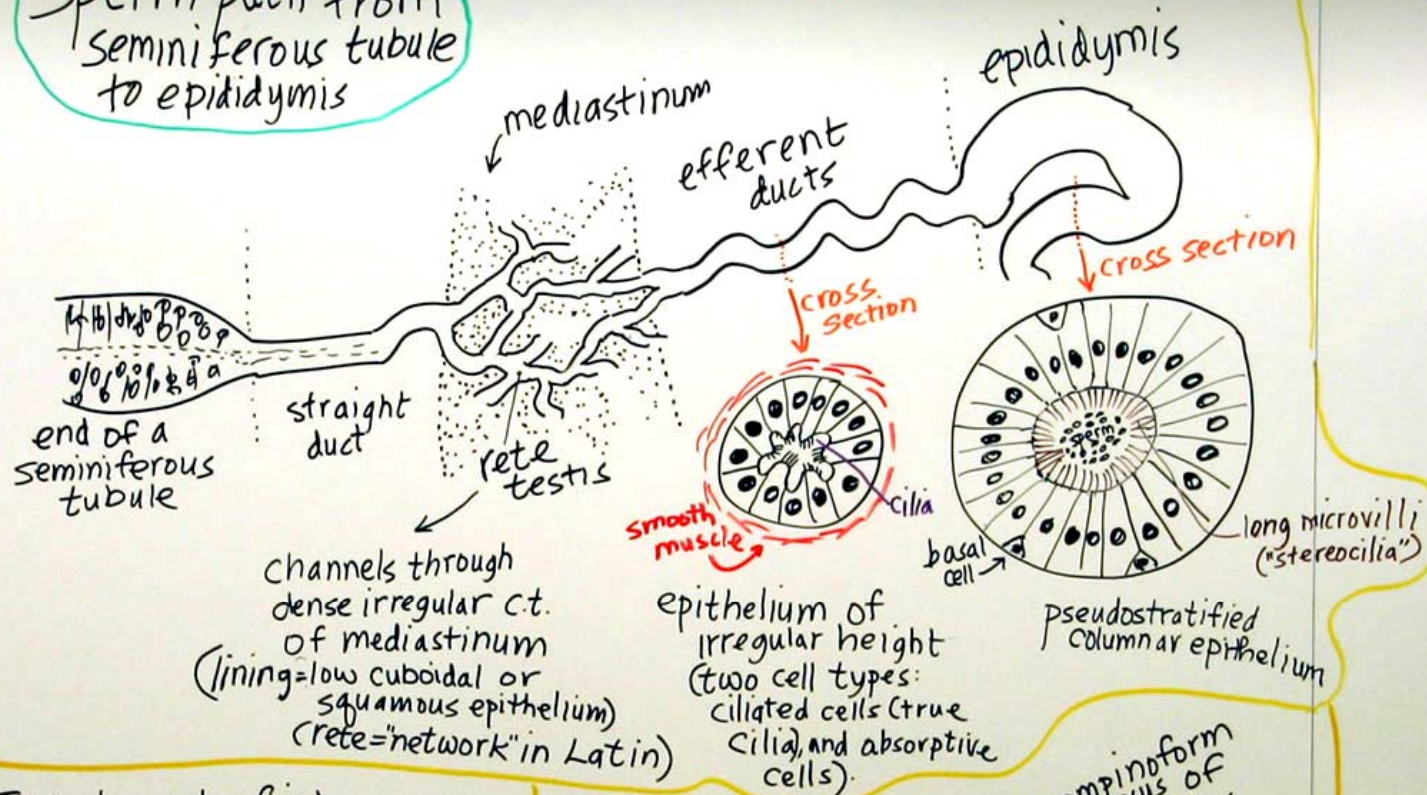
A. Kent Christensen

# Testis





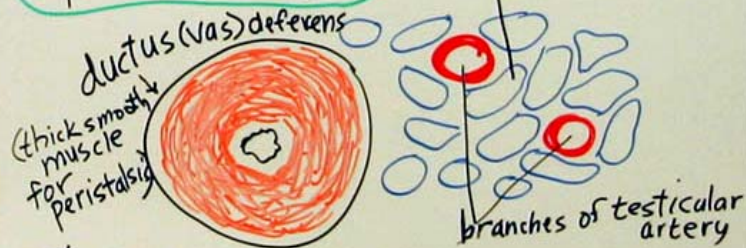
# Sperm path from seminiferous tubule to epididymis



It is hard to find secondary spermatocytes.

They arise from primary spermatocytes by the 1<sup>st</sup> meiotic division, but then promptly undergo the 2<sup>nd</sup> meiotic division to become spermatids. So secondary spermatocytes are rarely seen in your sections.

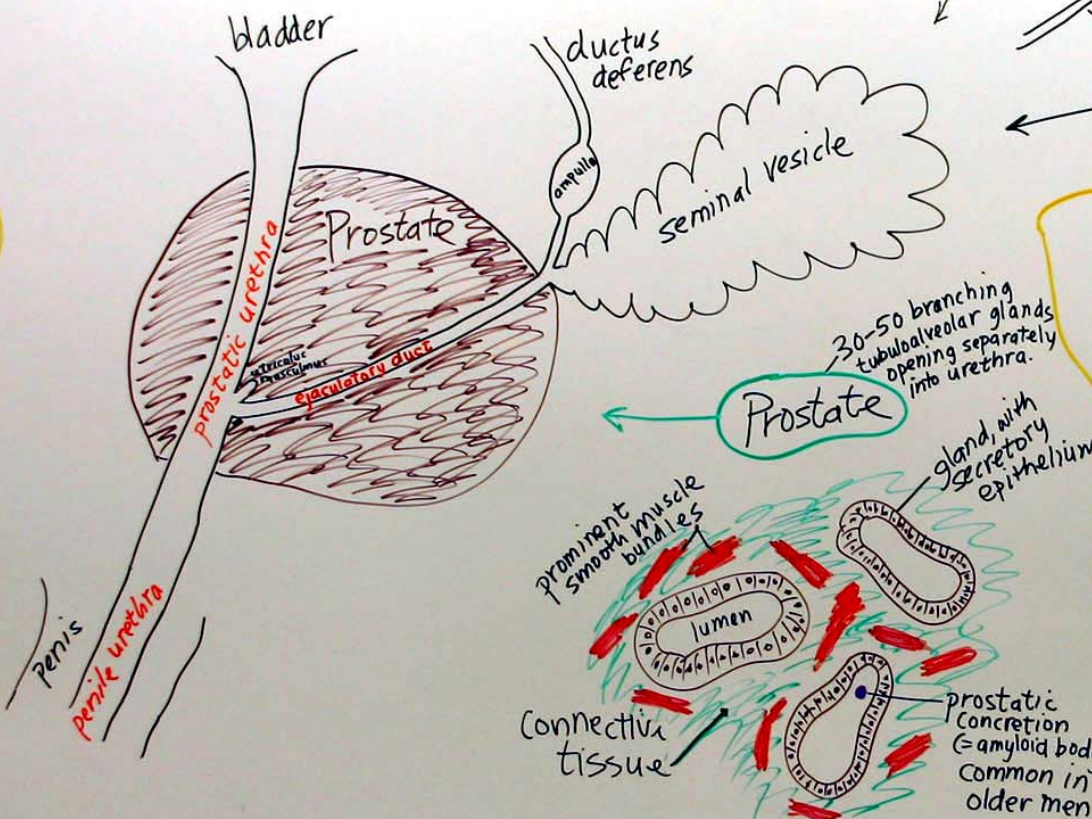
## Spermatic cord



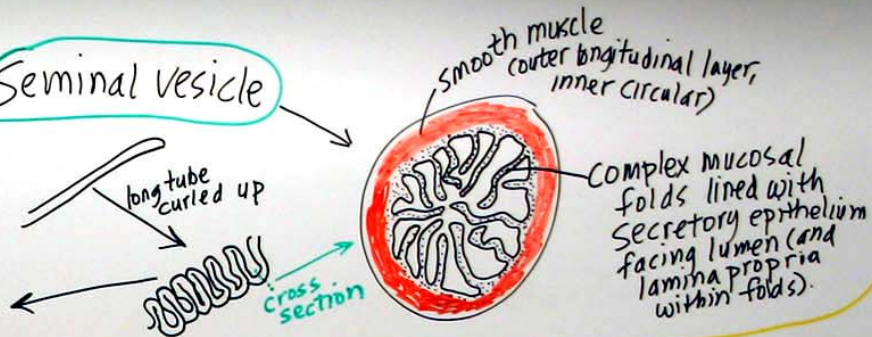
The pampiniform plexus of veins is clustered around the testicular artery to form a countercurrent exchange system to conserve cooler temperature of testis (necessary for spermatogenesis).



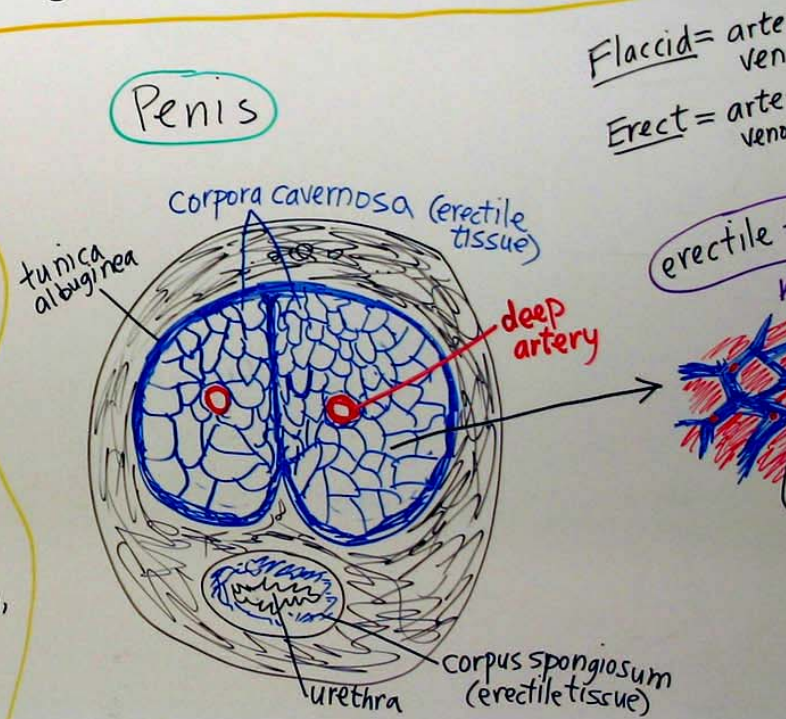
# Male tract



## Seminal Vesicle



## Penis

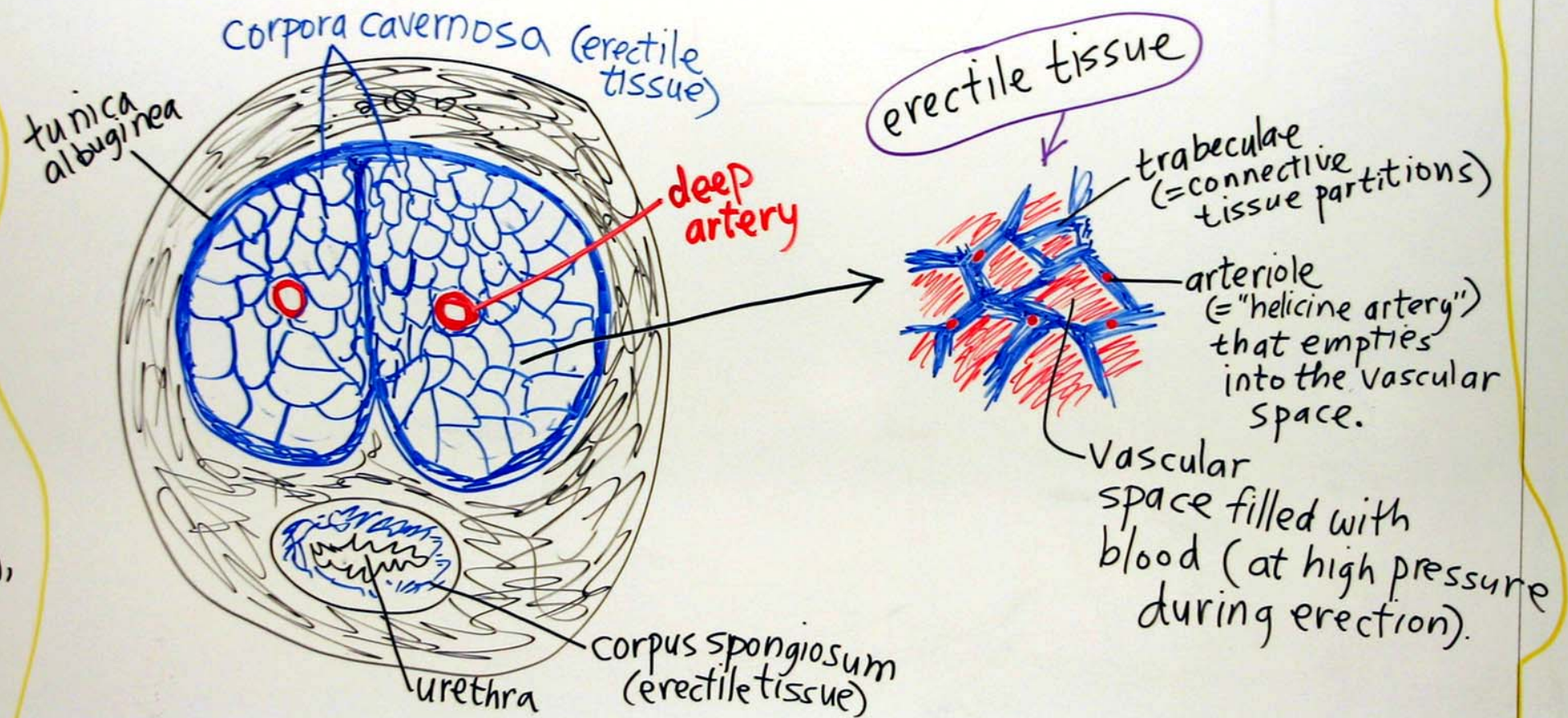




# Penis

Flaccid = arterial inflow limited,  
venous outflow open.

