## Module 04: Tissue Organization and Dynamics
Assignment
Total Point Value = 30

**Due by midnight on Day 7 of Module 4**
This should be submitted to Blackboard as a pdf.

1. Name that tissue and structure! Assign every word from the word bank below to an image or structure within an image. Please use arrows and circles to point to the structure you are labeling when necessary. Note there are 2 bonus images. Correct identification of the structure/tissue is worth 1.5 bonus points each.

Cilia	Neuron	Stratified cuboidal
Microvilli	Simple squamous	epithelium
Skeletal muscle	epithelium	Elastin
Columnar epithelium	Stratified squamous	Cryptus
Liver sinusoid	epithelium	Basement membrane
Myelin		

Note there is more than one correct answer for basement membrane.

Elastin, Cap, P

Liver Sinusoids

Stratified Cuboidal Epithelium, Basement Membrane

Stratified Squamous Epithelium, Basement Membrane, K

Simple Squamous Epithelium, N

Columnar Epithelium, Basement Membrane

BONUS IMAGES

Inner Ear
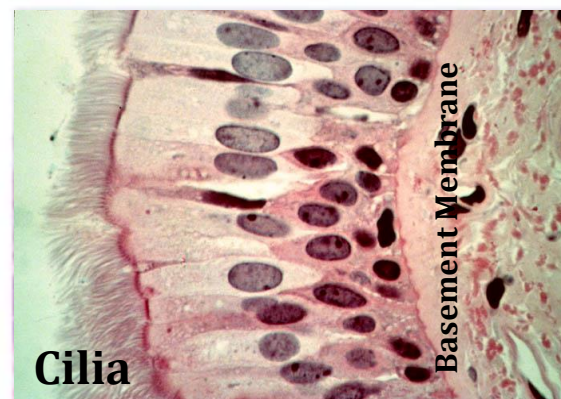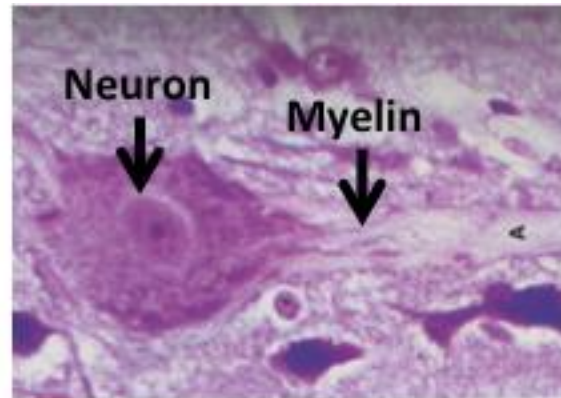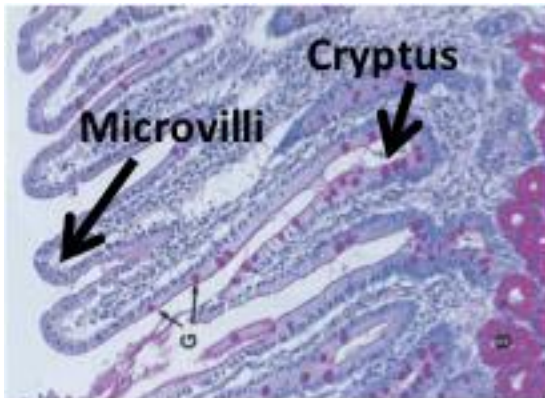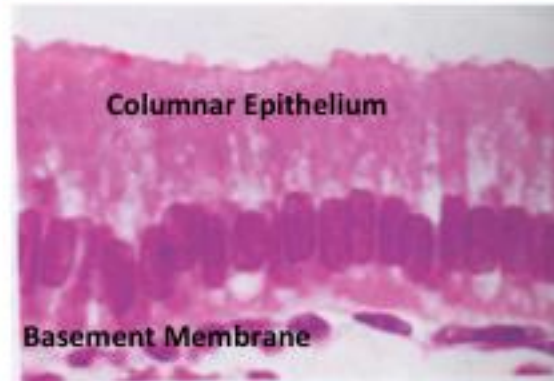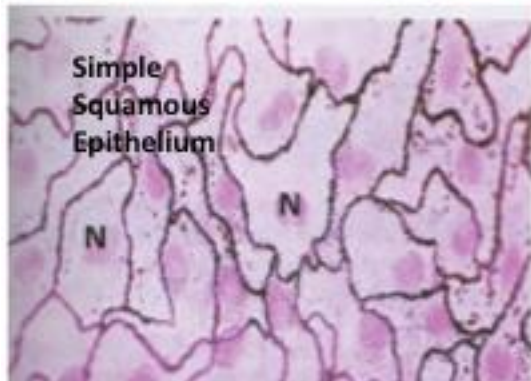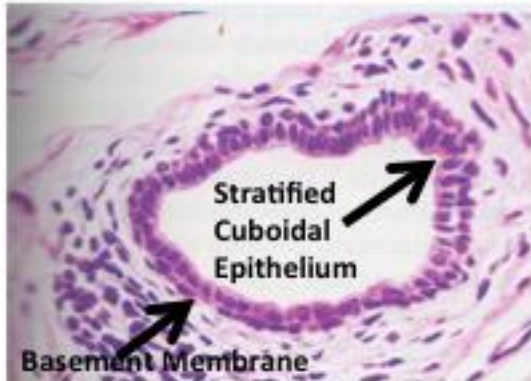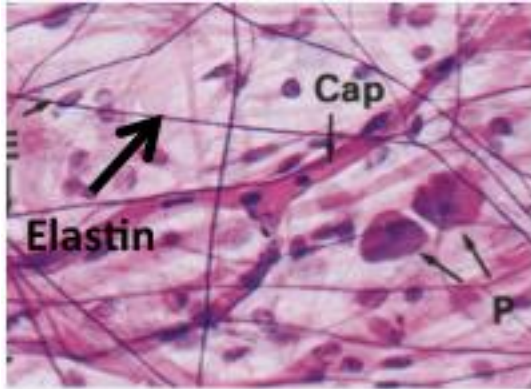
