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NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET
 INSTITUTT FOR FYSIKK



EXAM IN TFY4260 – CELL BIOLOGY AND CELLULAR BIOPHYSICS

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Time: 09.00-13.00

Examination aids: Dictionary Norwegian – English, English – Norwegian

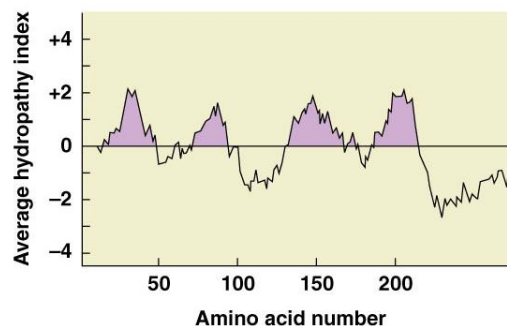
Read the exercises carefully and answer all questions.

The five exercises have roughly the same weight.

Good luck!

Exercise 1: Transport across membranes (20 pts)

- What is the difference between simple diffusion, facilitated diffusion, and active transport? Describe, briefly, one process (three in total), that makes use of each of these types of transports.
- The figure below shown the hydropathy plot of a protein involved in the transport across a membrane. What does the plot tell about the structure of the protein?



- Why is such type of structure relevant from a transport point of view?

Exercise 2: Cytoskeleton and cell cycle (20 pts)

- Describe the assembly process of microtubules.
- Microtubules are said to be polar. Explain what is meant with this and discuss the consequences of such polarity in terms of intracellular movement and cell division.
- Describe briefly how one can obtain the fraction of cells in the G1 and G2+M phases using flow cytometry.

Exercise 3: DNA packing and regulation of gene expression (21 pts)

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The genome is composed of very long DNA molecules that, when extended, can measure close to one meter.

- a) Describe the first two levels of DNA packing in eukaryotic cells.
- b) Give an example of genomic gene expression control. Justify.
- c) Describe how prokaryotes and eukaryotes coordinate the expression of groups of related genes.
- d) The synthesis of Ferritin (iron-storage protein) is under negative gene regulation at the post-transcriptional level, with iron being the inducer. Draw a scheme of the translation control in response to iron.

Exercise 4: Cell signaling and cancer cells (21 pts)

- a) Describe the structure of a G-protein-linked receptor, as well as the structure, activation and deactivation of G-proteins.
- b) *TRK* is an oncogene created by chromosomal inversion where an end of the tyrosine kinase (*NTRK1*) gene becomes fused with an end of the gene coding for nonmuscle tropomyosin (*TPM3*). Explain the mechanism of chromosomal inversion. Draw a scheme of the structure of the resulting fused protein and explain why such mutation leads to a cancer cell.
- c) Two of the hallmarks of cancer are sustained angiogenesis and evading apoptosis. Describe an experiment that has shown the requirement of angiogenesis for tumor growth. Describe the role of *p53* proteins in cell apoptosis and how they are targeted by the human papillomavirus (HPV).

Exercise 5: Mark the correct alternative with a cross. Deliver these pages together with the answers of the other exercises. Do not forget to indicate the candidate number. (1pt each, 18pts total)

- a) A particular plasma membrane possesses three main proteins, A, B, and C. When the membranes are treated with a high-salt solution, protein B is no longer detected in the membrane. The salt treatment has no effect on proteins A and C. What can we conclude?
 - Protein B might be a lipid-anchored membrane protein.
 - Protein B might be a peripheral membrane protein.
 - Protein B might be a singlepass integral membrane protein.
- b) Glycolipids are found
 - in the cytosol of the cell.
 - imbedded in the plasma membrane and facing the exterior of the cell.
 - imbedded in the nuclear membrane and facing the nucleoplasm.
- c) Cristae in mitochondria are related to
 - ATP synthesis.
 - packing of mitochondrial DNA.
 - ATP storage.
- d) The synthesis of proteins destined to the plasma membrane starts in the
 - cytosol.
 - ER.
 - Golgi complex.

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- e) ER to Golgi traffic is done
- along microtubules.
 - using clathrin-coated vesicles.
 - via retrograde transport.
- f) Mannose-6-phosphate tags enzymes for
- destruction by proteasomes.
 - transport to lysosomes.
 - transport to the ER.
- g) What role do voltage-gated calcium cation channels play in the transmission of signal across synapses?
- They substitute for potassium cation channels.
 - They bind to neurotransmitters such as acetylcholine.
 - They enable an influx of calcium to trigger neurotransmitter secretion.
- h) The transmission of an action potential along a myelinated axon is often called saltatory conduction. Why?
- Because the action potential jumps from node to node.
 - Because the electric signal propagates faster in the myelinated portions and more slowly in the nodes.
 - Because neurotransmitters are released to the synaptic cleft.
- i) Ras is
- activated by a GTPase activating protein.
 - activated by Raf.
 - a membrane bound protein.
- j) Actin filaments
- can be organized in 1, 2 and 3 dimensional structures.
 - are associated with gap junctions.
 - have no polarity.
- k) Myosin proteins are **not** involved in
- muscle contraction.
 - flagella motility.
 - vesicle trafficking.
- l) In relaxed muscle, calcium is found in high concentrations in the
- T tubules.
 - sarcolemma.
 - Sarcoplasmic reticulum.
- m) Cell fusion experiments showed that fusion of a cell in S phase with one in G1 phase leads the nucleus that was in G1 to begin S phase. The best interpretation of this finding is that ____.
- the DNA polymerase in the nucleus of the S cell moved to the G1 nucleus and started DNA replication

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- the G1 nucleus senses the plasma membrane fusion event and then enters S phase
 - the cytoplasm of the S cell contains a diffusible signal that causes the G1 nucleus to enter S phase
- n) During the cell cycle, and in order to be active, a Cdc-cyclin needs to be
- singly phosphorylated.
 - acetylated.
 - doubly phosphorylated.
- o) In recombinant technology, what is the purpose of the amp^R gene in the plasmid pUC19?
- To enable a scientist to use detection of the protein β -galactosidase to find plasmids carrying the gene of interest
 - To provide a series of restriction enzyme sites convenient for making recombinant plasmids
 - To enable a scientist to kill bacterial cells that are not carrying pUC19 or a recombinant derivative of pUC19
- p) The rolling of leukocytes along the endothelium cells that line blood vessels is mediated by
- selectins.
 - integrins.
 - cadherins.
- q) Tight junctions
- allow the passage of solutes with molecular weight above 1200.
 - block the lateral movement of proteins.
 - bind cells to the basal lamina.
- r) Genes that, when present, trigger the development of cancer are known as
- tumor suppressor genes.
 - oncogenes.
 - proto-oncogenes.