Erect = arterial inflow open,  
venous outflow limited.



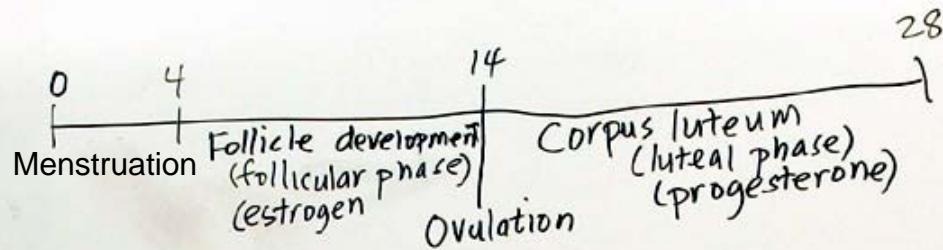
# Female Reproductive System

Histology Lab Drawings

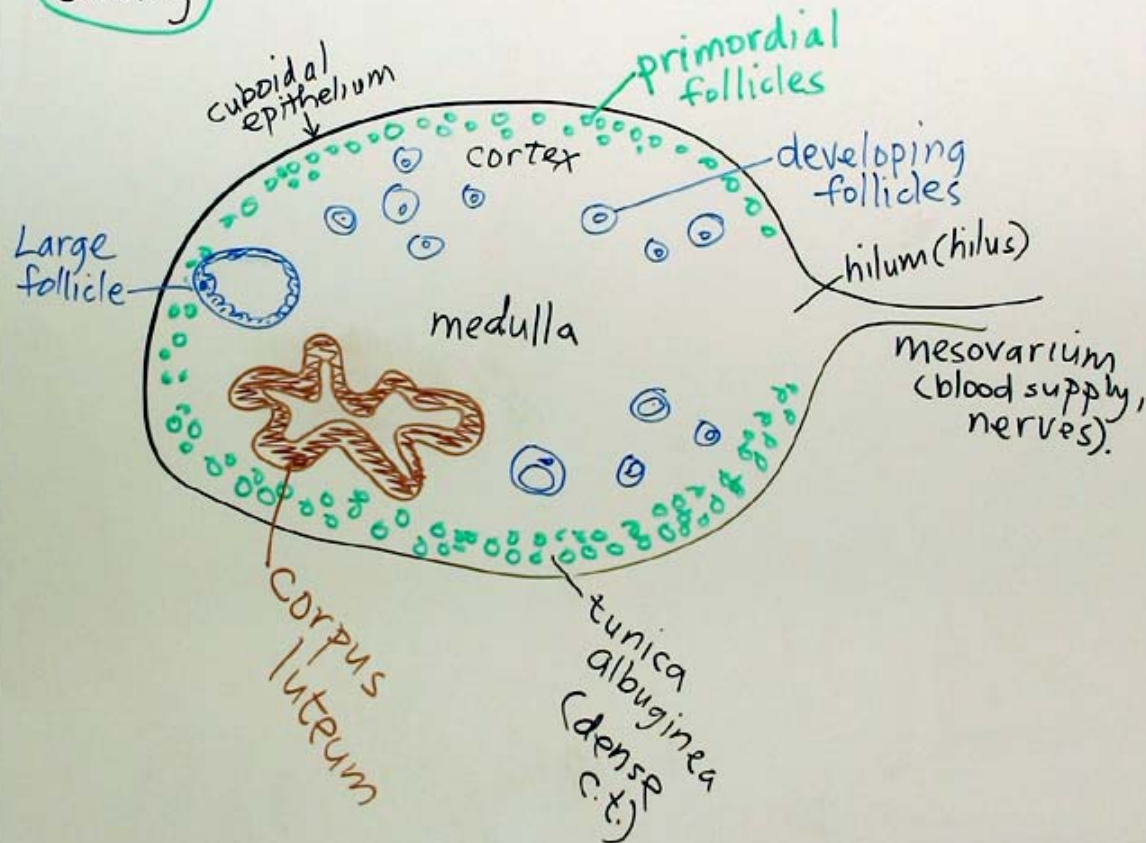
A. Kent Christensen



# Approximate timing of menstrual cycle



## Ovary

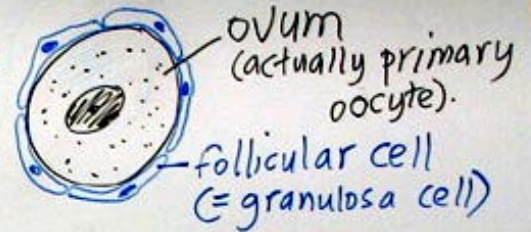




# Follicles (not to scale)

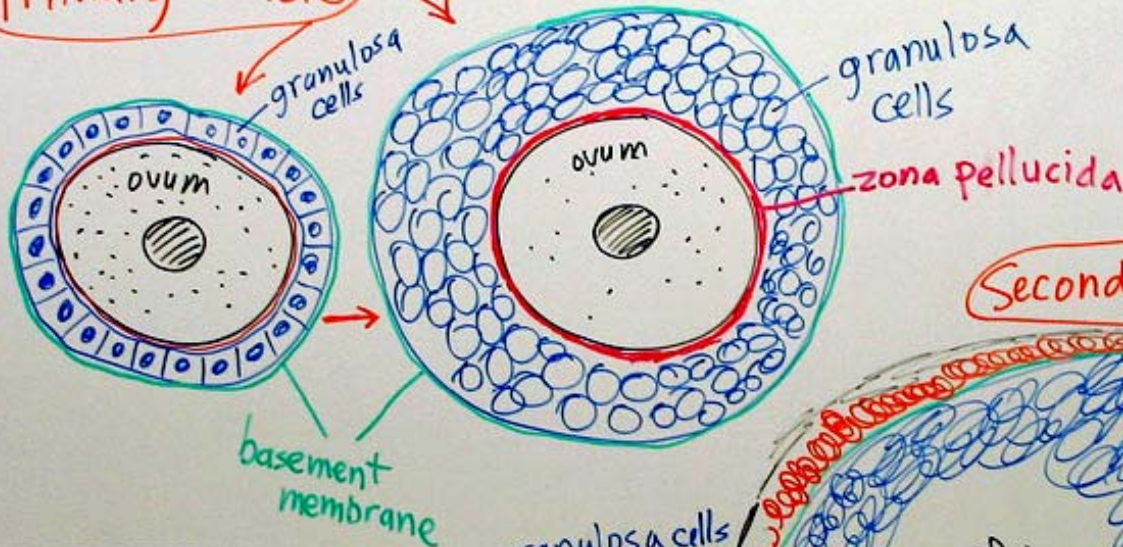
## Primordial follicle

(all follicles except the few that are developing at that particular time)



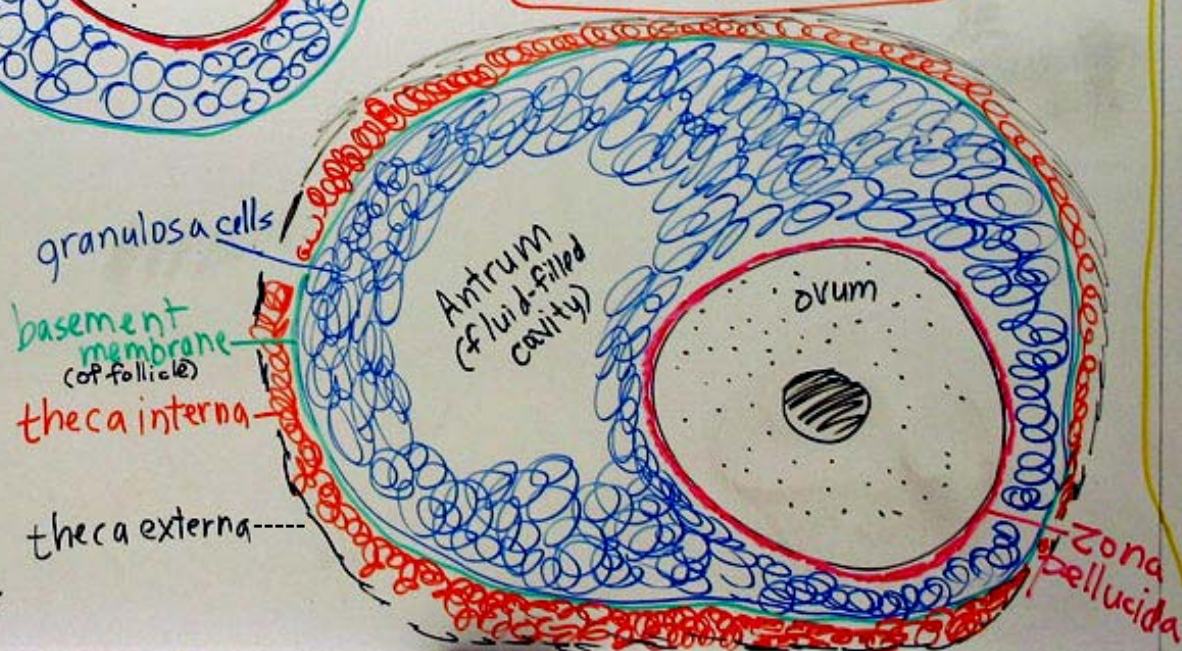
## Primary follicle

Ovum much larger than in primordial follicle



There are no blood vessels inside the follicle

## Secondary follicle



**Theca interna** (outside follicle)

Makes testosterone  
Under LH control

**Granulosa cells** (inside follicle)

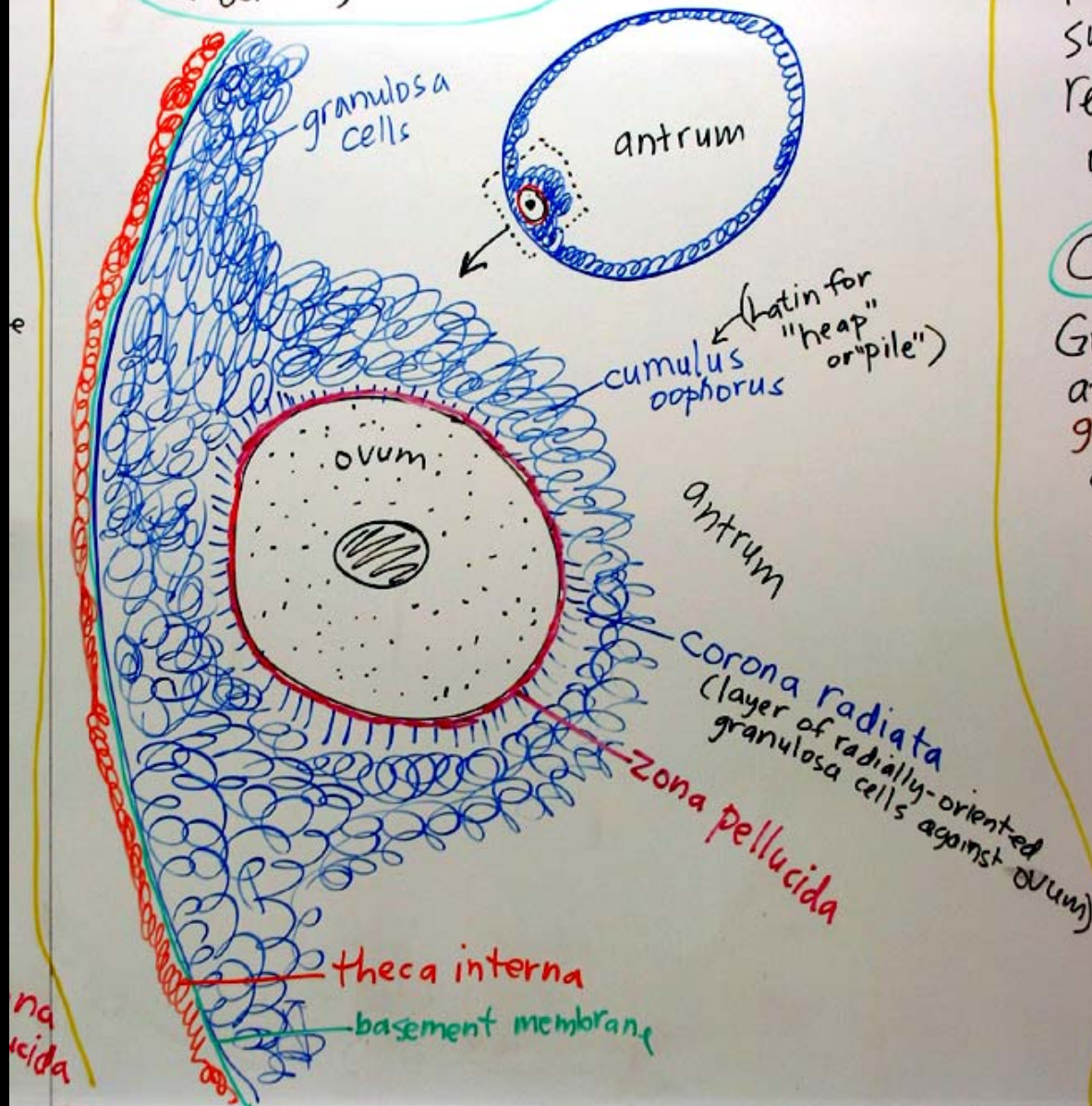
Converts testosterone into  
estradiol and other estrogens  
(under FSH control)



