Name: _____

MCB 141 **Midterm 2** **April 8, 2008**

100 points in 80 minutes (we need to stop at 12:30 exactly).

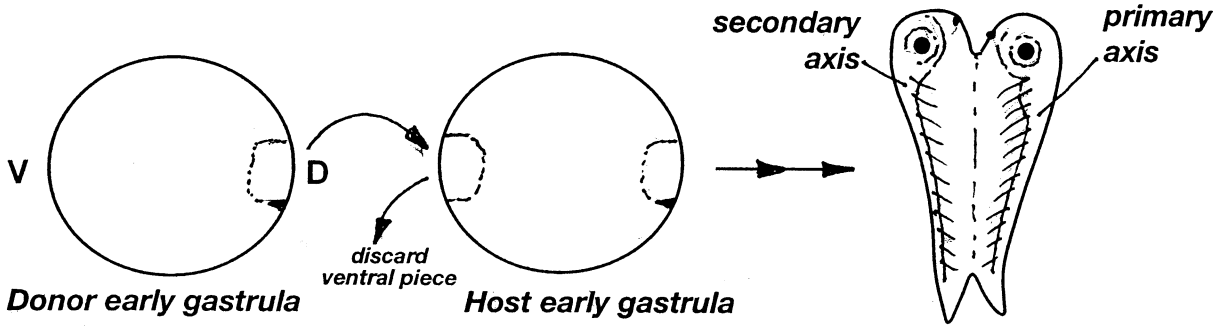
Midterm Question	Points	Score
1.	10	_____
2.	4	_____
3.	18	_____
4.	9	_____
5.	9	_____
6.	18	_____
7.	12	_____
8.	6	_____
9.	9	_____
10.	5	_____
Total for Midterm 2	**100**	_____

Note: Please use a pen. If you draw a picture as part of a short answer, please draw clearly and label the parts!

Number of pages you should have, including this one: 10

Name: _____

Question 1 ***(10 points):***
The Spemann and Mangold experiment of 1924 is outlined below. From their results, they concluded that the organizer graft had induced nearby ventral cells of the host to change their fates and to develop into nervous system and anterior somites of the secondary body axis.



To conclude this, they needed additional experimental results to eliminate two alternative interpretations:

A. Self-differentiation of the graft:
   i) How could you eliminate the possibility that the graft just self-differentiated into the entire secondary axis?

   ii) What did the organizer graft form in the secondary axis?

B. Recruitment of host cells that did not change fate:
   i) How could you eliminate the possibility that the cells of the nervous system of the secondary axis did not change fate but just migrated over to the region of the graft from the host's neural territory?

   ii) Regarding the cells that formed the nervous system of the secondary axis, what would have been their fate if the grafting had not been done?

Name: _____

Question 2 (4 points)

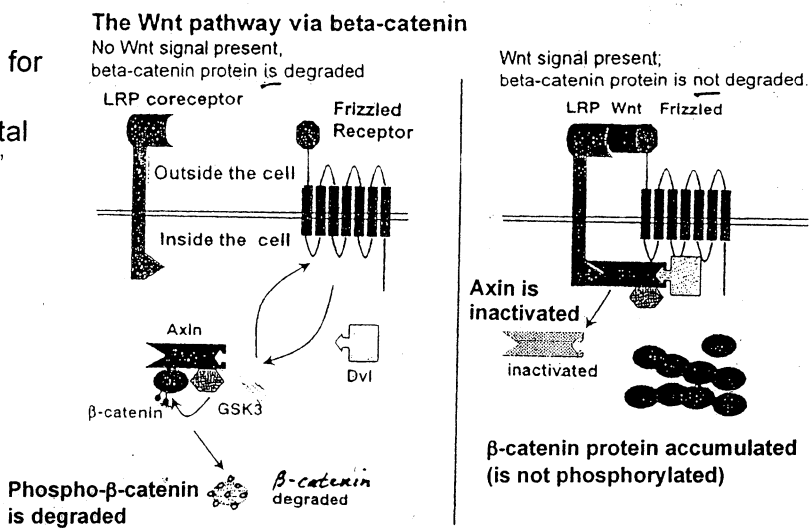
The developmental fates of early gastrula cells depend on 1) their membership in a particular competence group, and 2) their distance from the organizer. As you learned, these dependences reflect the exposure of cells to different protein signals at the blastula, gastrula, and neurula stages.

