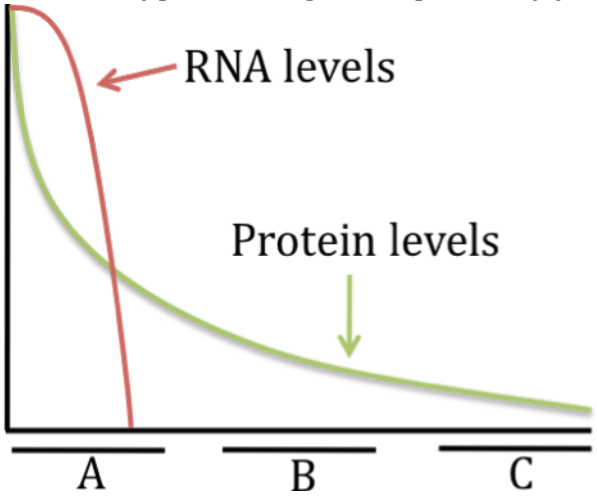
Developmental Biology 3230 Exam 2 **NAME**_____
March 5, 2010

1. (10 pts) What is the role of micromeres during sea urchin development? Describe one experiment used to support this role. What region of a vertebrate embryo performs an analogous function?

4 pts- role of mixromeres: organizing center controlling patterning and cell fate of surrounding tissues. Gives rise the mesoderm
3 pts- experiment: transplant micromeres to another region of blastomere results in secondary embryonic axis formation
3 pts- dorsal lip of the blastopore, primitive streak, henson's node

2. (10 pts) Which region or regions of the graph (A, B or C) would most likely be important in for differential regulation of targets during patterning in the fly embryo for this hypothetical gene. Explain why you choose this region?



5 pts- region A
5 pts- the steep protein gradient allows the protein to act as a morphogen gradient, which is utilized by cells to determine positional identity

3. (15 pts) Dorsal protein is expressed ubiquitously throughout the fly embryo. Explain how its uniform protein level still functionally acts as a morphogen gradient. How is this morphogen gradient regulated at the molecular level?

7 pts- dorsal is only activated and localized to the nucleus on the ventral region of the embryo
8 pts- ventricle follicle cells produce Pipe protein, which leads to Spatzle activation in the ventral perivitelline space. Spatzle binds to Toll, which activates Pelle kinase. Pelle kinase phosphorylates Cactus, which relieves its repression of the nuclear localization signal of Dorsal protein. Dorsal then enters the nucleus and acts as a transcriptional activator and repressor of target genes.

4. (15 pts) What is the full name of the ZPA? Describe two experiments used to identify the role of the ZPA and describe the results and conclusions drawn from those experiments. What role does it play in limb development?

4 pts- name: zone of polarizing activity
7 pts- experiments: 1) transplant ZPA to anterior region of the limb bud results in mirror image duplication. 2) transplant small population of ZPA cells to anterior region of limb bud results in mirror image duplication to a smaller extent. 3) shh soaked bead can recapitulate ZPA function
4 pts- role: anterior-posterior patterning of limb bud

5. (20 pts) What are homeotic (HOX) genes and how were they identified? Compare and contrast the function of "Hox" genes in fly axial patterning and human limb patterning.

10 pts- Hox genes are a family of transcription factors that all contain a highly conserved DNA binding homeodomain. These genes are important in anterior-posterior of the limb bud as well as proximal-distal patterning of the limb. Hox genes are arranged linearly along the chromosome and there expression patterns (A-P and P-D) correspond to there linear arrangement 3' to 5'.

10 pts- Hox genes have similar roles in all metazoans. The hox genes are important in specifying proper segmentation in the fly along the A-P axis. Similarly, Hox genes are involved in A-P patterning of the limb bud and specify digit formation. Famously, flies with a mutation in the ubx gene in the bithorax complex have an extra thoracic segment and 4 wings. Similar, defects can be seen in human that have polydactyl. Humans and other organisms that are larger and more complex have duplication of Hox genes allowing them to specify segmentation in smaller regions of the larger embryo.

6. (20 pts) Describe the reaction-diffusion model and the specific assumptions needed to account for its "self organization" characteristics. How can it account for both number and space regulating systems? Please diagram a specific example of each.

8 pts- a self-organizing system that leads can pattern formation. Assumptions: 1) all cells in the embryonic field have the capacity to autonomously produce slowly diffusing activator. 2) Activator auto-regulates itself and an inhibitor. 3) Inhibitor is a rapid diffusing inhibitor of the activator. (-5 for no direct or implied assumptions)
6 pts- number regulating system: long range diffusing inhibitor. Size regulating system: short range diffusing inhibitor. Other things such as protein stability or change in the size of the field also influence both systems
6 pts- see notes for diagrams of both

7. (10 pts) OK, I admit it, I didn't get a chance to review Shapiro's lecture. I heard it was about evolution of limbs…… many genes or few genes…..genes involved in limb development. What did you learn from Mike Shapiro? **(10pts) Extra Credit** if you answer these questions: What specific gene(s) regulates limb evolution? How did he identify them and what part of the gene(s) was mutated?

10 pts: something specific about how the studies were conducted and/or what they found by looking at marine vs freshwater 3 spine and 9 spine sticklebacks
5 pts: vague understanding but on topic

7.