# Edge of mature follicle

= Graafian follicle

= tertiary follicle

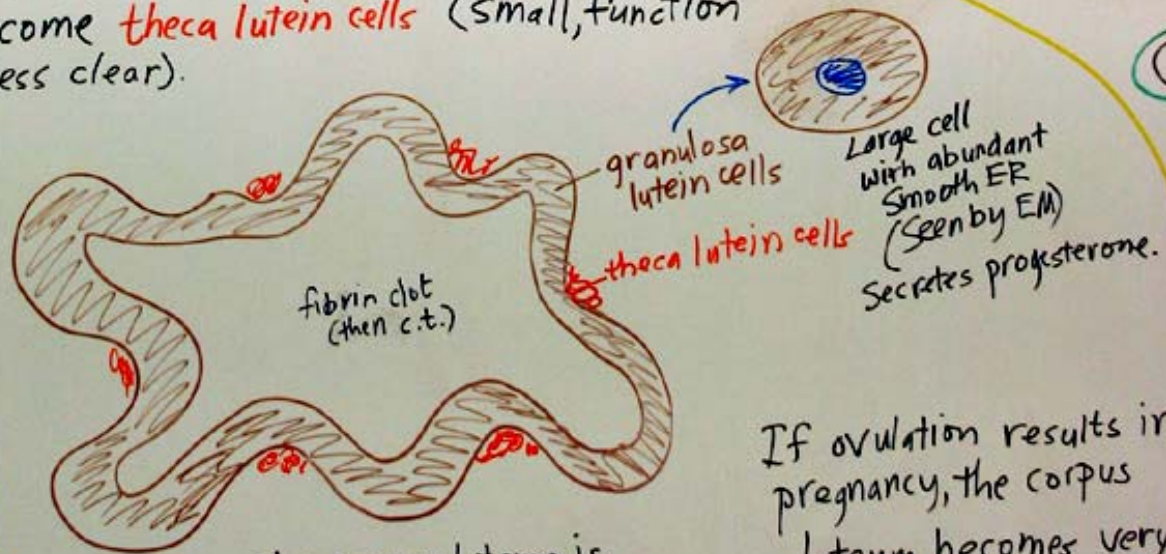


## Ovulation

Follicle ruptures. Cumulus mass (ovum surrounded by cumulus granulosa cells) released into abdominal cavity near opening (infundibulum) of oviduct

Corpus luteum (CL) ← Latin "yellow body"

Granulosa cells that remain in follicle after ovulation differentiate into **granulosa lutein cells**, secreting progesterone and some estrogen. Theca interna cells become **theca lutein cells** (small, function less clear).



The corpus luteum is well vascularized.

## Atretic follicles

Most of the follicles in each cycle degenerate (atretic). This can happen at any stage of follicle development.



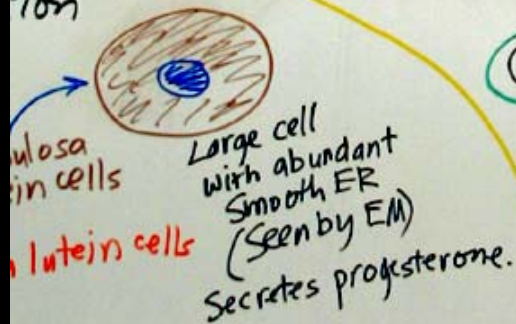
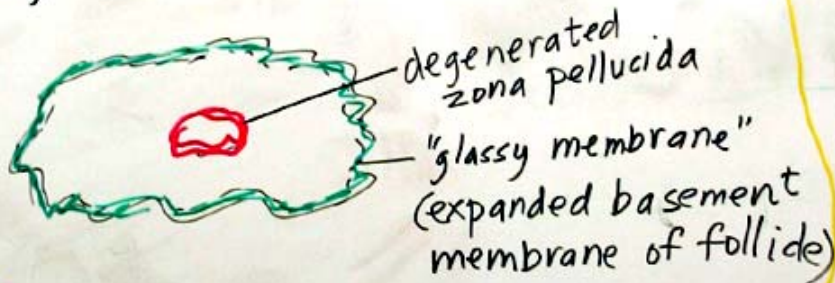
If ovulation results in pregnancy, the corpus luteum becomes very large

ta  
ly-oriented  
against ovum)



## Atretic follicles

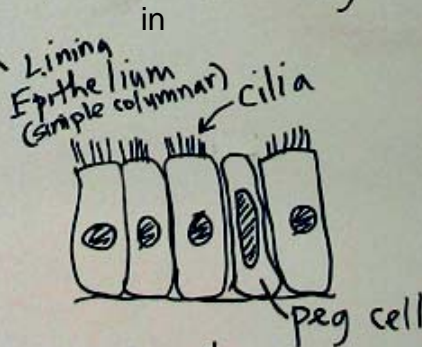
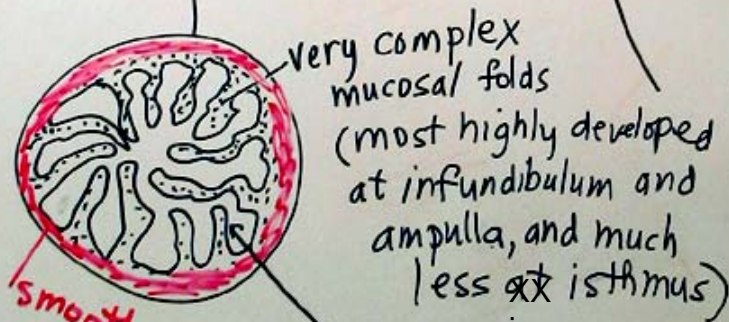
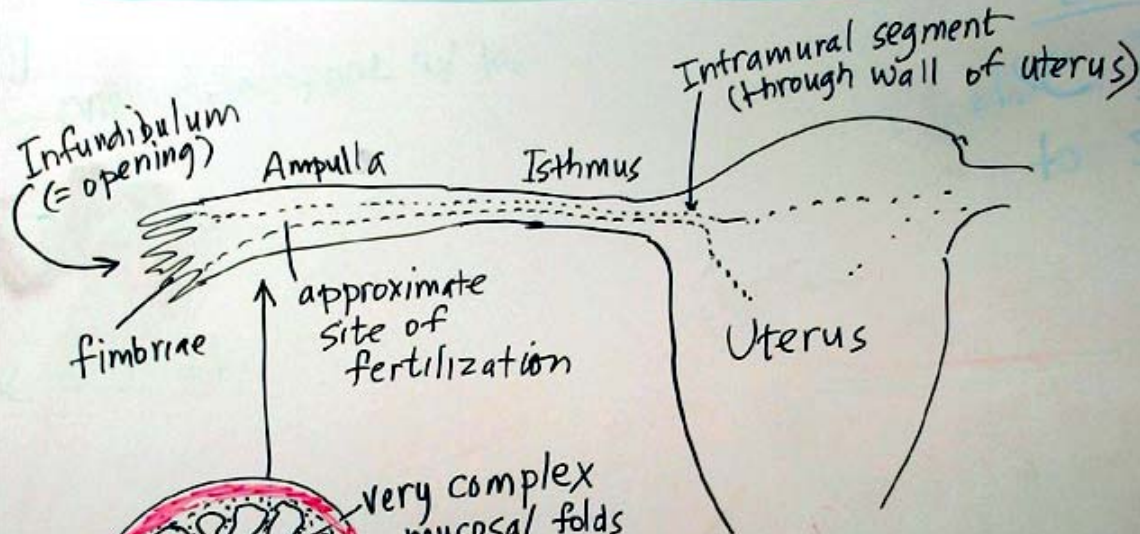
Most of the follicles <sup>that</sup> start developing each cycle degenerate (become atretic). This can happen at any stage of follicle development.



Corpus albicans ← Latin "white body"  
Degenerated corpus luteum  
(large, white, no cells)

If ovulation results in pregnancy, the corpus luteum becomes very large

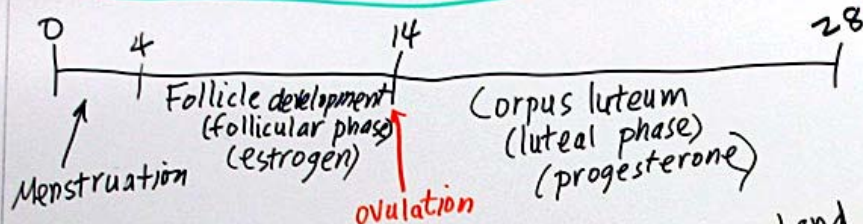
Oviduct = Fallopian tube = uterine tube



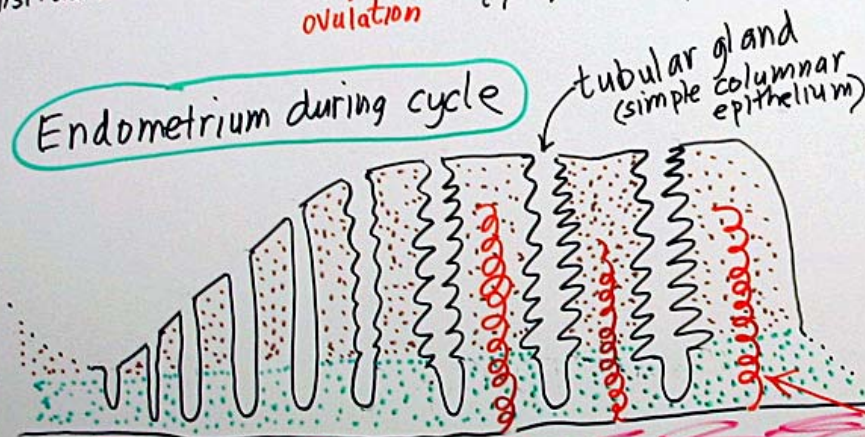
Ciliated cells  
and non-ciliated peg cells.



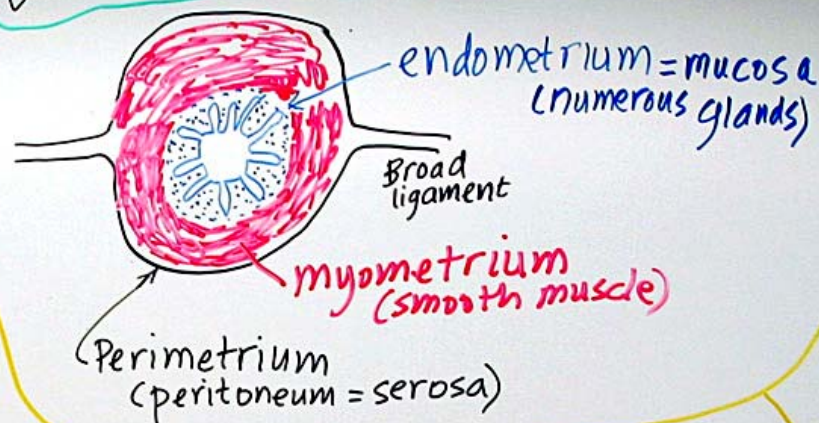
## Menstrual cycle



## Endometrium during cycle



## Uterus cross section



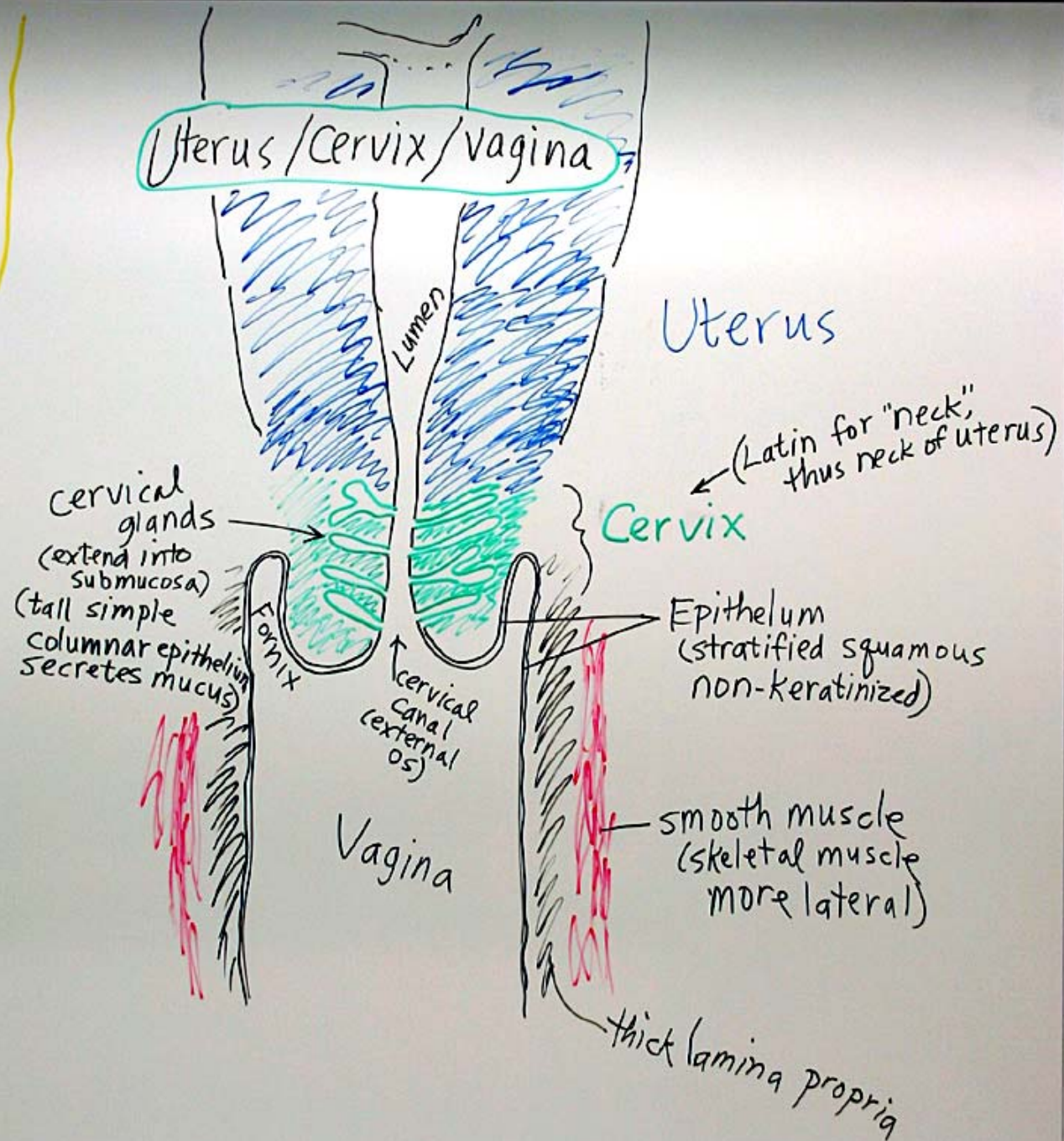
**functionalis** (functional layer — new each cycle)