Explain the location of the following territories on the fate map in terms of signals the cells are exposed to:

Territory of the Fate Map	Cells exposed to Nodal signals (write yes or no in each box)	Cells exposed to Bmp antagonists (write yes or no in each box)
Neural		
Epidermal		
Somite		
Lateral plate		

Question 3 (18 points)

The β-catenin protein is important for organizer formation, as has been demonstrated by the developmental consequences of "knocking down" (reducing, eliminating) individual components of the Wnt pathway, shown to the right.



LRP=lipoprotein receptor5/6; ACP=adenopolyposis coli factor; GSK3=glycogen kinase 3; GBP=GSK3 binding protein; DVL=Dishevelled

3A (2 pts). Briefly describe (one or two sentences) <u>two</u> methods to knock down components of the pathway in the *Xenopus* oocyte, egg, or embryo:

Method 1:

Method2:

Name: _____

Question 2 continued

3B (10 pts). For each of the following Wnt-pathway components, fill in the boxes to predict the consequences of the knockdown of the particular component for the embryo's development:

Component knocked down throughout the embryo	Does the level of β-catenin protein (choose one) increase, decrease, or stay the same?	At the gastrula stage, will the organizer be (choose one): absent, normal, or larger?	Eventual phenotype (choose one): ventralized, dorsalized, twinned, or normal)
Maternal β-catenin mRNA			
Maternal wnt11 mRNA			
Maternal axin mRNA			
Maternal GSK3 mRNA			
Maternal mRNA for the Frizzled receptor or LRP5/6 coreceptor			

3C (6 pts). Regarding the requirement of **cortical rotation** for organizer formation:

i. Which maternal components are moved during cortical rotation?

ii. From where, and to where, are they moved?

iii. Briefly describe the microtubule array along which they are moved.

Name: _____

Question 4 (9 points):
Give three different kinds of experimental evidence that, when taken together, implicate maternal **vegT mRNA** as an essential component for endo-mesoderm induction in *Xenopus* development:

A. One kind of experiment and its result:

B. A second kind of experiment and its result

C. A third kind of experiment and its result

Name: _____

Question 5 (9 points):
Pieter Nieuwkoop combined animal cap cells of the midblastula *Xenopus* embryo with either (A) dorsal vegetal cells (*recombinate A*) or ventral vegetal cells (*recombinate B*) of the same age. He discovered that recombinate A formed an organizer whereas recombinate B formed lateral-ventral mesoderm such as coelom and blood cells.

5A (2 pts). Describe an experiment and the result to determine whether the organizer in *recombinate A* was formed from animal cap cells or dorsal vegetal cells:

5B (5 points of 9). Organizer formation in the mid- and late blastula embryo requires inputs from endo-mesoderm induction and from beta-catenin (via cortical rotation). Explain briefly, in the space below, how these inputs lead to organizer formation.

5C (2 pts). Why didn't the dorsal vegetal cells, themselves, form an organizer?

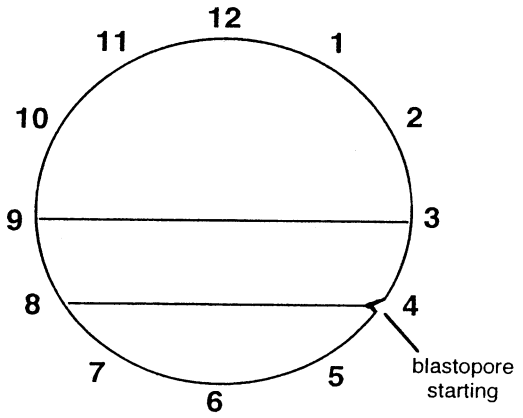
Name: _____

Question 6 (18 points):
In the left figure below, a *Xenopus* early gastrula embryo in drawn in surface view. Points on the bilateral plane are numbered 1 through 12.

