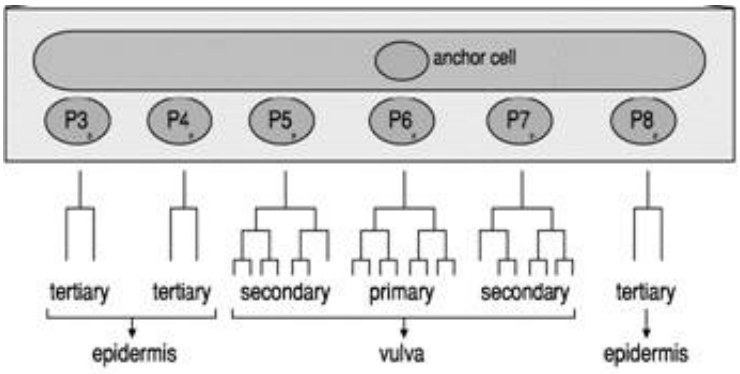
Sample Exam 1

You have two hours. Feel free to draw pictures to help answer the questions.



1) [10 points] The following diagram of C. elegans vulva development shows the fates of several precursor cells.

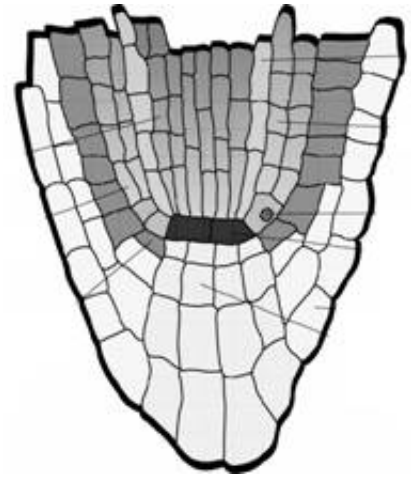
a) What effect would ablating the indicated cells (i.e. killing them with a laser beam) on this development?

i) ablate the anchor cell

ii) ablate P4p

iii) ablate P5p

b) In each case in which these ablation experiments reveals the action of a signal, indicate which cells are sending and receiving the signal.



2) [9 points] a) On the following diagram of an Arabidopsis root, indicate i) the quiescent center (QC), ii) the stem cells, and iii) which cells are dividing most often.

b) The WUSCHEL protein (WUS) regulates shoot apical meristem maintenance. Recently a very similar protein called WOX5 was found that appears to have an analogous role in maintaining the root meristem. The *WOX5* gene is expressed specifically in the quiescent center. In a *wox5* null mutant, what do you suppose happens to the structure of the root? You may use a sketch as part of your answer. Indicate which cells are likely to be changed, and how.

3) [21 points] Flowering of Arabidopsis is induced by long days. a) How do long days and consequent

induction of flowering affect each of the following? In each case, indicate which cells are affected.

i) stem elongation

ii) *LEAFY* expression

iii) *PI* expression

iv) *WUS* expression

b) Indicate the order in which the changes you indicate occur.

c) If mature leaves from a plant that has been exposed to long days are grafted to a plant that has been exposed only to short days, the resulting plant will flower even in short days. This experiment suggests that there is a signal (called "florigen") that induces flowering in response to long days.

i) Where is florigen produced?

ii) Which cells respond to it?

d) A number of Arabidopsis mutants with altered flowering time are known. One of these mutants, called *ft*, flowers late and does not respond to increasing day length. The *FT* gene has been cloned, and is thought to be a good candidate for florigen. What experiments would you do to test whether FT is indeed the signal that induces flowering in response to long days?

e) What genes would you overexpress if you wanted to make transgenic plants that would produce petals instead of leaves?

4) [17 points] Plant pollen tubes need to grow to the right place in order to fertilize their targets. a) On the following diagram of an Arabidopsis gynoecium, indicate i) where pollen germinates, ii) the route that pollen

tubes grow; iii) the site(s) of fertilization.

b) Which cell(s) are fertilized? Indicate what they are called, and where they are.

c) Suppose that a gradient of a pollen-attracting substance X provides the information that guides the direction of pollen tube growth.

i) In which tissues might this substance be present?

ii) Which cells might produce the substance?

iii) How might fertilization affect production of this substance?

iv) An enzyme that degrades molecule X is found to be required for correct pollen tube guidance. In a mutant lacking this enzyme, how would the pattern of X be changed? Why might this affect fertilization?.

5) [10 points] In what pattern and in how many domains are each of the following Drosophila genes expressed?

i) *Distal-less* (expressed in emerging legs and other homologous appendages)

ii) *even-skipped*

iii) *Toll*

iv) *spätzle*

v) *Antp*

6) [22 points] a) What phenotype would each of the following Drosophila mutant embryos have? (For any mutation that has a maternal effect, assume that the mothers were also mutant.)

i) *bicoid*

ii) deletion of entire *bithorax* complex

iii) *wingless* (defective in Drosophila equivalent of Wnt)

iv) *polycomb*

v) *twist*

vi) mutation in the *Dpp* promoter that eliminates control of this promoter by the Dorsal protein

vii) mutation in the *rhomboid* promoter that eliminates control of this promoter by the Snail protein

b) Which of the above mutations would have a maternal effect?

c) What molecules could you inject into the embryos in parts i and vi of part a above to rescue their phenotypes? Where would you inject those molecules and at what stage of development?

7) [11 points] a) What cells carry each of the following on their surface?

i) MHC II

ii) antibody

b) What does each of the molecules in part a bind to?

i) MHC II

ii) antibody

c) Where does the diversity of MHC II molecules come from?