**basalis** (basal layer — constant)

**spiral or coiled artery**

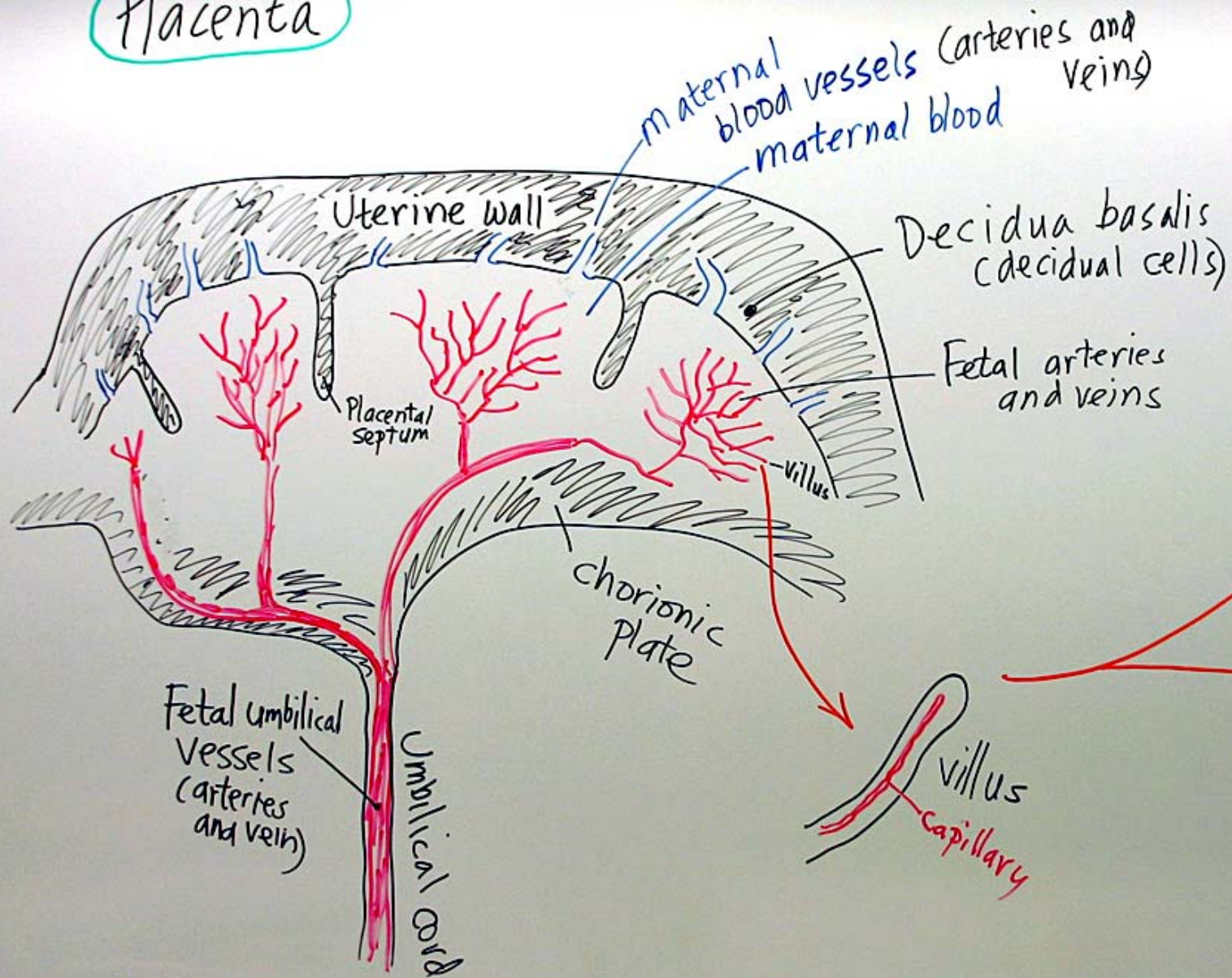
**Myometrium**







# Placenta





Arteries and  
veins  
blood

Decidua basalis  
(decidual cells)

Fetal arteries  
and veins

Villus  
capillary

## Villus in cross section

Early

Maternal  
blood

Nucleated  
RBC (embryonic condition)

Fetal  
connective  
tissue

Hofbauer  
cell (=macrophage)

Cytotrophoblast

Fetal  
capillaries

Syncytiotrophoblast

(makes chorionic  
gonadotropin and  
then progesterone)

Full term

RBC  
(no nucleus)

Cytotrophoblast mostly absent  
(because they have fused with  
syncytiotrophoblast, allowing it to grow)

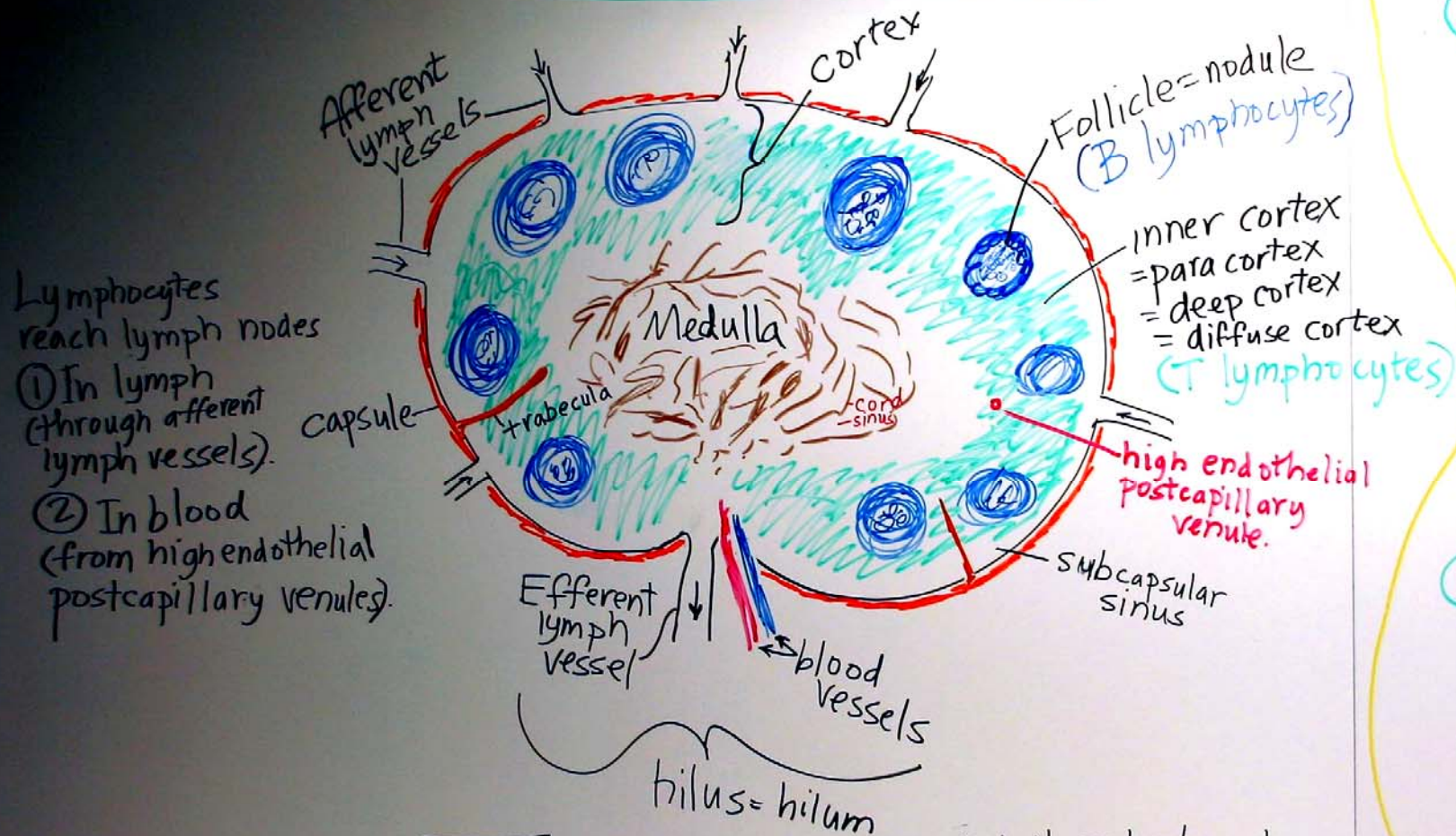


# Lymphatic system

Histology Lab Drawings

A. Kent Christensen

# LYMPH NODE (filters lymph)



When B lymphocyte is activated it seeks lymph node follicle, then (in germinal center) it divides to form clone. In tissue, the resulting lymphocytes differentiate into plasma cells, and secrete circulating antibodies.

T lymphocytes: Cell-mediated immunity, killer cells, helper cells, etc.

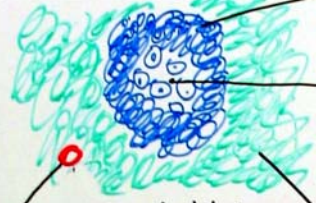


## Cortex

Primary follicle  
Secondary follicle (has  
germinal center)



follicle = nodule  
(mainly B lymphocytes)



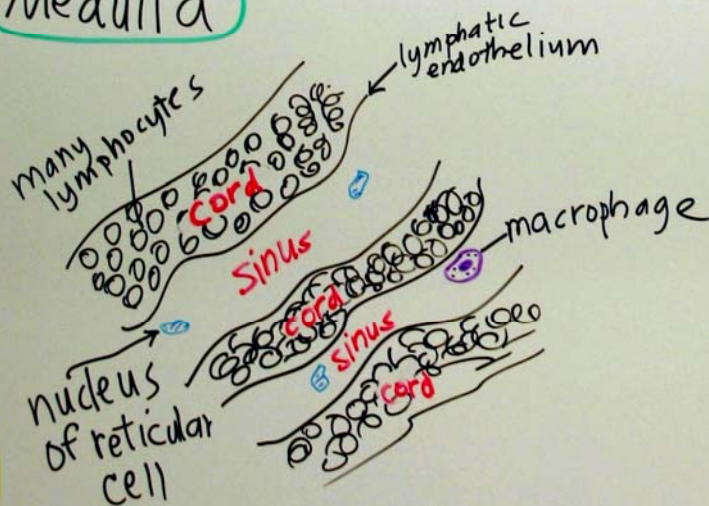
Germinal center  
(medium-sized  
B lymphocytes = lymphoblasts  
dividing to produce clone).

high endothelial  
postcapillary  
venule  
(lymphocytes pass  
~~xxx~~ from blood).

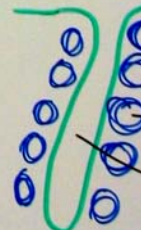
deep cortex = inner cortex  
= paracortex

(mainly T lymphocytes)

## Medulla



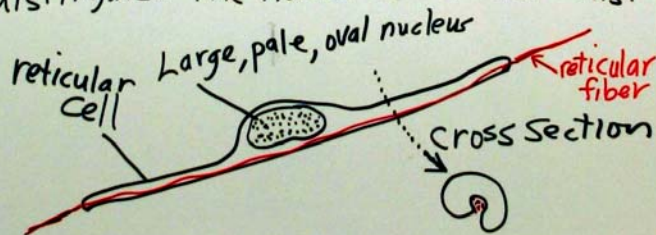
## Tonsil



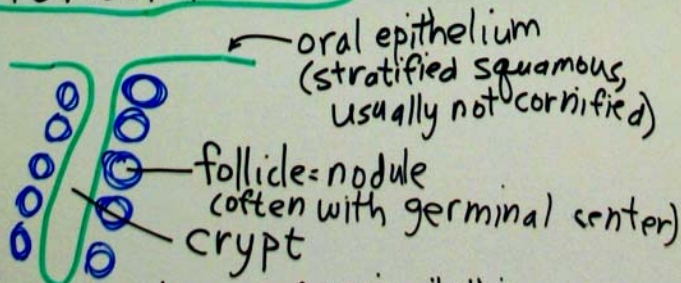
What are your  
sleeves

## Reticular cells

Make reticular fibers (collagen type III) that form structural framework supporting lymph nodes, spleen, tonsil, solitary nodules (thymus also has, but different) Reticular connective tissue found throughout lymph node, but seen most easily in sinuses (subcapsular or medulla). You can usually only distinguish the nuclei of reticular cells.



