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The University of Melbourne

Semester 1 Assessment 2005

Departments:	• **School of Botany** • **Department of Anatomy and Cell Biology** • **Department of Zoology**
Subject Number:	**606-309**
Subject Title:	**FRONTIERS OF CELL BIOLOGY**
Reading time:	**Fifteen (15) minutes**
Writing time:	**Three (3) hours**

This paper has 6 pages, including this cover page

Authorised Materials:

Students are NOT permitted to bring any written material into the examination.

Electronic calculators are permitted.

Instructions to Invigilators:

Students need **one** 14-page script book and **four** 6-page script books.

This paper may be taken from the examination room at the conclusion of the examination.

Instructions to Students:

Section 1: Spend 3 minutes on each of the 20 questions in Section 1 (60 minutes)
(3 x 20 marks each = 60 marks)

Section 2: Spend 30 minutes on each of the 4 questions in Section 2 (120 minutes)
(30 marks each = 120 marks)

Section 1: Use the 14-page script book for Section 1.
Section 2: Use a **separate** 6-page script book for **each** of the 4 questions in Section 2.

Credit will be given for logical, concise presentation of relevant material.

Use diagrams or tables where appropriate to illustrate answers.

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SECTION 1

Twenty questions. 3 minutes each, 3 marks each. Total: 60 marks

Spend 60 minutes on this section.

*Answer **all** 20 questions in this section.*

Write short notes (no more than **six lines** for each) on the following:

1. What is a kinetochore and its role during mitosis?
2. Leukocyte extravasion
3. Plasmid expression vector
4. Components of the extracellular matrix
5. Ti-plasmid of *Agrobacterium tumefaciens*
6. Genetic vaccines
7. Embryonic stem cells
8. Describe the structural changes to myosin that enable it to move along an actin filament
9. Electroporation
10. Gene-therapy
11. Difference between primary and secondary metabolite production during growth in plant cell cultures
12. Phospholipids in cell membranes
13. Role of maturation promoting factor
14. p53 protein
15. Evidence that cancer results from multiple mutations
16. Passive (preformed) plant defense mechanisms
17. Nuclear localisation signal
18. Cell cycle checkpoints
19. Anoikis
20. Tight junctions

(Total = 60 marks)

SECTION 2

Four questions.
30 minutes each, 30 marks each. Total: 120 marks
*Answer **all** 4 questions in this section.*

*Answer each question in a **SEPARATE** script book.*

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QUESTION 1
*Answer either **Part A** or **Part B** of this question*

PART A

(i) Outline the major structural features of plant resistance genes (R-genes) and the proposed function(s) of each of their domains.

(20 marks)

(ii) Bacterial blight, caused by *Xanthomonas oryzae*, is a major disease of rice (*Oryza sativa*). Resistance is determined by a specific R-gene (*Xa*21) in the plant and it has been cloned. Outline the steps involved in introducing this gene into a commercial variety of rice. Provide diagrams of constructs you would employ in the transformation experiment.

(10 marks)

(Total = 30 marks)

OR

PART B

You are looking down the light microscope at a large green algal cell and notice cytoplasmic streaming.

(i) What techniques could you apply to living cells to determine whether this cellular phenomenon is governed by microtubules or actin filaments?

(20 marks)

(ii) What techniques could you apply to fixed (dead) cells in order to help determine microtubule or actin filament involvement in cytoplasmic streaming?

(10 marks)

(Total = 30 marks)

QUESTION 2
*Answer either **Part A** or **Part B** of this question*

PART A

Cells of the various blood cell lineages are derived from stem cell populations in the bone marrow.

(i) Describe four (4) parameters that may control the rate of blood cell production from stem cells. **(4 marks)**

(ii) Describe the difference between environmental asymmetry and divisional asymmetry with respect to stem cell division. Draw a diagram to illustrate examples of each. Include molecules that may regulate asymmetry in your diagrams. **(8 marks)**

Mutations in proto-oncogenes (to form an oncogene) and tumour suppressor genes can result in tumours forming from stem cell populations.

(iii) Outline the differences between oncogenes and tumour suppressor genes and provide examples of how each can cause increased cell proliferation. **(10 marks)**

(iv) Overproduction of the *Bcl-2* gene can also play a role in the initiation of cancer. Explain why this may be the case by outlining the normal cellular role of Bcl-2. **(8 marks)**

OR

PART B

Receptor tyrosine kinases utilise both transmembrane protein transport and vesicular transport in order to arrive at their functional location in the cell.

(i) Draw a diagram of a receptor tyrosine kinase in its functional location in the cell. Describe how receptor activation can lead to activation of the Ras GTPase. **(6 marks)**

(ii) Describe transmembrane protein transport. Use diagrams to illustrate your answer. **(10 marks)**

(iii) Describe the role of clathrin in vesicular transport. **(8 marks)**

The location of receptor tyrosine kinase molecules in a fixed cell can be visualised using anti-receptor tyrosine kinase antibodies conjugated to a fluorescent dye.

(iv) Illustrate why confocal microscopy may give a clearer indication than standard fluorescence microscopy of the location of the fluorescent staining. **(6 marks)**

(TOTAL 30 marks)

QUESTION 3

*Answer **all** parts of this question*

(a) Explain how fusion proteins can be used to determine the cellular location of E–cadherin in cultured mammalian cells.

(5 marks)

(b) Explain how positive-negative selection is used to identify cultured cells containing a gene-targeting construct.

(5 marks)

(c) Farm animals are now being used to generate therapeutic proteins for human use

(i) Outline the genetic technology that allows human antithrombin III protein to be secreted into the milk of sheep.

(5 marks)

(ii) What are some of the problems associated with using farm animals as bioreactors?

(4 marks)

(d) To avoid the problems of immuno-rejection, a person suffering from Parkinson's disease, would like nerve cells to be generated from his own embryonic stem cells before undergoing cell replacement therapy in the near future.

(i) Outline how this is 'technically' possible?

(6 marks)

(ii) Outline the advice, for and against the procedure, that you would provide to the patient considering this therapy.

(5 marks)

(Total = 30 marks)

QUESTION 4

*Answer **all** parts of this question*

Beta-catenin plays roles in both cell adhesion and cell signalling.

(i) Draw a cell junction that contains beta-catenin and indicate the name of the junction, the various components of the junction, and describe the role of this junction in cell adhesion.

(8 marks)

(ii) Beta-catenin mutations are found in many tumour types. Describe a signalling pathway that utilizes beta-catenin and explain why mutation of specific serine amino acid residues in beta-catenin leads to increased signalling.

(12 marks)

Integrins also play roles in both cell adhesion and signalling.

(iii) Draw a diagram to show the structure of integrin receptors. Illustrate their association with other proteins which link the cytoskeleton to the extracellular matrix. Explain two ways by which cells can modulate integrin-mediated cell adhesion.

(10 marks)

(Total = 30 marks)

END OF EXAM PAPER