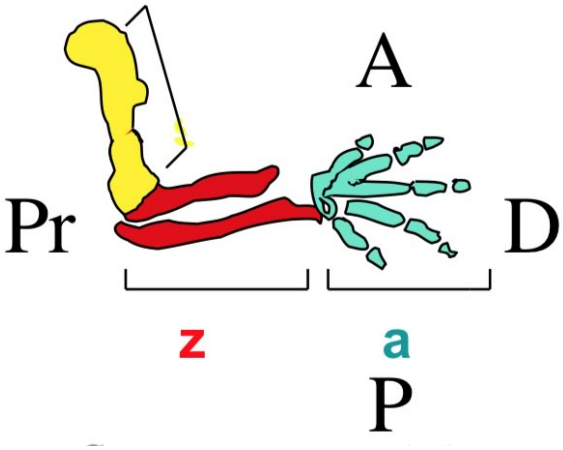
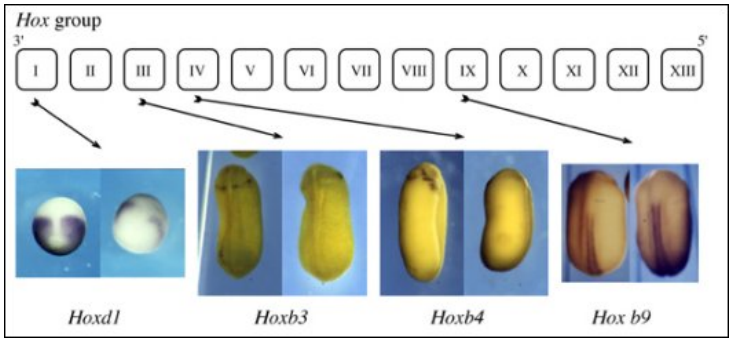
Course review questions - part 2



1. How are axes of the limb generated? What processes mediate the formation of digits?
2. Indicate the position of Shh and FGF signaling centers in the limb. Predicate phenotypes associated with their loss.
3. How can a single nucleotide change specifically effect Shh's role in limb formation; that aspect of regulation / function is effected
4. Describe a mechanism by which distant regulatory elements can influence gene expression. Explain the impact of the location of such regulatory sequences
5. Does it matter where (up stream or down stream of the coding sequence, these regulatory sequences are?
6. Describe how, in Xenopus and other vertebrates, gastrulation leads to a change in the interactions between cell types (be able to make a drawing) - what important inductive interactions become possible (particularly in the context of the neuroectoderm)
7. There are gradients of Wnt and BMP signaling during the formation of the neural tube; what is their role in the developing nervous system?
8. If you had to diagram a typical signaling pathway, what components would be essential.
9. How is it that different signaling pathways produce different effects?
10. Based on your models of signaling pathways, how can the timing of various signal activities influence the outcome (genes expressed, etc). How can different cellular responses (patterns in gene expression) arise from the same set of signaling events (over time)
11. Think about the gradient of Shh signaling from the notochord and neural tube's ventral floor plate - how does this system generate different types of neurons (located along the neural tube's ventral-dorsal axis?
12. How is a similar system working in the developing limb?
13. How might the anterior-posterior expression of HOX genes influence neural tube patterning?
14. Given a sequence of HOX genes, generate a series of graphs that indicate the position of expression of each along the embryo's anterior-posterior axis.
15. A subset of HOX genes are expressed in the developing limb, indicate where they are expressed as a function of the limb's A-P axis?
16. Make a prediction as to the effects of mutations in a specific HOX gene.



17. What did the authors of the in vitro gradient system actually demonstrate? what do you think they should do next?
18. How is the linking up of neurons (neuronal pathfinding) similar to neural crest migration? How does it differ?
19. Explain why various "insults" (e.g. cyclopamine, ethanol, viral infection) often have greater impacts on the developing fetus compared to the adult.
20. Cyclopamine inhibits smoothened activation of the transcription factor GLI; why does this mimick the absence of Shh? You can use the Shh pathway from your notes.

21. Describe the effects of mutations in Shh pathway components; predict which loss of function (amorphic) mutations will activate the pathway and which will inhibit it. Do the same thing with the Wnt-β-catenin pathway (using your notes).
22. What factors make studies of fetal alcohol syndrome in humans difficult?
23. Describe the differences between ES and IPS cells…
24. What factors lead to differences between iPSC lines. How might the source of the somatic cells used to generate iPSCs generate differences in their behaviors.
25. What does the ability to generate a teratoma reveal about the totipotency or pluripotency of a cell line?
26. What would the practical differences be between using "integrative" versus a "non-integrative" methods to generate iPSCs?
27. What exactly is an organoid? What types of factors determine (or influence) the types of cells / tissues formed?
28. How can neural (cerebral) organoids be used to study the effects of developmental perturbations (e.g. Zika infection)? What are the limitations of this approach?
29. Why can't all these studies be done in the mouse (or primates)?
30. How is the development of a new organism the same and different from the development of a cancer?
31. Why does the incidence of cancer increase with age?
32. Under what conditions would you suspect the presence of an inactivated tumor suppressor gene?
33. In your own words, how would you describe the difference between an oncogene and a tumor suppressor gene (gene product)?
34. Devise an experimental approach to determine the cell type that generated a cancer?
35. What molecular / cellular events are critical in the development of metastatic cancer?
36. Within a tumor, explain why you would or would not expect to see changing genetic diversity (and populations of cells) over time, and in response to treatment.
37. How might a tumor regress spontaneously?
38. Given a signaling pathway, predict whether a protein (gene) acts as an oncogene or a tumor suppressor.
39. How might a tumor be contagious?
40. Why is CAR-T considered a gene (cell) therapy?
41. Why would you suggest to someone that they consider generating a three parent embryo? what type of defect would that address?
42. How would such a child be related to its various "parents"?
43. What are the general properties of a morphogen? Use an image (drawing/graph) to clarify your answer.
44. In a developing limb, predict the effect of a second source of Shh. What type of mutation would mimic the presence of a second source of Shh?
45. What is it that makes a cell able (competent) to respond to the presence of a morphogen?
46. How would the phenotype of a mutation that leads to the loss of the ability to response to a morphogen compare to the phenotype of a mutation that inhibited the synthesis of the relevant morphogen? (start with a drawing of the limb or the neural tube).
47. How can you best determine the expression domain of a particular gene. Why is RT-PCR not (generally) a good answer?
48. Under what conditions should genetic engineering of an embryo be allowed or banned?
49. What are the social dangers of genetic engineering in humans?
50. Suppose you could generate a clone of yourself without a brain (for organ transplantation); would that be ethical or not?