## Tonsil (palatine)



What are your chances of seeing it this clearly in a random section?

Everything that isn't white pulp is red pulp

Whi

fol  
c  
e

Homolo

Lymph

Deep

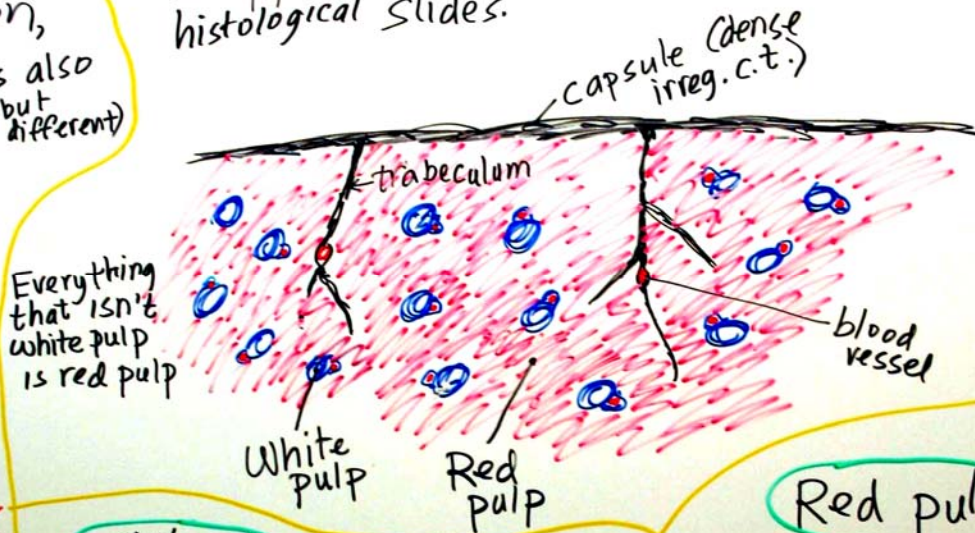
Folli



type III)  
ork  
leen,  
nus also  
as, but  
different)  
e

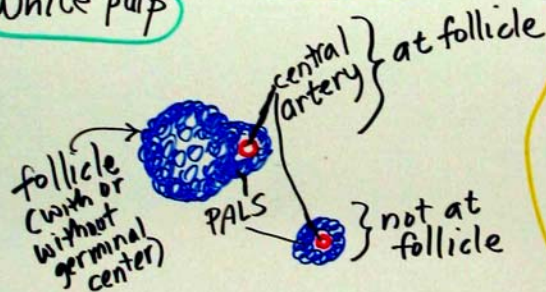
# Spleen Modulates blood.

Terms: "White pulp" and "red pulp" are based on appearance in fresh tissue, not in histological slides.



s.  
ular  
ber  
on

## White pulp

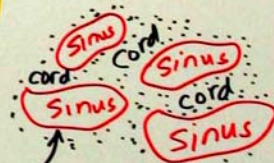


Homology:

Lymph Node	Spleen
Deep cortex	PALS
Follicle	Follicle

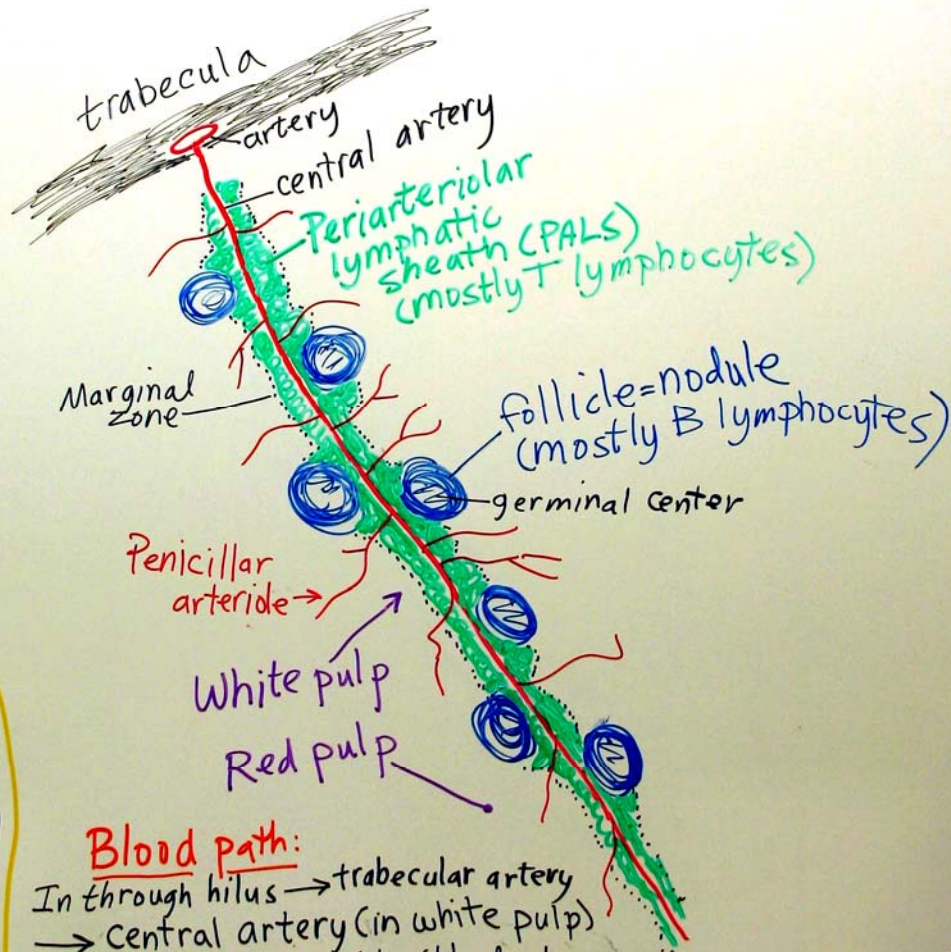
Contains mostly:  
T lymphocytes  
B lymphocytes

## Red pulp



Wall of sinus is unusual "endothelium" composed of long rod-shaped cells with some space between (for passage of RBCs, etc.)  
cross section  
longitudinal section

# Organization of blood circulation in spleen



## Blood path:

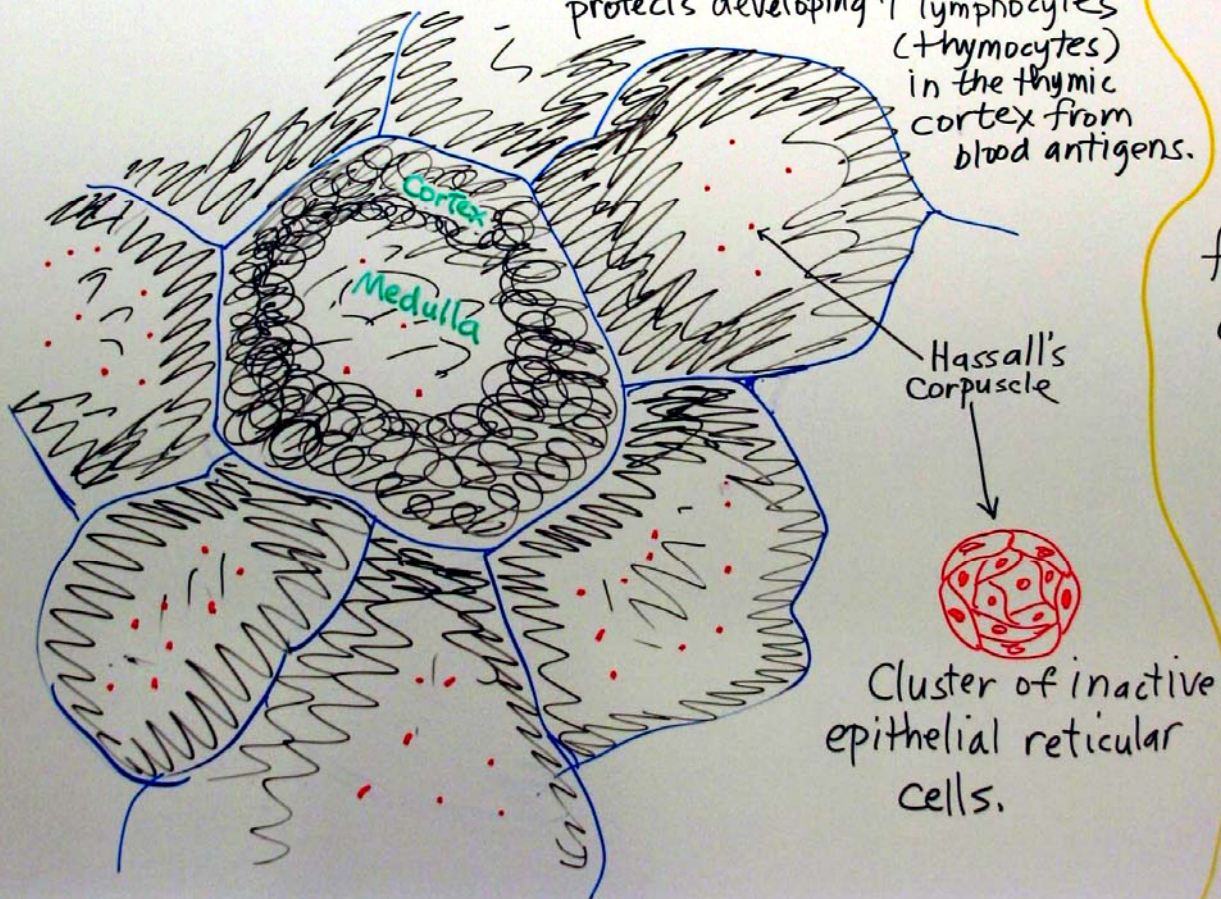
- In through hilus → trabecular artery
- central artery (in white pulp)
- penicillar arteriole (blood released?)
- Splenic sinuses<sup>(red pulp)</sup> → trabecular veins
- out in larger veins through hilus



# Thymus

T lymphocytes mature in the cortex of the thymus, then pass to the medulla to enter blood vessels to the body. The thymus is most active in young individuals.

The blood-thymus barrier protects developing T lymphocytes (thymocytes) in the thymic cortex from blood antigens.

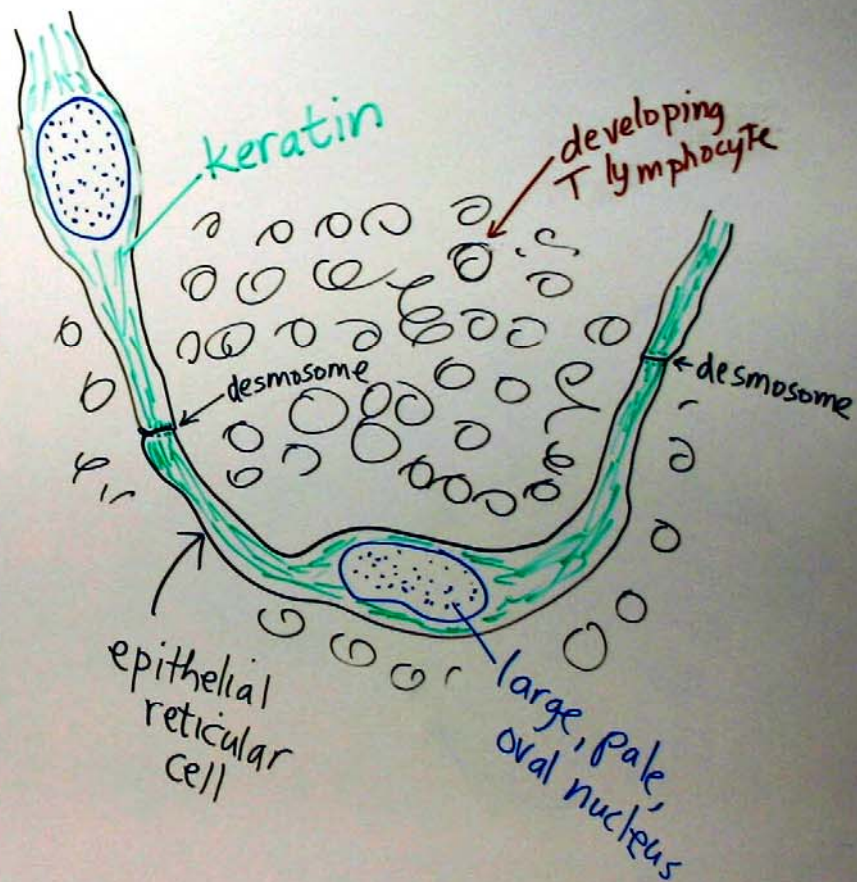




## Epithelial reticular cells (in thymus)

The thymus is derived embryologically from endoderm (branchial pouches), so has epithelial reticular cells (rather than mesothelial, as in lymph node, spleen, etc.).

These cells form a structural framework by ~~intercellular~~ <sup>intracellular</sup> bundles of intermediate filaments (keratin), and by desmosomes forming attachments between cells. This is in contrast to the lymph node, spleen, etc. (derived from mesoderm) where reticular cells make extracellular reticular fibers.



