NAME ________________________________

BIOLOGY 205/SECTION 7 DEVELOPMENT- LILJEGREN
Final Examination – May 6, 2010

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1.) (8 pts) It’s important to remember that proteins have specific jobs to do in the cell. For each protein below, indicate which of the following categories best describes its job: (Some categories may not be used.)

- a. Transcription factor
- b. Transmembrane receptor kinase
- c. Membrane-bound signal
- d. MADS-domain transcription factor
- e. Secreted signal
- f. Homeodomain transcription factor
- g. Transmembrane channel protein
- h. Ras G-protein

Hunchback __________________ Abdominal B __________________
LIN-3 __________________ PISTILLATA __________________
LET-60 __________________ Steel __________________
White (fly) __________________ White-spotting __________________

2.) (2 pts) Which organism(s) uses genomic imprinting as a mechanism to regulate transcription of specific genes?

- (A) Chicken
- (B) Frog
- (C) Mouse
- (D) Zebrafish
- (E) Fruit fly
- (F) All of the above

Write letter(s) here ______

3.) (8 pts) We discussed how the fly body plan is specified by a cascade of genes during embryonic development. For each of the functions described below (which are NOT shown in order), name which gene category it represents, and name ONE actual gene in that category selected from the following list.

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Peccadillo Fugu sushi Nanos Bic
Ultrabithorax Knirps Engrailed Lorax

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4.) (2 pts) Based on the LIN-12/LAG-2 signaling involved in deciding anchor cell fate, what would you expect during the signaling in the fly neurogenic ectoderm? 

Write letter(s) here ________

(A) Cells with activated Notch would produce more Delta
(B) Cells with activated Notch would produce the same amount of Notch
(C) Cells with activated Notch would produce less Notch
(D) Cells with activated Notch would produce less Delta
(E) Cells with activated Notch would produce more Notch
(F) Cells with activated Notch would produce the same amount of Delta

5.) (1 pt) In generating MyoD ‘knockout’ mice, researchers tested whether:

(A) MyoD is necessary for muscle development
(B) MyoD is sufficient for muscle development
(C) MyoD is correlated with muscle development

Write letter here ______

6.) (2 pts) When making MyoD mutant mice, researchers injected modified ES cells into multiple mouse blastocysts, and allowed them to develop in a surrogate mother. What was the genotype of the mice in this litter?

Write letter here ______

(A) The mice were homozygous for the transgene
(B) The mice were heterozygous for the transgene
(C) A quarter of the mice were homozygous for the transgene
(D) Some of the mice were heterozygous for the transgene
(E) The mice contained some heterozygous mutant tissue and some wild-type tissue

7.) (12 pts) For each statement, circle T or F. For any that are false, indicate briefly why in the space below.

a. T F Acetylation of DNA shows a positive correlation with gene expression.

____________________________________________________________________

b. T F Vincent Wigglesworth characterized the first fly mutant.

____________________________________________________________________

c. T F Methylation of DNA shows a negative correlation with gene expression.

____________________________________________________________________

d. T F Oliver Smithies developed a mouse model of Huntington’s disease.

____________________________________________________________________

e. T F In apetala1 mutant flowers, the petals are transformed into sepals and the stamens are transformed into carpelloid organs.

____________________________________________________________________

f. T F Mutations in the mouse Bmp7 gene affect kidney development.

____________________________________________________________________

NAME ________________________________
8.) (8 pts) The diagram shows the cell fates chosen by different cells of the vulval equivalence group in a wild-type worm. How many 1° cells, 2° cells, and 3° cells will be made in the cases listed below?

a) In a worm in which the anchor cell has been ablated
1° _____ 2° _____ 3° _____

b) In a worm with a homozygous loss-of-function mutation in LIN-3
1° _____ 2° _____ 3° _____

c) In a worm with homozygous loss-of-function mutations in both LIN-3 and in LET-60
1° _____ 2° _____ 3° _____

d) In a worm with a homozygous loss-of-function mutation in LIN-12, and in which the two central VPC cells have been ablated
1° _____ 2° _____ 3° _____

e) In a worm with homozygous loss-of-function mutations in both LIN-12 and in LIN-3
1° _____ 2° _____ 3° _____

9.) We’ve discussed homeotic mutants in plants, flies, and mice.

a.) (1 pt) What is a homeotic mutant?

b.) (2 pts) Mutations in which of the following genes cause a homeotic phenotype?

(A) MyoD  (D) Pax3
(B) Hoxc8  (E) Steel
(C) Bmp7  (F) Wnt-1

Write letter(s) here  ________

10.) (3 pts) The first cloned cat, “CC”, had a different pigmentation pattern than “Rainbow”, the calico cat who provided the nucleus used in the cloning procedure. Which of the following statement(s) best describes why this happened.

(A) “CC” was a male cat.  Write letter(s) here  ________
(B) “Rainbow” was a female cat.
(C) The cytoplasmic factors of the enucleated egg used in generating “CC” reprogrammed the nucleus from “Rainbow”’s somatic cell.
(D) The pattern of X-chromosome inactivation was random in the somatic cells of “Rainbow” and “CC”.
(E) The pattern of X-chromosome inactivation was random in the germline cells of “Rainbow”.
(F) The pattern of Xist protein localization was different in the somatic cells of “Rainbow” and “CC”.
(G) The pattern of histone H3 methylation was different in the somatic cells of “Rainbow” and “CC”.
11.) (5 pts) Bicoid and Caudal are two transcription factors that are involved in establishing the fly anterior(A)-posterior(P) axis.

