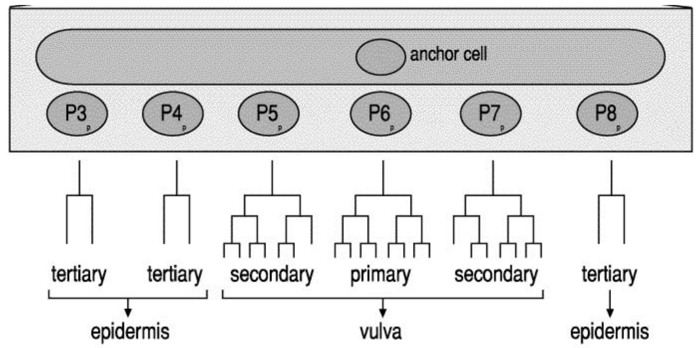
Name:ANSWERS

Biology 205 exam IV, May 4, 2007
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.

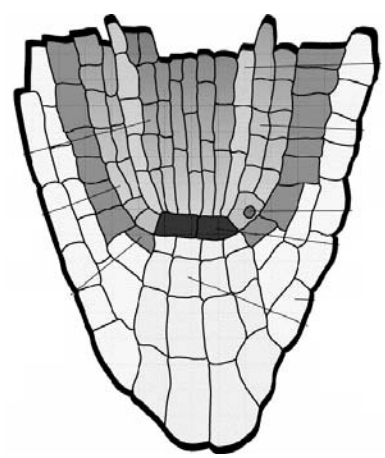
a) What effect would ablating the indicated cells (i.e. killing them with a laser beam) on this development?

i) ablate the anchor cell
no vulva; all cells become epidermis

ii) ablate P4p
no effect on vulva (fewer cells contribute to the epidermis)

iii) ablate P5p
P4p then acquires secondary fate

b) In each case in which these ablation experiments reveals the action of a signal, indicate which cells are sending and receiving the signal.
i) AC signals to P5p, P6p and P7p
ii) AC now signals to P4p also; P6p may signal to adjacent cell (normally P5p but instead P4p if P5p is ablated)



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.
QC are the cells with darkest shading in diagram
Stem cells surround QC
Fastest division occurs in cells above the stem cell region

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.
Stem cells differentiate instead of dividing.

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

increases (cells behind/below shoot apical meristem)

ii) *LEAFY* expression

Increases in lateral organ primordia, which become flowers instead of leaves

iii) *PI* expression

Turned on in whorls 2 and 3

iv) *WUS* expression

Turned on in lateral organs (flower meristems)

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

i and ii, then iv, then iii

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?

in leaves

ii) Which cells respond to it?

shoot meristem, stem, lateral organs

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?

Check for expression in leaves by northern hybridization (might be induced by long days), and for movement of the protein from leaves to the shoot apex by using a tagged protein or antibody against FT.

To test whether *FT* is sufficient to induce flowering, use a transgenic construct to misexpress the gene under conditions when it is not normally expressed (such as in short days) to see whether that induces flowering. Another approach could be to graft a wild-type leaf (from a plant subjected to long days) onto an *ft* mutant plant to see whether that rescues flowering. Conversely, an *ft* mutant leaf should lack ability to induce flowering even when grafted onto a wild-type plant.

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

AP2 + *PI* + *AP3* + *SEP1*, *2*, or *3* (A, B, and E functions)

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.

Pollen germinates on the stigma, the pollen tube grows down the transmitting tract and up the funiculus to the micropylar end of an ovule, where it bursts and releases two sperm cells. One haploid (1N) sperm fertilizes the haploid egg to produce a diploid (2N) embryo. One sperm fertilizes the diploid central cell to produce a triploid (3N) endosperm.

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?

Transmitting tract, funiculus, micropylar end of ovule

ii) Which cells might produce the substance?

synergids, egg, or other nearby cells

iii) How might fertilization affect production of this substance?

It should decrease it, so that after fertilization additional pollen tubes are not attracted.

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?.

The overall level should be increased (because of lack of degradation). This might cause loss of a concentration gradient of X, which might eliminate directional information for the growing pollen tube.

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)

about 12 (emerging legs, mouth parts, antennae, etc.)

ii) *even-skipped*

7 stripes

iii) *Toll*

in nurse cells, leading to presence throughout the embryo surface

iv) *spätzle*

ventral follicle cells

v) *Antp*

Segment T2 and also some more posterior segments

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*

no anterior end

ii) deletion of entire *bithorax* complex

posterior segments converted to thorax (T2) identity

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

loss of polarity of each segment

iv) *polycomb*

all segments acquire more posterior fates despite having set up correct pattern initially

v) *twist*

no mesoderm/no ventral structures

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

Dpp expression on ventral side, dorsalized embryo

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

Ectopic *rhomboid* expression on ventral side, possibly leading to some neurogenic ectoderm identity in cells that should form mesoderm

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

i only (*bicoid*)

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?

i) *Bicoid* mRNA or protein, injected early at one end

vi) SOG protein (which inhibits Dpp), into ventral side, late blastoderm

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

i) MHC II - antigen-presenting cells (dendritic cells, macrophages, B cells)

ii) antibody - naive B cells, memory B cells

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

i) MHC II - peptide from an antigen; Together with this peptide, it may then bind to a specific T cell receptor

ii) antibody - binds an antigen

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

multiple gene loci in each individual
allelic diversity in the population
(heterozygosity)