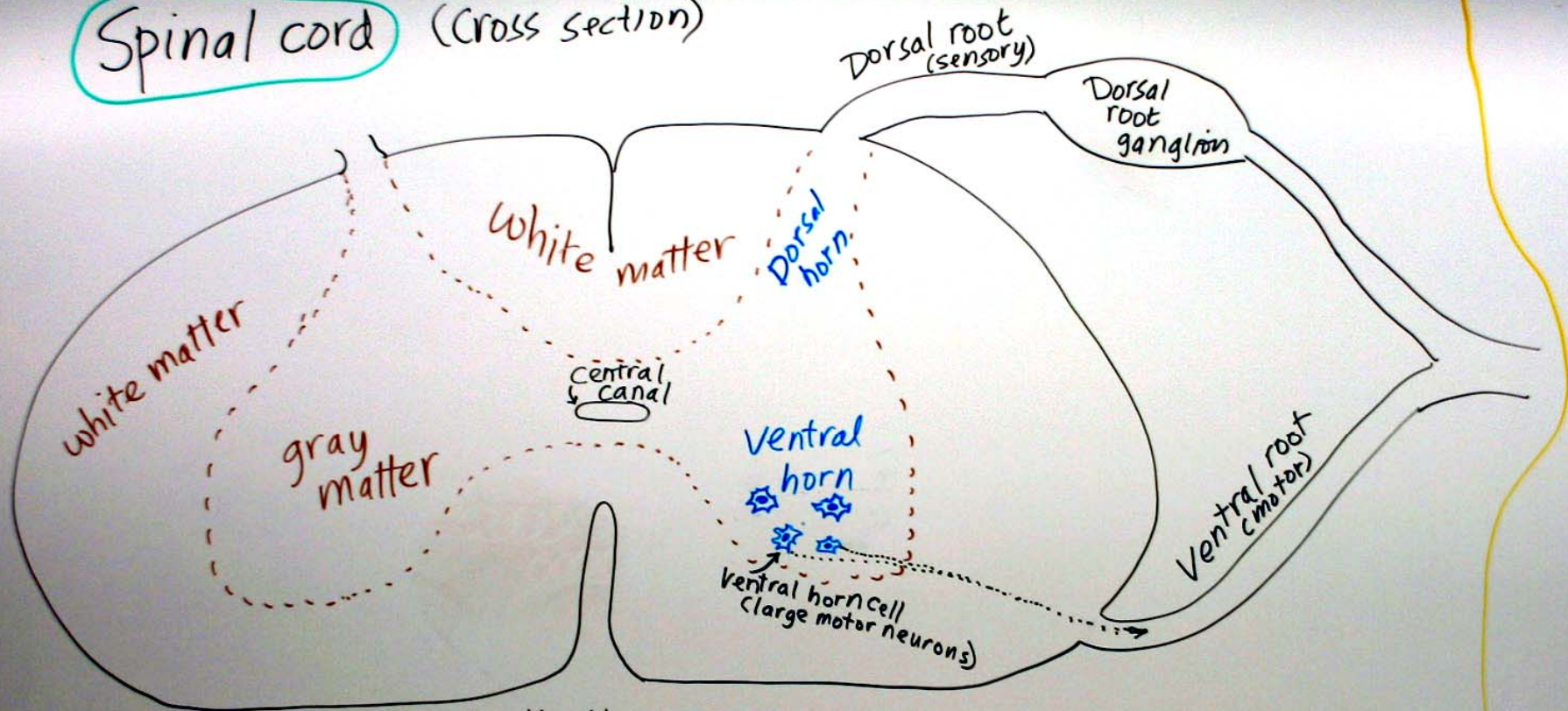


# Central Nervous System

Histology Lab Drawings

A. Kent Christensen

# Spinal cord (Cross section)



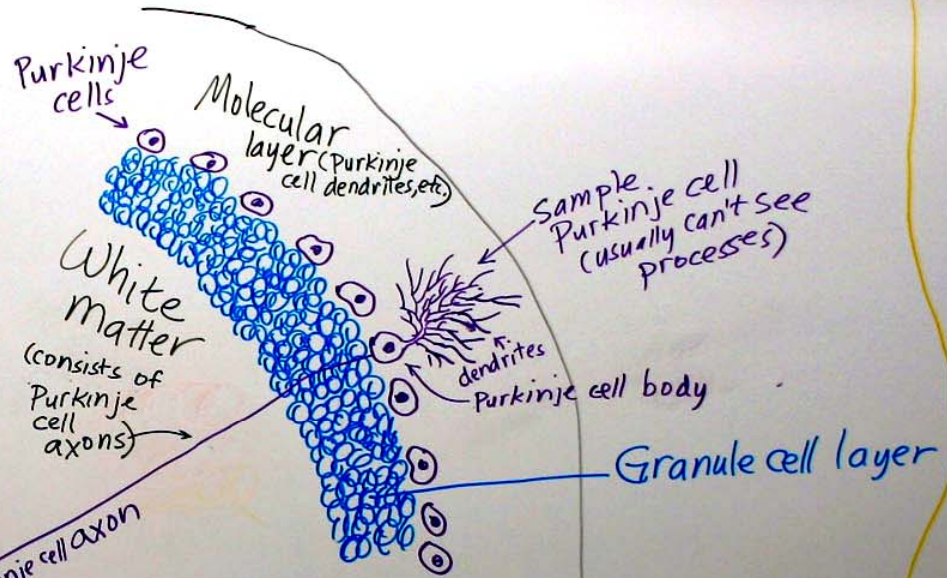
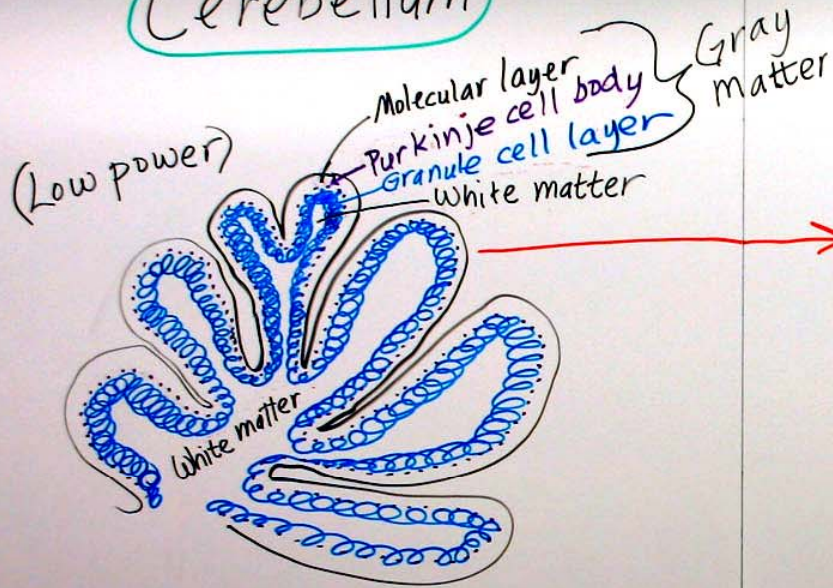
White matter (axon tracts, glia, blood vessels)

Gray matter (neuron cell bodies, dendrites, axons, glia, blood vessels)

In fresh tissue, white matter is white, and gray matter is gray



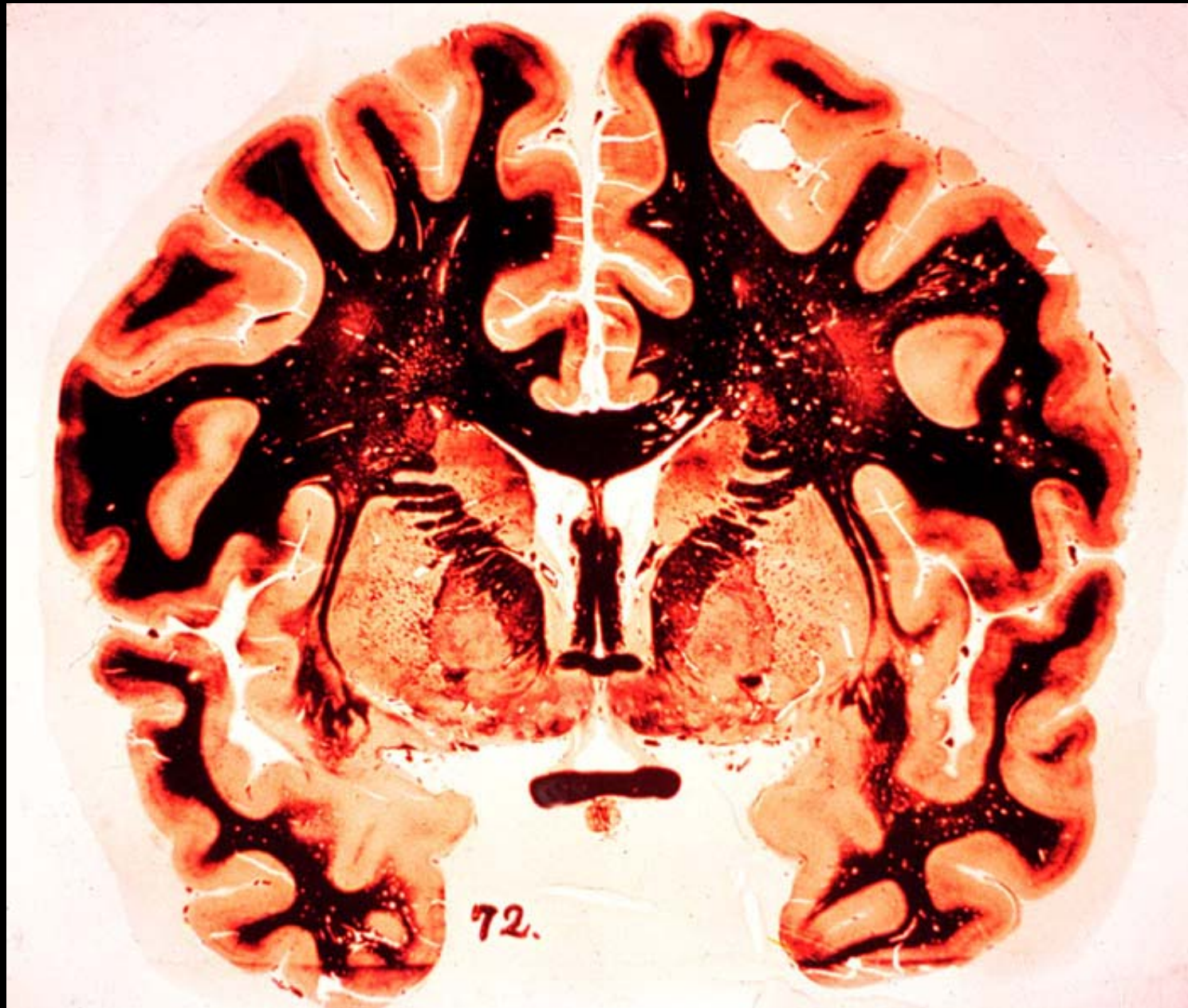
# Cerebellum



etc. — Purkinje cell axon

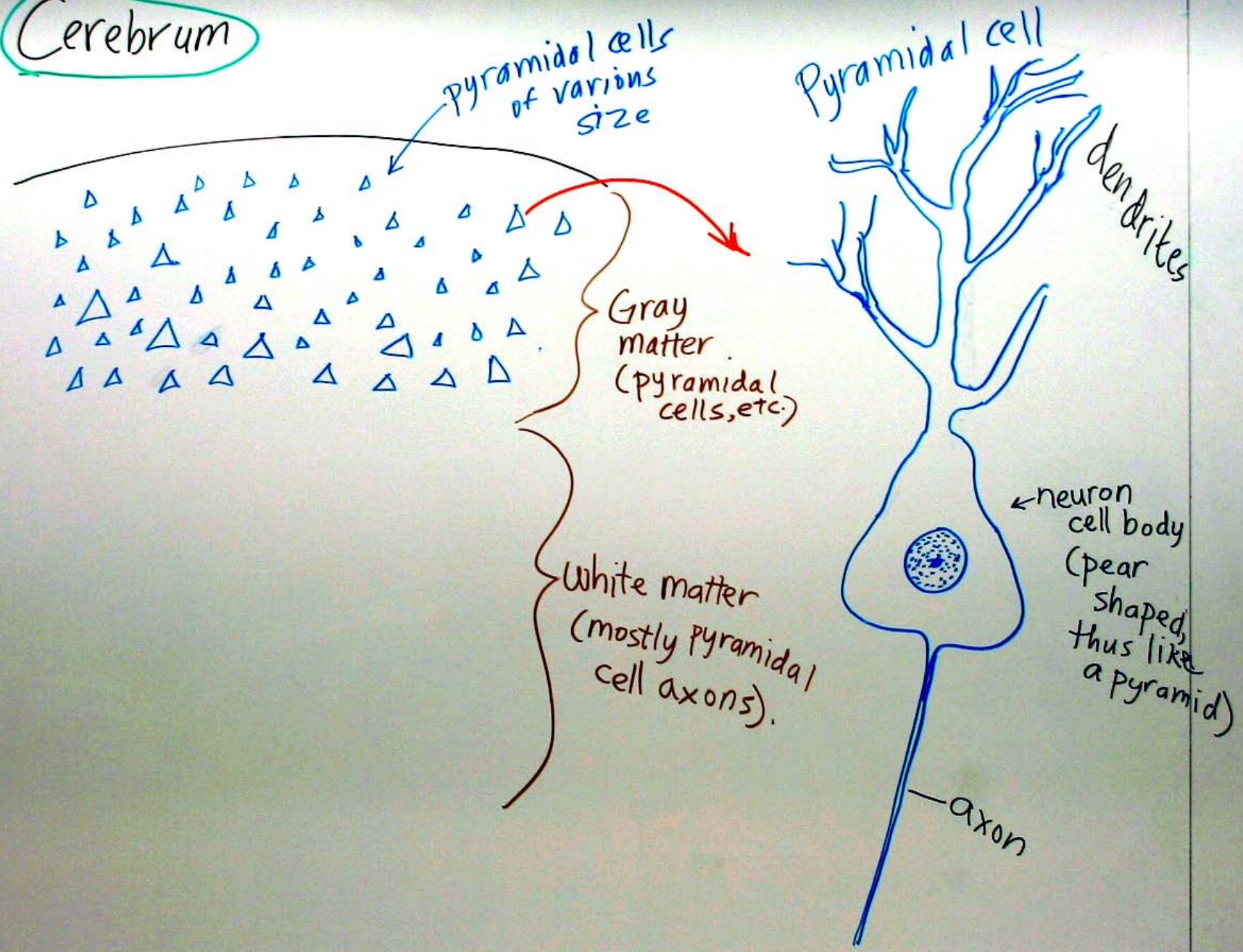


# Coronal section of human brain: cerebral cortex





# Cerebrum



# Ear & Eye

Histology Lab Drawings

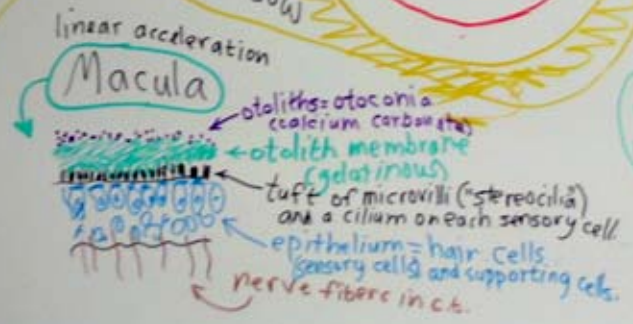
A. Kent Christensen



PLEASE SAVE UNTIL 3 APRIL

# EAR

Bony labyrinth = series of interconnected channels and compartments in bone (perilymph  $\text{Na}^+$ )  
Membranous labyrinth = series of interconnected membrane-bound sacs and tubules within the bony labyrinth (endolymph  $\text{K}^+$ )