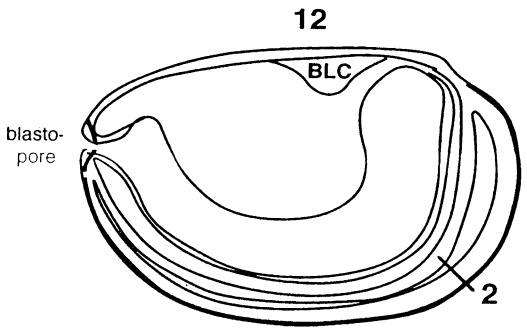
6A (5 pts). On the late neurula diagram to the right, please locate those points after gastrulation and neurulation by marking the figure with numbers and arrows. (Points 2 and 12 have been placed for you; BLC means "blastocoel").

6B (5 pts). On the late neurula diagram, identify each of the following parts or locations by marking the diagram and labeling your marks with the appropriate letter:

a. the dorsal side
b. the head organizer
c. the notochord
d. the trunk-tail organizer
e. the archenteron
f. the location of the forebrain and midbrain
g. the prechordal plate (head mesoderm)
h. the anterior endomesoderm (AEM)
i. cells secreting noggin, chordin, and follistatin.
j. the approximate site of the heart



Late blastula (external view)



Late neurula (internal view)

6C(2 pts). Identify the two points between which the greatest displacement has taken place: _____ _____

6D (6 pts). Identify the two kinds of morphogenetic activity that drive this greatest displacement and describe each morphogenetic activity briefly.

Morphogenetic activity 1:

Name: _____

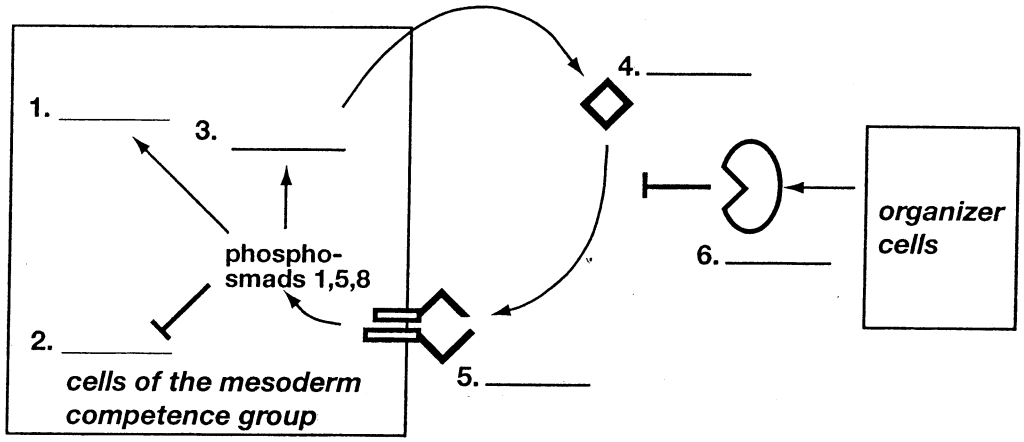
Question 6D continued

Morphogenetic activity 2:

Question 7: (12 points)

7A (6 pts). Below is an incomplete diagram of the circuitry of "dorsalization of the mesoderm" according to the **DEFAULT MODEL**. Complete the diagram by writing the appropriate letter from the list into each of the 6 blanks in the diagram. Not all letters will be used. Flat-headed arrows indicate inhibition or repression. Pointed arrows indicate activation or production.

A. Bmp antagonists such as chordin, noggin, and follistatin
B. Stabilized beta-catenin protein
C. The receptor of Bmp antagonists
D. Wnt antagonists such as dkk, frzb, and crescent.
E. The Bmp receptor
F. Bmp protein
G. The neural development option
H. The somite development option
I. The epidermal development option
J. The lateral plate/coelom option
K. Bmp gene expression
L. the Frizzled Wnt receptor



7B (3 pts). Introduce the mRNA for a dominant negative form of Component 5 into mesodermal cells and introduce antisense morpholinos to deplete Component(s) 6. Predict the developmental outcome, and explain your prediction briefly.