Retinal Photoreceptors
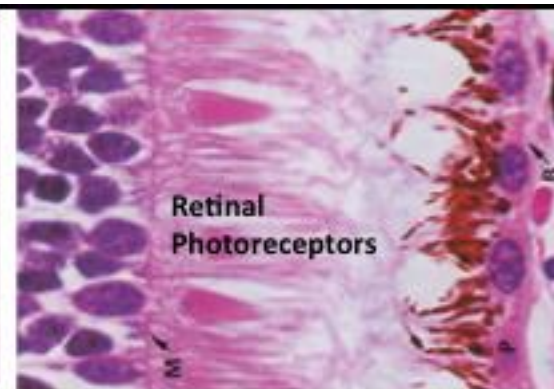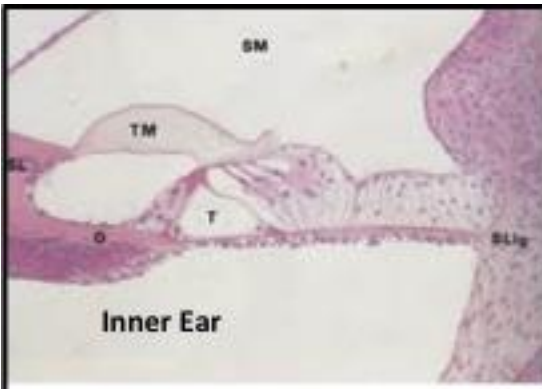
2. Atherosclerosis ("hardening of the arteries") is a disease hallmarked by the build-up of plaques in blood vessels. These plaques make it more difficult for blood to flow, which blocks the vital delivery of nutrients to downstream tissue. Complications from atherosclerosis include clots, heart attack and stroke. This disease can manifest in many locations including the coronary artery (when its termed "coronary artery dis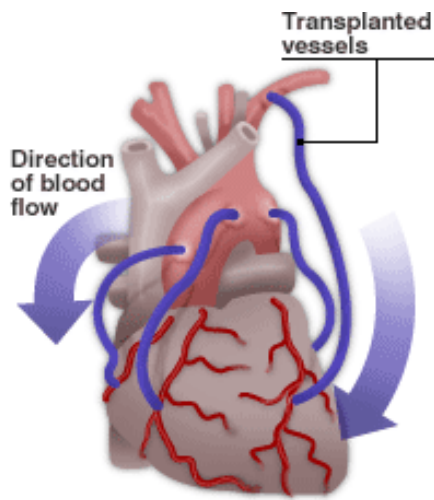ease"), the cerebral or peripheral vasculature. One way to treat extreme coronary artery disease is through surgery – a Coronary Artery Bypass Graft (CABG). In this surgery a healthy artery from elsewhere in the body is taken and use to bypass the segment of blocked vessel. The disease can become so progressed that it necessitates quadruple or even quintuple bypasses and typically the patients in this state do not have enough healthy vessels to sacrifice (see image where purple vessels indicate typical locations of bypass for the red coronary arteries).