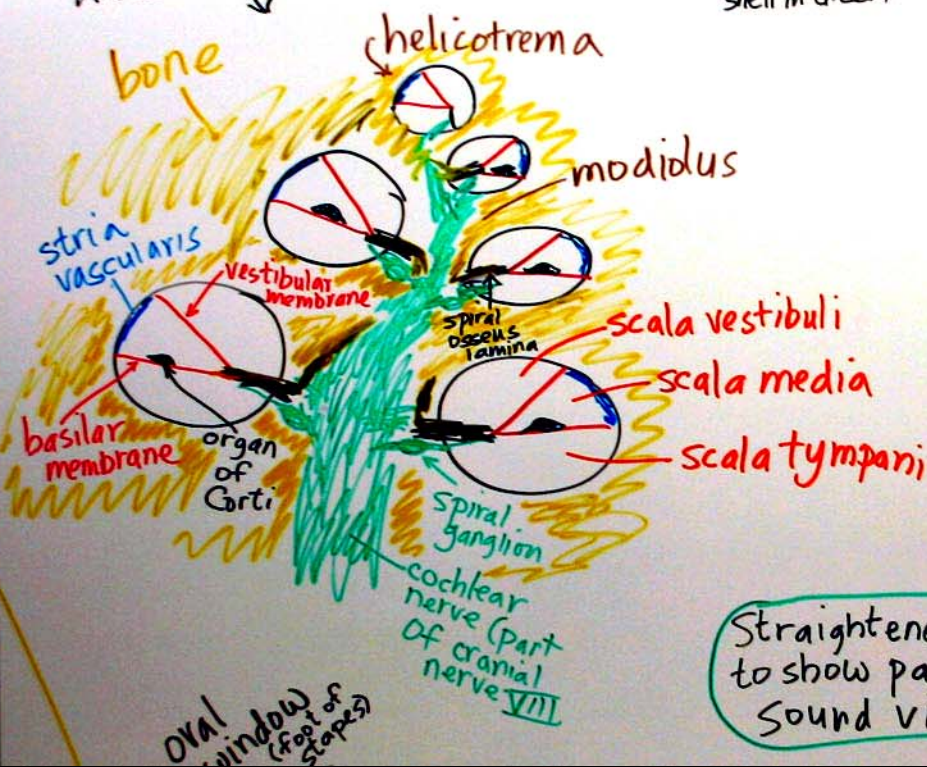


# Cochlea

View in section

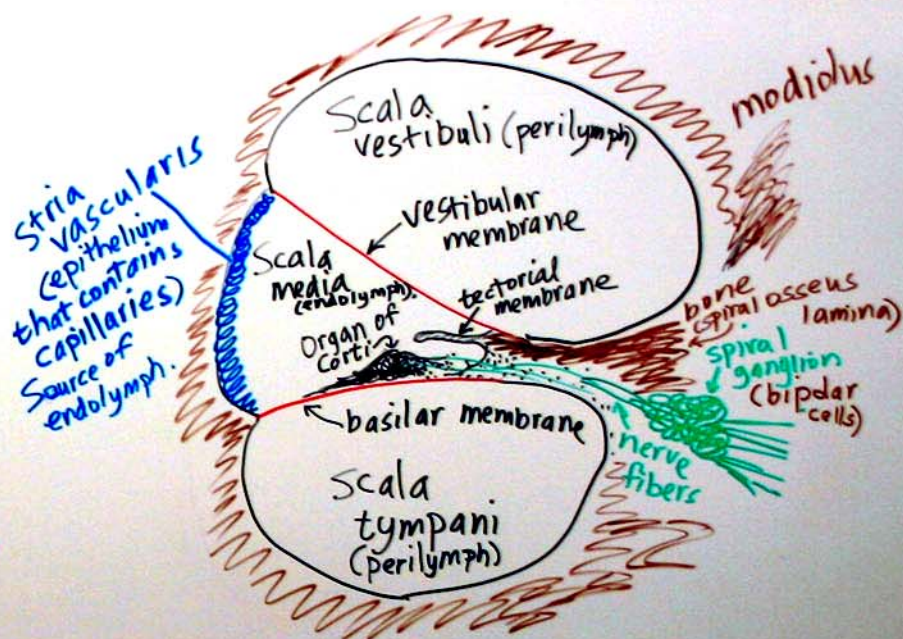


In 3D  
has shape of  
snail shell  
(cochlea = snail  
shell in Greek)



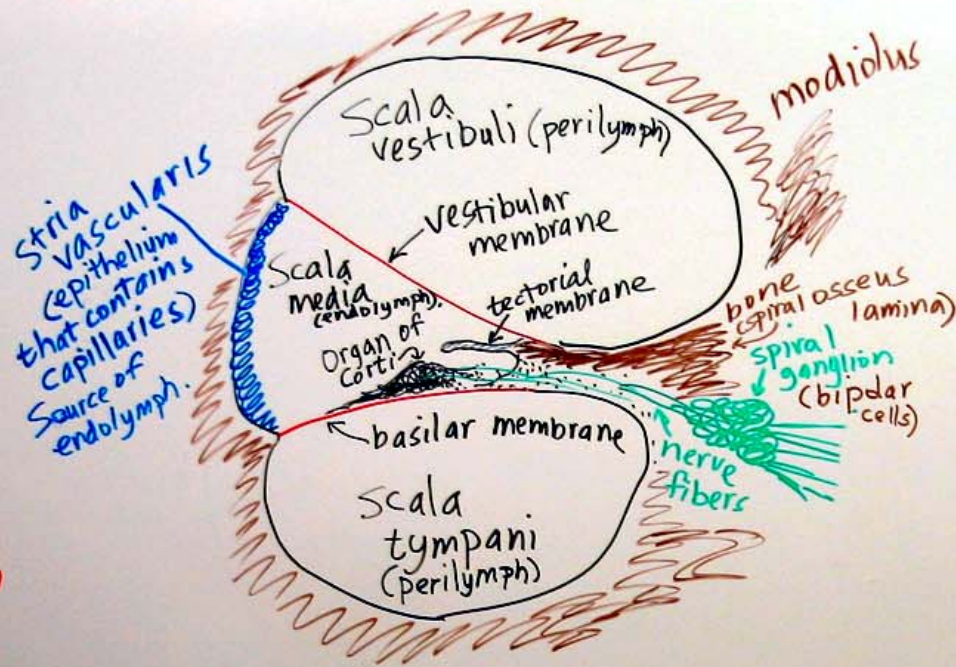
Straightened cochlea  
to show path of  
sound vibrations

# Cochlear canal

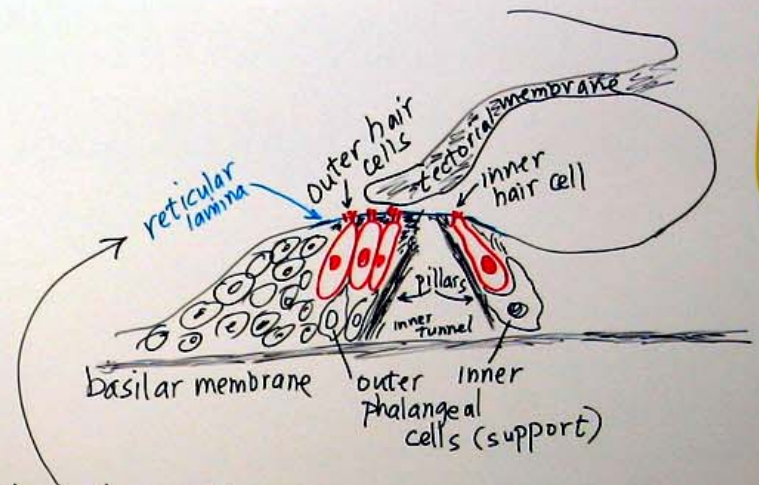




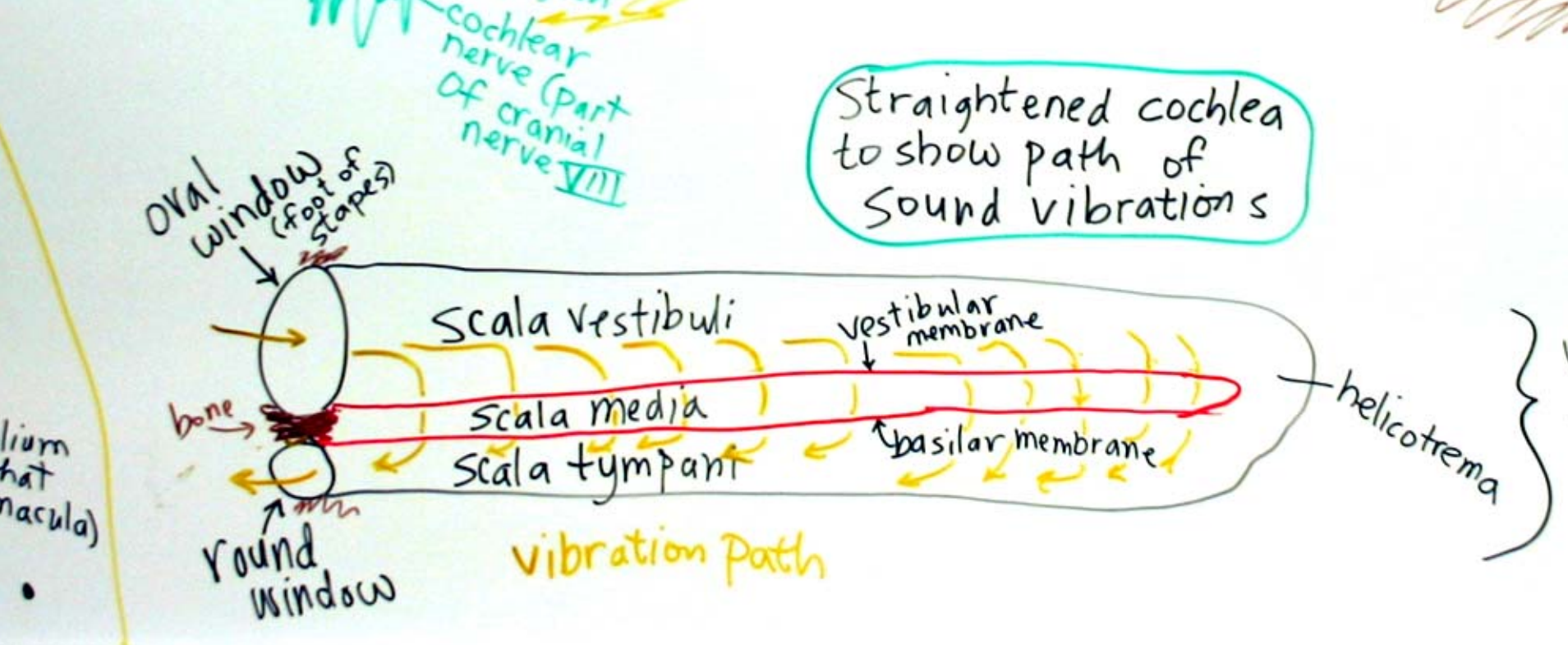
## Cochlear canal



## Organ of Corti



The reticular lamina (formed by processes of phalangeal cells) supports the apices of hair cells, and forms a barrier between endolymph above and perilymph below.