Name: _____

Question 7 continued

7C (3 pts). Introduce the mRNA for a constitutively active form of Component 5 into the mesodermal cells and introduce excess mRNAs to increase the amount of Component(s) 6. Predict the developmental outcome, and explain your prediction briefly.

Question 8 (6 points):

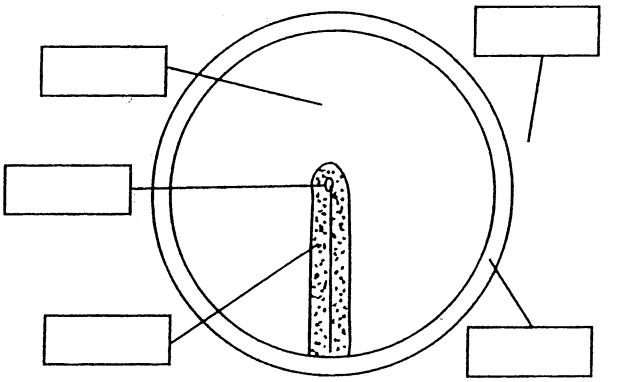
Dkk (Dickkopf) is a Wnt-antagonist normally produced by the head organizer. When Dkk activity is knocked down, a severly "micro-cephalic" embryo results, that is, one with a greatly reduced forebrain and midbrain. The more posterior parts of the nervous system are normal. Explain this result in terms of your understanding of the induction of the anterior and posterior parts of the nervous system.

Name: _____

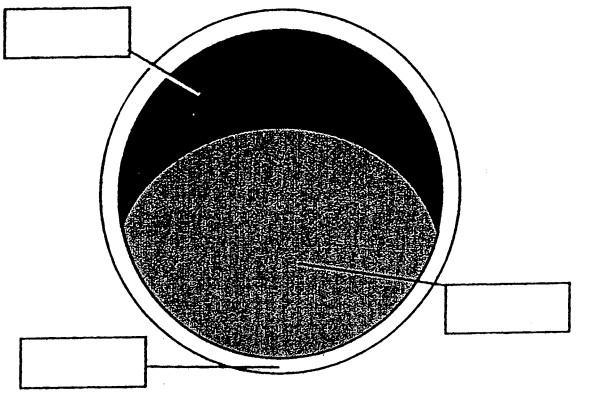
Question 9 (9 points):
The figure below shows top and bottom views of a chick blastodisc at the "maximum streak stage", about 14 hours after egg laying. Regions are marked by lines and boxes. Select letters from the list below and enter them in the boxes to indicate the identity of each marked region. *(Some boxes may contain more than one letter, and a letter may be used in more than one box).*

A. Marginal zone
B. Primitive streak
C. Hensen's node
D. Epiblast
E. Posterior marginal zone (PMZ)
F. Endoblast
G. Hypoblast
H. Cerberus-producing cells
I. Nodal producing cells
J. Endo-mesoderm cells about to engage in waterfall ingression
K. Will become extra-embryonic endoderm
L. Notochord precursors
M. Uncleaved yolk mass
N. Site at which anterior neural development will occur.
O. Was uppermost when the blastodisc was tipped to one side in the oviduct.
P. High level of nodal signaling
Q. Vg1 protein first produced here
R. Will regress the length of the primitive streak

top view of blastodisc



bottom view of blastodisc



Question 10 (5 points):
Below is a diagram of a chick embryo 9 days after egg laying. Extraembryonic parts are indicated by lines and boxes. Into each box, put appropriate letters from the list below to identify and describe the parts. A box may contain more than one letter.

a. yolk sac
b. allantois
c. chorion
d. amnion
e. a lining composed of ectoderm and mesoderm.
f. a lining composed of endoderm and mesoderm.
g. lines a cavity that surrounds the embryo in a controlled aqueous environment.
h. lines a cavity in which metabolic wastes are stored.
i. is involved in mobilizing nutrients for the embryo
j. contains hypoblast and endoblast cells