Module 05: Morphogenesis

Assignment

Total Point Value = 30s

Due by midnight on Day 7 of Module 5

This should be submitted to Blackboard as a pdf.

1. Exercise 3.1 From *Tissue Engineering*, Saltzman

   a) germ layer, location in embryo and tissue types

Layer	Location	Tissues
A. Endoderm	Bottom layer	Epithelial tissue- Lung, thyroid, pancreas
B. Ectoderm	Top layer	Epithelial tissue - Skin, melanocyte Neural tissue - neuron
C. Mesoderm	Middle layer	Connective tissue - blood cells Muscle tissue - Cardiac muscle, skeletal muscle, smooth muscle

   b) Typically all of one tissue is derived from one germ layer. Some examples of tissues that are comprised of cells from multiple germ layers are:

   1. epithelium – the epidermis (skin) comes from the ectoderm, but the mesoderm provides the lining of the body cavities and the endoderm provides the lining of the GI tract.
   2. bone – cranial bones and branchial cartilage are derived from the ectoderm (neural crest), while the rest of the bones and cartilage in the body arise from the mesoderm

   Reference : http://www.medbullets.com/step1-embryology/3004/germ-layer-derivatives

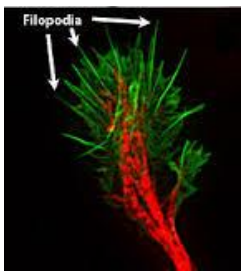
2. Explain why fingerprints can be used to tell identical twins apart.

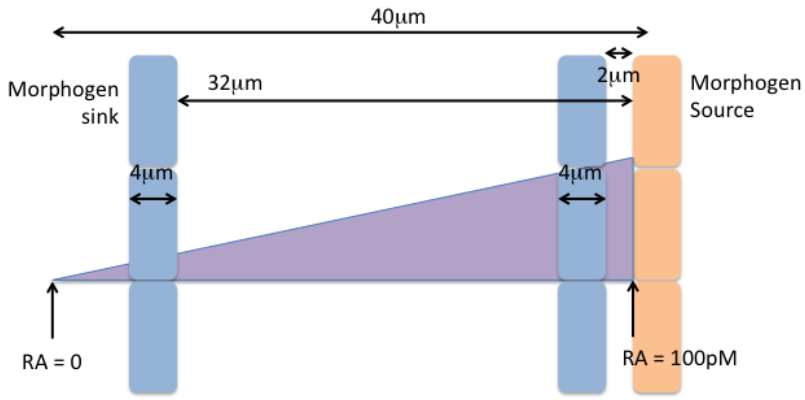
   Fingerprint structures are formed by mechanical forces that act during embryonic development. Although identical twins have the same genetic code these forces are unique to each individual. For example one of the biggest factors to influence these forces is simply the position of the fetus in the womb, which can alter pressure points and regional exposure to amniotic fluid),

3. Describe how semaphorins and slits function similarly in directed migration.

   In lecture we learned how semaphorin3a1 and 3a2 are repulsive cues that direct migration of the blood vessels in the developing zebra fish. The growing blood vessel (endothelial cell) expresses the semaphoring receptor plexin. When plexin binds to semaphorin the cell interprets a repulsive signal and will not migrate in that direction. Similar to semaphorin, slit is used as a repulsive cue during long-range axon guidance in human development. The receptor for slit is robo, which is expressed by the neuron. When robo binds to slits the neuron gets a repulsive signal and like the endothelial cell migrates away from slit.

4. Gradient calculations.
    a. Gradients of soluble morphogen are used to direct both cell specification and cell migration in the embryo. Given the diagram ***quantitatively*** determine the location (2μm or 32μm) at which the blue cells feel the steepest gradient.





The gradient sensed by the cell at the 2μm location can be calculated as follows:
The over all gradient is 100pm/40μm = 2.5pM/μ
Therefore at the front of the cell (closest to the source) the concentration is 95pM
2.5pM/μm * 2μm = 5pM
100pM – 5pM = 95pM

At the rear of the cell the concentration is 85pM
2.5pM/μm * 6μm = 15pM
100pM – 15pM = 85pM

Therefore the gradient is (95pM – 85pM)/ 85pM = 0.118 or 11.8 %

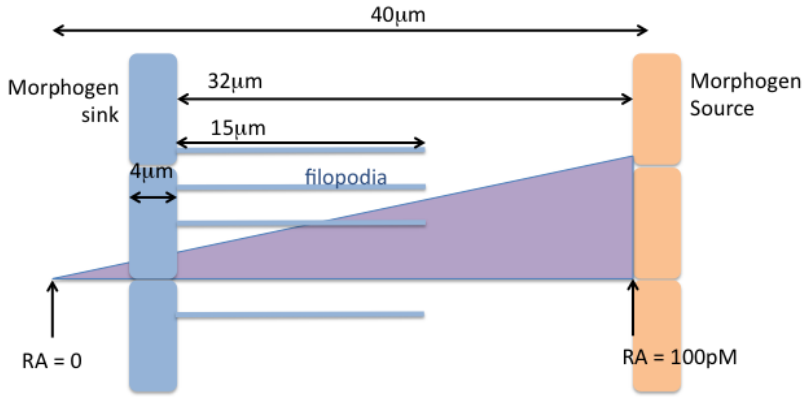
The gradient sensed at the 32μm location is similarly calculated as follows:
At the front of the cell (closest to the source) the concentration is 20pM
2.5pM/μm * 32μm = 80pM
100pM – 80pM = 20pM

At the rear of the cell the concentration is 85pM
2.5pM/μm * 36μm = 90pM
100pM – 90pM = 10pM

Therefore the gradient is (20pM – 10pM)/ 10pM = 1 or 100 %

The answer to the question is that the gradient sensed by the cell is steepest at the 32μm location

b. Cells use special structures called filopodia to sense their local environment. These thin projections of the actin cytoskeleton reach out and survey both the chemical and mechanical composition of the environment as the cell decides what direction to migrate in. ***Quantitatively*** determine how filopodia change the gradient sensed by the cell in the diagram below.



The filopodia change the front location of the cell. With the cell starting at the 32μm location, we recalculate the concentration felt at the front of the cell we get 57.5pM
2.5pM/μm * 17μm = 42.5pM
100pM – 42.5pM = 57.5pM

Now when we calculate the gradient sensed by the cell we get (57.5pM – 10pM)/ 10pM = 4.75 or 475%. This shows us how the use of filopodia can increase the steepness of the gradient sensed by the cell therefore increasing the response of the cell to the morphogen.

Assignment Rubric

Question	Component	Total Point Value
1	A (1pt each)	12
	B	4
2		3
3		3
4	A	4
	B	4

Total Point Value = 30

References:
Filopodia Image: en.wikipedia.org.