A. What is the most common alternative vessel used when there are no arteries left for CABG? The saphenous vein

B. What are the problems with this solution? What properties of this vessel are unmatched to the needed function? Please describe differences in both form and function. A vein has a different structure and function than an artery making it a non-ideal candidate for grafting. This table lists the difference between the internal mammary artery (IMA) and saphenous vein.

	IMA	Saphenous vein
Anatomic properties		
Endothelial fenestrations	Few	Many
Intercellular (IC) processes	Many	Few
IC junction permeability	Low	High
Internal elastic lamina (IEL)	Well defined	Poorly defined
Heparan sulfate in IEL/media	High	Low
Dependence on vasa vasorum	Minimal	High
Valves	Absent	Present
Size match with grafted native vessel	Good	Poor
Resistance to trauma of harvesting	High	Low
Physiological properties		
Flow reserve	High	Low
Shear stress	High	Low
Nitric oxide/prostacyclin production	High	Low
Vasomotor response to thrombin	Relaxation	Constriction
Vasoconstrictor sensitivity	Low	High
Vasodilator sensitivity	High	Low
Basic fibroblast growth factor receptors	Few	Many (8× IMA)
Lipolysis	Rapid	Slow
Lipid synthesis	Less active	More active
Lipid uptake	Slow	Rapid

The differences are split into two categories – anatomical (form) and physiological (function). Differences between the artery and vein include a thinner elastic lamina in the vein, which supports low blood pressure, compared with a thick elastic lamina in an artery supporting high blood pressure. Veins are larger in diameter and have valves, which helps them to hold a large blood volume, compared with arteries, which have smaller diameters and no valves allowing them to move oxygenated blood rapidly to the tissues. Of specific interest to surgeons is fact that veins are more difficult to harvest without damaging them ("trauma of harvesting" above) compared to arteries due to their inferior structural integrity. (Reference for table: Otsuka et al, 2013)

C. Why does this not end up being a problem for many patients in the long run?
Even though there are numerous differences between veins and arteries the saphenous vein ends up being a reasonable solution for bypass patients because *the human body adapts*! Over time vein grafts remodel and become more arterial in form and function. Additionally *surgeons can adapt* and try to fix or re-bypass (although very rarely!) the original graft.

D. Describe 3 desirable design properties of tissue engineered blood vessels.

There are many desirable design properties of TE blood vessels. The list includes:
1. Ability to adapt to changing physiological environment and regulate blood pressure appropriately (diet, exercise, age…)
2. Compatible with the body (no immune response)
3. Structurally support required blood flow (pressure and volume)
4. Resist disease (specifically atherosclerosis)
5. Durability over the lifetime of the patient
6. Ease of surgical placement and connectivity to existing vascular structure
7. Short time to produce (readily available for patients with acute needs)

Reference for image: www.indiasurgery.indicure.com

Assignment Rubric

Question	Component	Total Point Value
1	1pt each	13
2	A	5
	B	4
	C	4
	D	4

Total Point Value = 30