The University of Melbourne

Semester Two 2004

Department: Anatomy and Cell Biology
Subject Number: 516-302
Subject Title: Developmental Biology

Exam Duration: 2 hours

Reading Time: 15 minutes

This paper has 5 pages

Authorized materials:

None allowed

Instructions to Invigilators:

Script Books: 3 x 14 page
Exam paper may be removed from the exam room

Instructions to Students:

This exam paper has three sections (Sections A, B and C).
The time that we recommend you spend on each section reflects the marks that will be awarded:
Section A – 25%
Section B – 50%
Section C – 25%
ALL THREE sections should be attempted.
Begin each section in a new script book.
Indicate which questions you have answered on the front page of the script book.
DIAGRAMS SHOULD BE USED WHEREVER POSSIBLE.

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SECTION A:
Short answer questions – ANSWER ALL

3 marks / 3 minutes each (Total 30 marks)

1. Describe and illustrate what is meant by the terms "epiboly" and "convergent extension".

2. Explain the role of *"oskar"* during germ cell formation in the fly?

3. How does the bicoid protein act as a morphogen in *Drosophila* development? Give an example of an experiment that can demonstrate that bicoid acts as a morphogen.

4. What are "maternal determinants"? Give an example.

5. What is meant by the term "dominant-negative receptor"?

6. Describe evidence that Hox genes control regional identity along the anterior-posterior axis during vertebrate development.

7. Describe two sorts of parthenogenote and explain why they don't survive.

8. Describe the organ derivatives of the pharynx region of the gut tube.

9. Are clones identical? Explain, using specific examples where relevant.

10. Describe and illustrate the morphological events that occur during neurulation.

SECTION B:
Long answer questions – CHOOSE TWO

30 marks / 30 minutes each (Total 60 marks)

Use labelled diagrams where appropriate.

Question 11

In the developing lens there is a distinct sequence of cell behaviours (quiescence, proliferation, migration and differentiation) that regulate lens polarity and growth. Describe the experiments that showed these processes involve signalling from growth factors in the ocular media (vitreous and aqueous) and describe the role(s) of 2 growth factor families that signal in the lens development.

Question 12

a) In frog, what is "cortical rotation"? Does it have any developmental significance?

b) Explain the "inside – outside hypothesis" and its role in mouse development.

c) Briefly outline a strategy to produce pancreatic beta cells from mouse embryonic stem cells.

Question 13

Compare and contrast sex determination and differentiation in mice and insects.

SECTION C:
Problem solving questions – ANSWER ALL

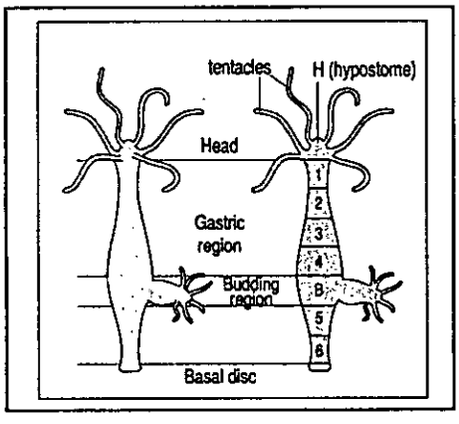
Total of 30 marks / 30 minutes

Question 14

Outline an experiment to test whether a cell in the animal hemisphere at the late blastula stage of a frog embryo is determined.

(8 minutes)

Question 15



What is the name of the organism in the above diagram? (1 minute)

Why does grafting of region 1 into region 2 of an intact organism fail to induce a secondary axis? Describe two grafting experiments that will allow region 1 to induce a secondary axis.

(6 minutes)

Section C continued over page

Question 16

a) Dr Paul Burgoyne generated XX-XY chimaeric mice using male and female mice bearing different markers, allowing him to distinguish XX and XY cells in the tissues of the resulting chimaeric mice. These mice were male and he found that in the testes, although both XX and XY cells were present in all somatic cell lines, almost all Sertoli cells were XY, whilst in other cell types (eg connective tissue, Leydig cells) there were similar numbers of XX and XY cells. Why were the chimaeras male, and why did the ratio of XY:XX cells vary between cell types?

(4 minutes)

b) In gonads from female embryos where various treatments have caused death of the germ cells, it is common to find testis-like tubules forming in the gonad. Based on your knowledge of gonadal differentiation what hypotheses can you suggest to explain this transformation?

(4 minutes)

Question 17

Researchers discover a novel gene, which has a large atypical extracellular domain with numerous repeat motifs, a single membrane-spanning domain and a putative intracellular kinase domain.

What kind of protein could this be? (1 minute)

It is expressed in several developing organs including neural ectoderm and neural tube, autonomic ganglia, cardiac ganglia, kidney adrenals and the eye lens.

Two independent groups over-express the gene in spinal cord neurons and in neural crest cells in vitro. In neurons, it causes clumping of cells and fasciculation of axons whereas in neural crest cells it inhibits migration.

How would you interpret these experiments? (6 minutes)

End of Exam