![Graphs A, B, C, D, E]

a) Which of the above graphs best illustrates the levels of Bicoid protein expression in a wild-type embryo?  
Write letter here __________

b) Bicoid is a negative regulator of Caudal. Which of the above graphs best illustrates the levels of Caudal protein expression in a wild-type embryo?  
Write letter here __________

c) Which of the above graphs best illustrates the levels of Caudal protein expression in an embryo whose mother lacked Bicoid?  
Write letter here __________

d) You inject Bicoid mRNA into the center of an embryo whose mother lacked Bicoid. Which of the above graphs best illustrates the levels of Bicoid protein expression in the injected embryo?  
Write letter here __________

e) Which of the above graphs best illustrates the levels of Caudal protein expression in the injected embryo described in d)?  
Write letter here __________

12.) a) (2 pts) The ABC model is conserved throughout flowering plants, and modifications to this model are thought to contribute to the floral diversity found in nature. On a tour of the Kirstenbosch Botanical Garden in South Africa, you see a plant that produces flowers with two outer whorls of petals, a whorl of stamens, and two fused carpels in the center. Draw the most likely modified version of the ABC model that could account for this particular arrangement of floral organs.

b) (2 pts) Describe one correlative experiment you could do with the plant described in (a) to test your hypothesis about how the ABC model might be modified in these flowers?
13.) (3 pts) Which of the following statements are correct? Write letter(s) here ______

(A) If blood precursor cells with homozygous mutations in White-spotting are transplanted into wild-type mice embryos, they will migrate correctly to the bone marrow.
(B) If blood precursor cells with homozygous mutations in White-spotting are transplanted into Steel homozygous mutant embryos, they will migrate correctly to the bone marrow.
(C) If blood precursor cells with homozygous mutations in Steel are transplanted into White-spotting mice embryos, they will migrate correctly to the bone marrow.
(D) If wild-type blood precursor cells are transplanted into Steel homozygous mutant embryos, they should migrate correctly to the bone marrow.
(E) If wild-type blood precursor cells are transplanted into White-spotting homozygous mutant embryos, they should migrate correctly to the bone marrow.
(F) White-spotting is cell-autonomous.
(G) Steel is cell-autonomous.

14.) (5 pts) Answer the questions that follow, given the following lineage diagram:

a.) Draw a circle around the first cell division to take place in the wild-type lineage. If more than one cell division takes place at the same time, draw an additional circle.

b.) How many total differentiated cells will be present from the wild-type lineage in an adult worm? ______ What about for the mutant #1 lineage? ______

c.) What is the best description of the type of defect shown in mutant #1?

____________________________________________________________________

d.) What is the best description of the type of defect shown in mutant #2?

____________________________________________________________________
You’re a graduate student in a lab studying the molecular basis of floral organ development.

a.) (1 pt) Name a set of genes that when misexpressed transform Arabidopsis leaves into petals __________________________________________________________

b.) (3 pts) What can ___________________________________________ cells do that allows scientists to use them to make transgenic plants? __________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

c.) (4 pts) You have cloned DNA for the genes described in a). Describe the other steps involved in making a gain-of-function transgenic plant that would misexpress these genes in leaves.

d) (2 pts) You successfully create transgenic plants in which the leaves are transformed into flowers. If you wanted to look for additional genes that act downstream of the genes described in a) what is a forward genetics experiment you could do with the transgenic plants described above?

e) (2 pts) During your graduate studies, you discover a novel transcription factor that is expressed in the petals and leaves of Arabidopsis plants. Describe a reverse genetics experiment you could do to test whether this transcription factor is required for petal and/or leaf development.

f) (2 pts) You discover that your new transcription factor is indeed required for petal development, but isn’t necessary for leaf development. If you wanted to test whether this transcription factor acts downstream of the gene described in a), what is a genetic experiment you could do?
16). (6 pts) Shown below is the lineage of *C. elegans* through the 8-cell stage of embryo development.

![Lineage of *C. elegans*](image)

a) **(Circle one)** Most cell fate decisions in the worm are determined by autonomous (mosaic) OR conditional (regulative) specification.

b) Bob Goldstein was instrumental in figuring out the cell signaling required for the gut lineage to form. The inducer cell is named ____________, and the responder cell is ____________. What does the responder cell do as a result of this induction? ____________________________________________________________

What does the responder cell do if it is not induced? ________________________________

The inducer cell secretes a signal that is a homolog of what well-known protein? ________________________________

17.) (14 pts) For each statement, circle T or F. For any that are false, indicate briefly why in the space below.

a. T F Ectopic apoptosis occurs in a ced-3 loss-of-function mutant. ____________________________________________________________

b. T F Changes in DNA methylation can be passed on to daughter cells. ____________________________________________________________

c. T F Maternal imprinting of the human *Igf2* gene prevents fetal overgrowth. ____________________________________________________________

d. T F A mouse that inherits a mutant *Igf2r* gene from its mother is born 40% smaller than normal. ____________________________________________________________

e. T F The lin-14 microRNA prevents translation of lin-4 RNA after the first larval stage. ____________________________________________________________

f. T F In the fly neurogenic ectoderm, gain-of-function of Notch signaling would cause overproduction of neurons. ____________________________________________________________
Insect larva treated with the natural insecticide precocene do not produce the active molting hormone 20E and fail to undergo metamorphosis.

I certify that I have performed my work on this examination in full conformity with the provisions of the Honor Code.

Signature

(1 pt extra credit) What do *C. elegans* worms eat for breakfast?