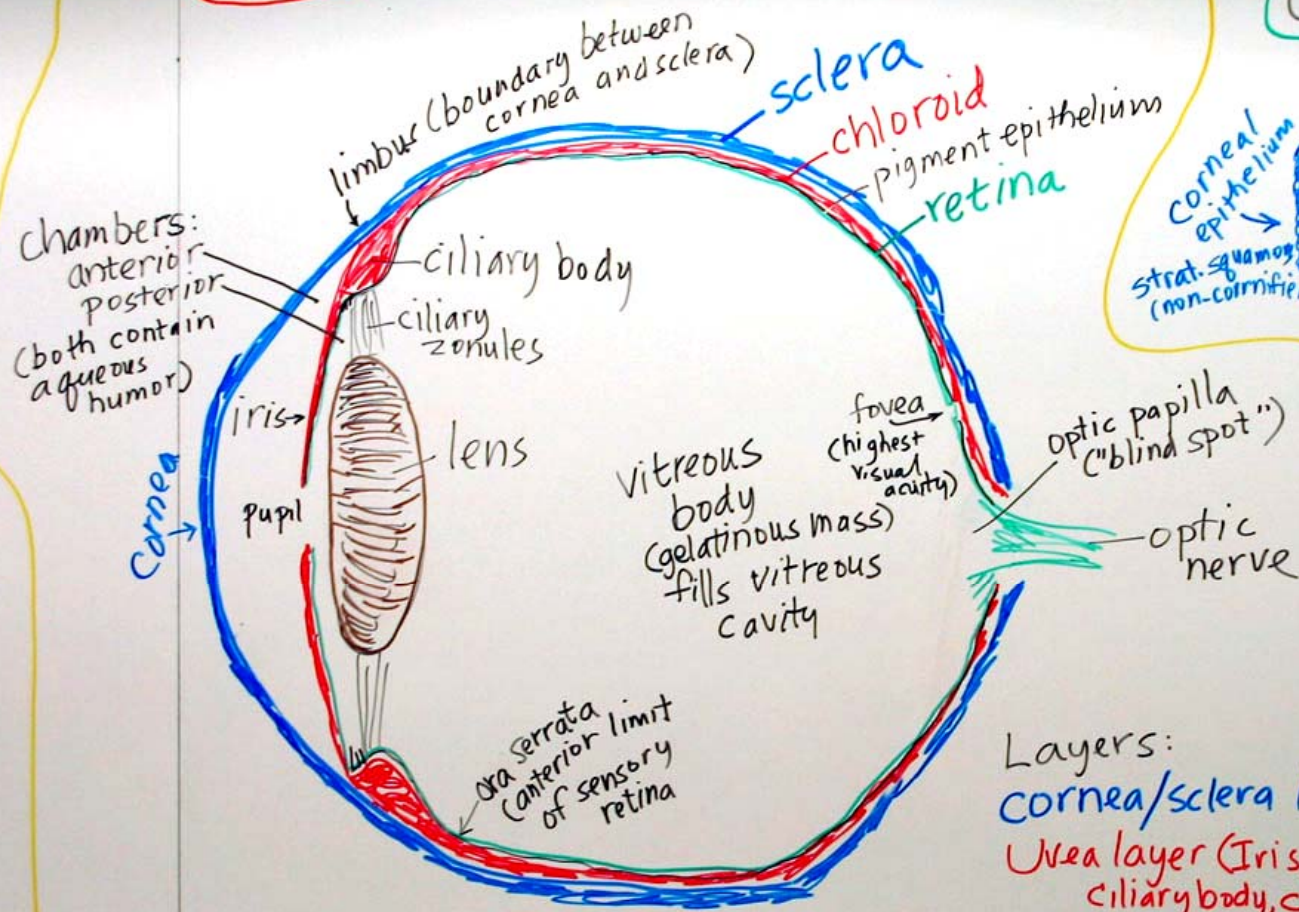


helicotrema

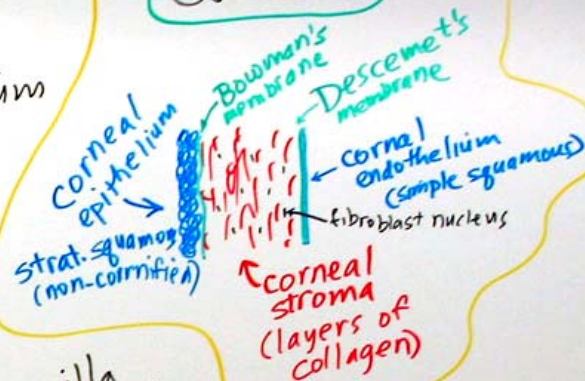
Vibrations are communicated from foot of stapes (in oval window) through vestibule, then through scala vestibuli, across scala media to scala tympani, then to round window. The basilar membrane is wider at the apex (helicotrema) of cochlea than at the base, so lower sounds are sensed toward the apex and higher sounds toward the base. The oval and round windows have reciprocal vibrations.



# EYE



## Cornea

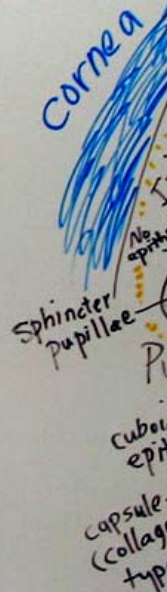
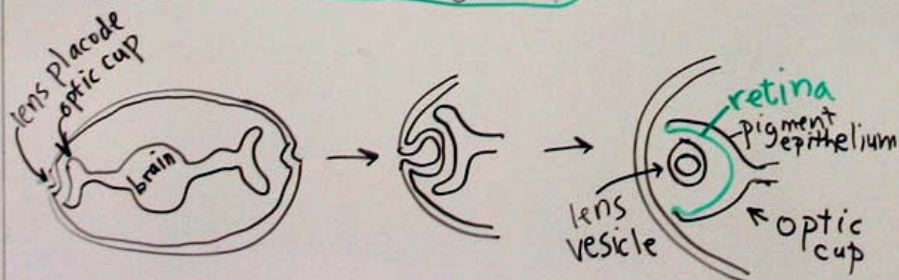


- Path of aqueous humor
- (1) From ciliary processes
  - (2) Around iris
  - (3) Trabecular meshwork
  - (4) Canal of Schlemm
  - (5) To veins

Layers:

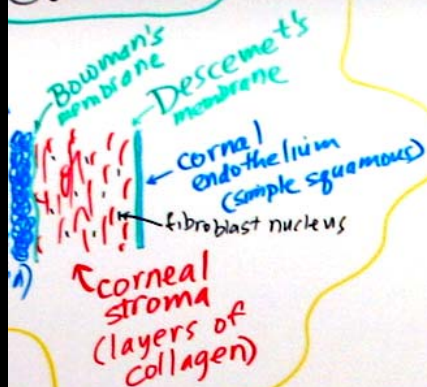
- cornea/sclera layer
- Uvea layer (Iris, ciliary body, choroid)
- Retina/pigment epithelium

## Remember the embryology





# Cornea



# Ciliary body, iris, lens

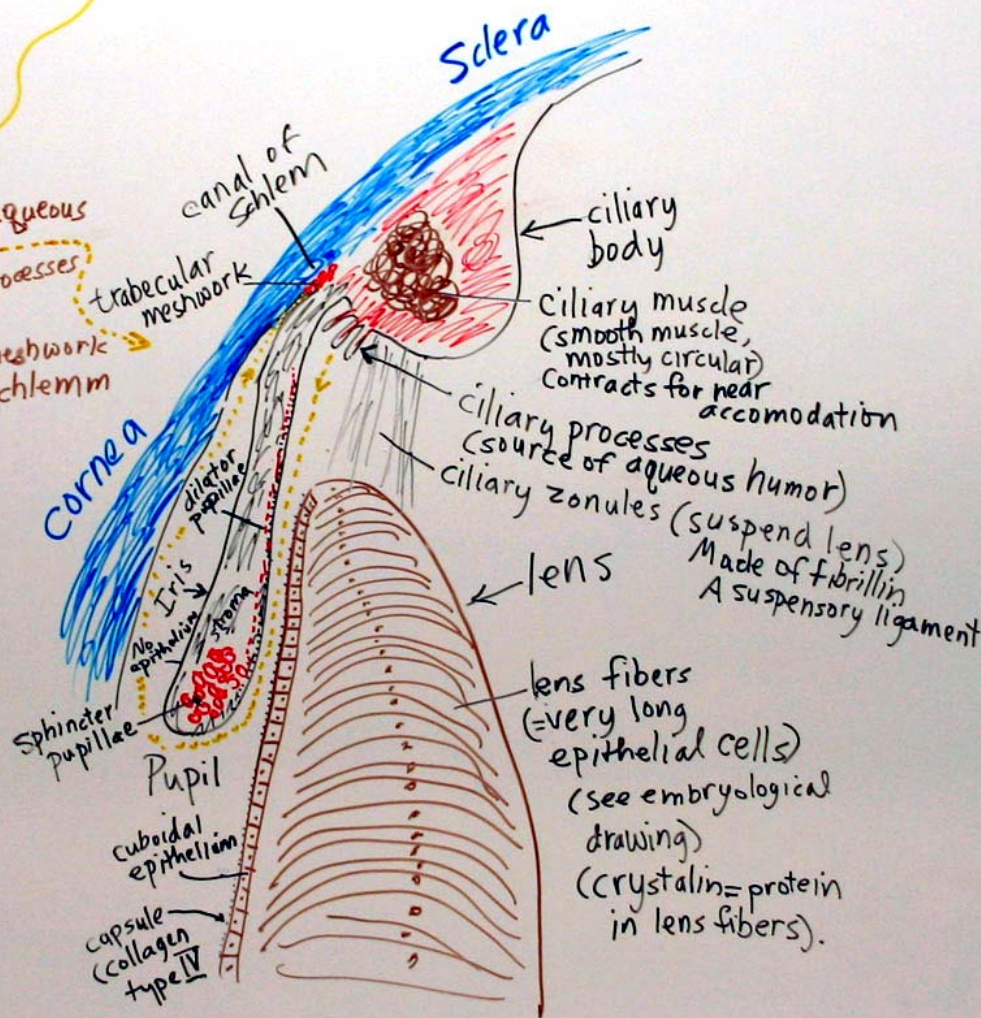
# Retina

- Path of aqueous humor
- (1) From ciliary processes
  - (2) Around iris
  - (3) Trabecular meshwork
  - (4) Canal of Schlemm
  - (5) To veins

layer

choroid)

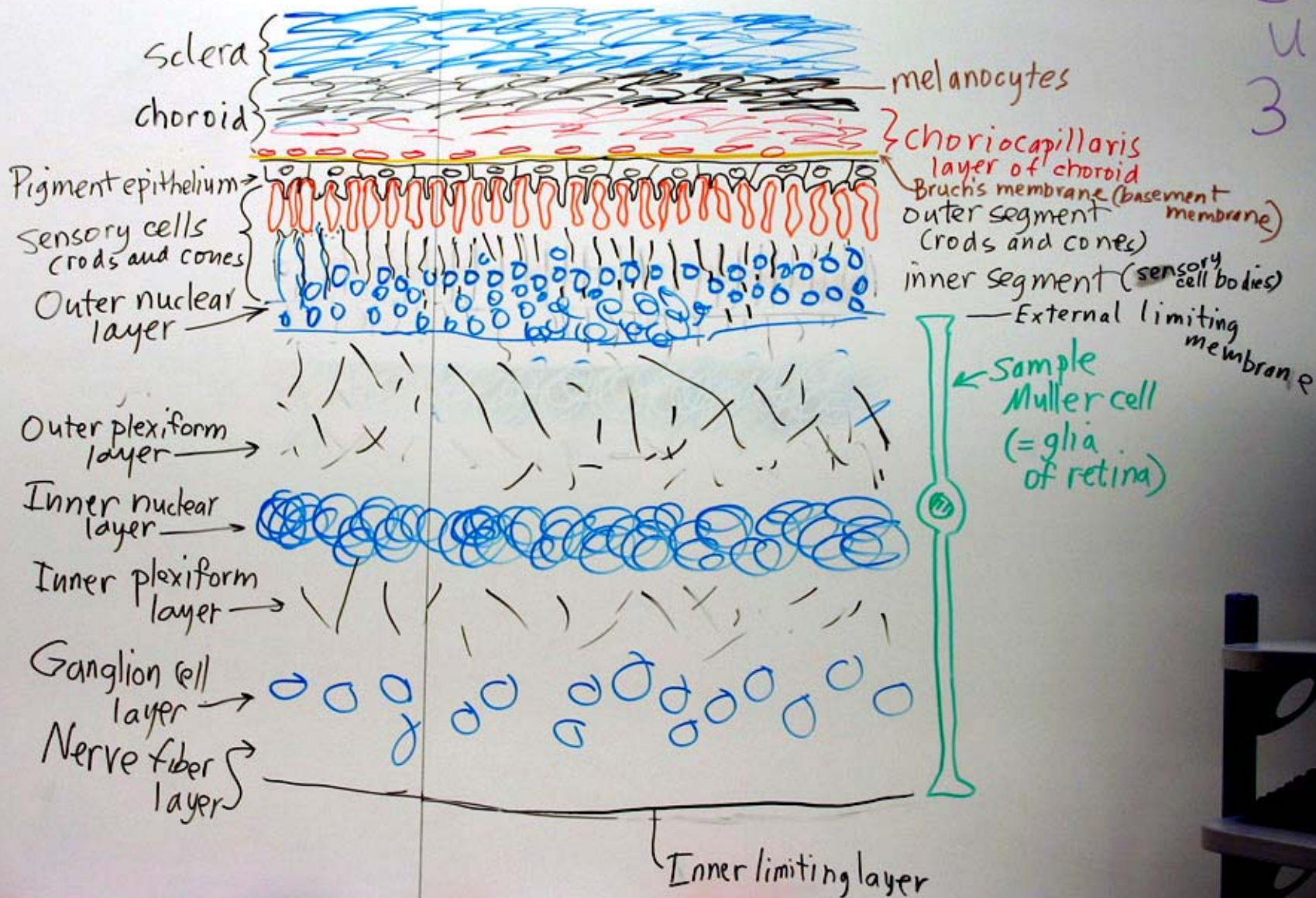
nt epithelium





# Retina and associated layers

PL  
SA  
UN  
3 f



# Blind spot (image on optic papilla)



Cover left eye  
and look here  
with right eye



At a certain  
distance from  
the board, this  
will disappear