BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

FIRST SEMESTER 2016-17

BIO G542- ADVANCED CELL & MOLECULAR BIOLOGY

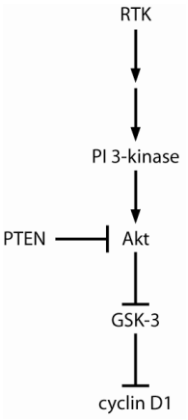
Comprehensive Examination (Closed/ Open Book)

Duration: 3 Hrs **W'tage: 40%** **M.Marks: 80** **3.12.2016**

NOTE:
Attempt all questions in sequence. Give figures and examples wherever necessary.
Attempt Closed book and Open Book in separate answer sheets.
Submit Closed Book answer sheets and collect Question paper & Answer sheets for Open Book.

M. Marks: 50 **CLOSED BOOK** **Dur: 2 Hrs**

Q1. Figure shows a signaling pathway that is turned on inappropriately in many human cancers. The key proteins and their positive or negative influences on each other are shown. **(3 x 3=9.0)**



- **A.** Both PTEN and Akt are cancer-critical genes. Which is a tumor suppressor? Which is a proto-oncogene? Justify
- **B.** The pathway contains additional cancer-critical genes. Name a potential proto-oncogene and a potential tumor suppressor in this pathway.
- **C.** If many tumors were found to contain two mutations in this pathway, what hypothesis would it suggest?

Q2. Detail various factors that may lead to tumor/ cancer development in an individual. **(6.0)**

Q3. Discuss the function of molecular chaperones and co-chaperons. **(6.0)**

Q4. List the most crucial amino acids present in the sequence of a protein destined for proteolysis such that their mutation can lead to failure of proteolysis activity in a cell. Justify. **(4.0)**

Q5. What are 'transit amplifying divisions' in the context of stem cells? What are their benefits? Describe how transit amplifying divisions form an important part of the strategy of growth control. **(5.0)**

Q6. What is stem cell plasticity? Describe its implications in stem cell therapy. **(5.0)**

Q7. Describe what experimental evidences exist in favor of the following.

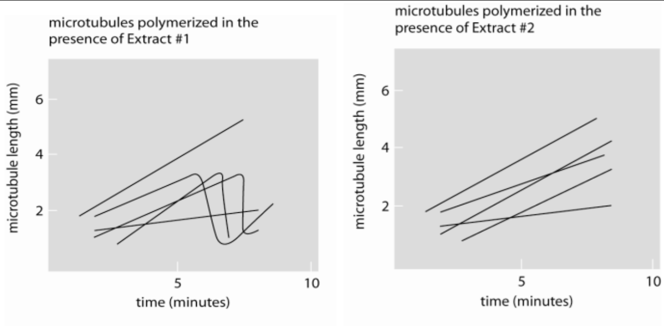
(A) Compaction of an early mouse embryo has a lot depending on cell-cell adhesion and its functional elements. **(5.0)**

(B) Cells help organize the collagen fibrils they secrete by exerting tension on the matrix and vice versa **(5.0)**

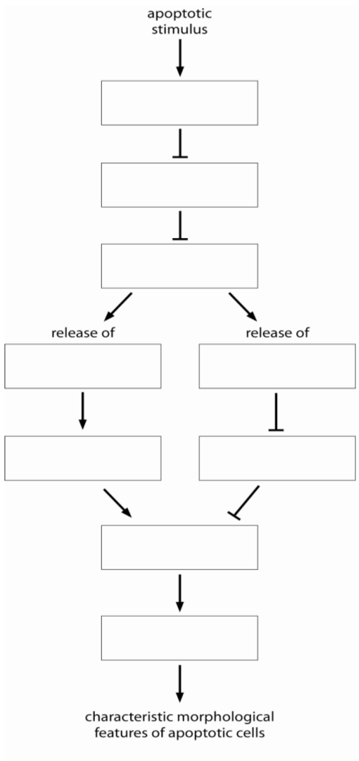
Q 8. How do microtubules in plant cells help orient cell wall deposition? **(5.0)**

M. Marks: 30 **OPEN BOOK** **Dur.: 1 Hr**

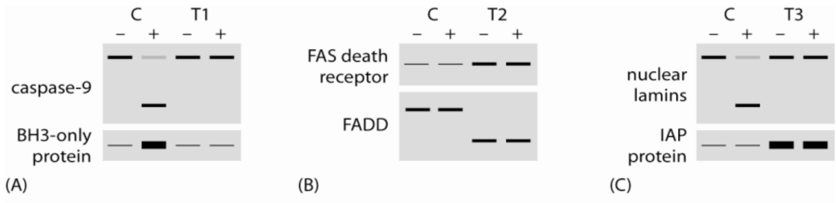
Q1. Your friend comes to you in a panic. He was purifying extracts from interphase cells as well as mitotic cells. Unfortunately, the labels came off his tubes and he cannot tell which extract is from which cells. You do an experiment in which you add a small amount of each extract to fluorescent microtubules you have polymerized *in vitro*, and then use video microscopy to follow the behavior of individual microtubules in the reaction over time. Your results are shown in the graphs in Figure 1. Which extract do you think is from mitotic cells and which from interphase cells? Why? **(3.0)**



Q2. A genetic pathway map of the intrinsic pathway of apoptosis is shown in, with empty boxes instead of protein names. Fill in the boxes with the following proteins: caspase-9, Bcl-2, anti-IAP protein, Apaf-1, cytochrome *c*, executioner caspase, BH3-only protein, IAP protein, BH123 protein. A → symbol indicates activation; –**|** indicates inhibition. **(4.0)**



Q3. You want to find out why apoptosis fails to occur in several cell lines derived from tumors. To identify differences between the tumor cell lines (T1, T2, and T3) and a control cell line (C) that might prevent tumor cells from undergoing normal apoptosis, you isolate proteins from cells that have (+) or have not (–) been treated to induce apoptosis. You load the protein samples on gels and perform immunoblotting with antibodies against proteins involved in apoptosis. Confusingly, several proteins have altered levels or altered apparent sizes in the tumor cell lines, as shown in Figure. Suggest a hypothesis for each tumor cell line to explain its apoptosis defect and the immunoblots. **(3.0)**



Q4. Nuclear localization signals are not cleaved off after transport into the nucleus, whereas the signal sequences for import into other organelles are often removed after import. Why do you suppose it is critical that nuclear localization signals remain attached to their proteins? (Hint: Consider cell division) **(4.0)**

Q5. GPCRs activate G proteins by reducing the strength of GDP binding, allowing GDP to dissociate and GTP, which is present at much higher concentrations, to bind. How do you suppose, the activity of a G protein would be affected by a mutation that caused its affinity for GDP to be reduced without significantly changing its affinity for GTP? **(3.0)**

Q6. Why do you suppose that cells use Ca^{2+} (intracellular concentration 10^{-7} M) for signaling rather than the more abundant Na^{2+} (intracellular concentration 10^{-3} M)? **(3.0)**

Q7. When erythroleukemic cells are incubated with sodium butyrate, they differentiate into non dividing, hemoglobin synthesizing cells. Butyrate induced differentiation is accompanied by accumulation of acetylated forms of H3 and H4 histones. In principle, butyrate treatment could increase the activity of histone acetyl transferases (HATs) or decrease the activity of histone deacetylase complexes (HDACs).

Design an experiment to distinguish between the above two activities of butyrate, describing with the help of graphs and labels the data that might be obtained under various conditions of the experiment. Also describe the tentative observations/results that might be obtained and give suitable explanation/s and inferences/conclusions that might be drawn on the basis of each experiment. **(10.0)**