

Department of Biology

**Examination paper for Bi3016
Molecular Cell Biology****Academic contact during examination: Per Winge****Phone: 99369359****Examination date: 20th December 2017****Examination time (from-to): 09.00-13.00 (four hours)****Permitted examination support material: None****Other information:****Language: English****Number of pages (front page excluded): 2****Number of pages enclosed, including multiple choice: 7****Informasjon om trykking av eksamensoppgave****Originalen er:****1-sidig 2-sidig** **sort/hvit farger** **skal ha flervalgskjema** **Checked by:**_____
Date_____
Signature

NOTICE THAT QUESTIONS 1- 4 ARE WEIGHTED EQUALLY, BUT SINGLE QUESTIONS MIGHT BE WEIGHTED DIFFERENTLY (INDICATED IN %). IF NO WEIGHTING IS GIVEN THE SUB-QUESTIONS ARE WEIGHED EQUALLY. THE MULTIPLE CHOICE PART HAS THE SAME WEIGHT AS A THE MAIN QUESTIONS (20 %).
PLEASE START ANSWERING EACH QUESTION ON A NEW SHEET OF PAPER.

Question 1

The posttranscriptional controls that occur after the RNA polymerase has started the RNA synthesis are crucial for the regulation of many genes.

- a. Describe the main posttranscriptional controls that operate in a eukaryotic cell. (60%)

The even-skipped gene (*Eve*) in *Drosophila melanogaster* displays a striking expression pattern during embryo development.

- b. Give a short outline of embryo development in *Drosophila* and explain the basic principles behind the regulation of the *Eve* gene and how the characteristic “stripes” of expression are established. (40 %)

Question 2

G-protein coupled receptors (GPCRs) form the largest family of plasma membrane receptors in eukaryotic cells and mediates a variety of extra cellular signals.

- a. Describe the general structure of GPCRs and explain how they mediate signaling. (40 %)
- b. Explain how signaling from GPCRs and G-proteins are turned off. (20 %)
- c. Describe how GPCRs that are coupled to stimulatory G-proteins (G_s) mediate signaling that induce gene expression and explain how cholera toxin can interfere with this pathway (40 %)

Question 3

Flagella and cilia are essential for the locomotion of individual organisms / cells and to move fluid or materials past an immobile cell.

- a. Explain how flagella provide motility to a cell and describe the composition of an axoneme.

Integrins have a crucial role in mediating interaction with the extracellular matrix and may also bind various cell surface glycoproteins on adjacent cells.

- b. Explain how integrins are activated and how they play an important role during cell locomotion.

The p53 gene is mutated in about 50 % of human cancers and has been described as the “guardian of the genome”.

- c. Why do p53 have such an important function and what happens when it is inactivated by a mutation?

Question 4

Define / explain 4 of the 5 the following words and terminologies and give a short description of their function, max 100 words.

- a. DNA maintenance methylase
- b. Cyclin
- c. Apoptosome
- d. Ras protein
- e. Pathogen Associated Molecular Patterns (PAMP)

Question 5

See multiple choice questions!

Use figures where appropriate to explain your answers, (questions 1-4).

MULTIPLE CHOICE QUESTIONS: Write the letter corresponding to the correct answer on the line beneath each question, only one alternative is correct. Use capital letters!

1. What determines the time and place that a certain gene is transcribed in the cell?
- A) The type of *cis*-regulatory sequences associated with it
 - B) The relative position of *cis*-regulatory sequences associated with it
 - C) The arrangement of various *cis*-regulatory sequences associated with it
 - D) The specific combination of transcription regulators present in the nucleus
 - E) All of the above

Answer: _____

2. Which of the following is true regarding genomic imprinting?
- A) It is an epigenetic phenomenon.
 - B) It occurs in most animals.
 - C) It always involves inactivation of genes through direct DNA methylation.
 - D) It can "unmask" recessive alleles but cannot "mask" dominant ones.
 - E) All of the above.

Answer: _____

3. Transcription regulation has similarities and differences in bacteria and in eukaryotes. Which of the following is correct in this regard?
- A) Most bacterial genes are regulated individually, whereas most eukaryotic genes are regulated in clusters.
 - B) The rate of transcription for a eukaryotic gene can vary in a much wider range than for a bacterial gene (which is, at most, only about 1000-fold).
 - C) DNA looping for gene regulation is the rule in bacteria but the exception in eukaryotes.
 - D) Transcription regulators in both bacteria and eukaryotes usually bind directly to RNA polymerase.

Answer: _____

4. What is the function of RNA-dependent RNA polymerases in RNA interference (RNAi)?
- A) They prevent the spread of the RNAi activity by replicating the target RNAs.
 - B) They help amplify the RNAi response by replicating the target RNAs.
 - C) They produce additional copies of the siRNAs to ensure that the RNAi response is sustained and spread.
 - D) They are viral proteins that prevent the spread of RNAi by preferentially replicating siRNA that deplete Argonaut mRNAs.

Answer: _____

5. A cell expresses a transmembrane protein that is cleaved at the plasma membrane to release an extracellular fragment. The fragment binds to receptor proteins on nearby cells and activates signaling pathways resulting in altered gene expression patterns in the cells. What form of intercellular signaling does this represent?
- A) Contact-dependent signaling
 - B) Paracrine signaling
 - C) Synaptic signaling
 - D) Endocrine signaling
 - E) Autocrine signaling

Answer: _____

6. Which of the following is a major consequence of activation of phospholipase C- β (PLC β) by the G $_q$ trimeric GTPase?
- A) Elevation of intracellular cAMP levels, leading to the activation of protein kinase A
 - B) Elevation of PIP $_3$ levels in the plasma membrane, leading to the activation of protein kinase B (Akt)
 - C) Elevation of intracellular Ca $^{2+}$ levels, leading to the activation of protein kinase C
 - D) Elevation of IP $_3$ in the plasma membrane, leading to the activation of protein kinase D
 - E) Elevation of intracellular cGMP levels, leading to the activation of protein kinase G

Answer: _____

7. What is the effect of using scaffold proteins on precision and amplification capacity in cell signaling?
- A) Both precision and amplification are improved.
 - B) Precision is improved, but amplification is limited.
 - C) Precision is compromised, but amplification is improved.
 - D) Both precision and amplification are limited.

Answer: _____

8. *Arabidopsis thaliana* seedlings show positive phototropism: they bend and grow toward the source of (blue) light. However, phototropism is not observed if the seedlings are treated with an auxin efflux inhibitor called NPA. Knowing that auxin stimulates elongation of the cells in the growing shoot, these observations are consistent with a model in which, in the presence of a lateral light, ...
- A) auxin efflux transporter proteins become localized to the side of the cell that is facing the light source.
 - B) auxin efflux transporter proteins become localized to the side of the cell that is away from the light source.
 - C) auxin influx transporter proteins become localized to the side of the cell that is facing the light source.
 - D) auxin influx transporter proteins become localized to the side of the cell that is away from the light source.
 - E) auxin efflux transporter proteins become uniformly distributed around the cell.

Answer: _____

9. In the polymerization *in vitro* of actin filaments and microtubules from their subunits, what does the “lag phase” correspond to?
- A) Nucleation
 - B) Reaching steady state
 - C) Nucleotide exchange
 - D) ATP or GTP hydrolysis
 - E) Treadmilling

Answer: _____

10. Consider an actin subunit that has just been incorporated into an actin filament at the leading edge of a lamellipodium. Before its ATP is hydrolyzed, how does its distance from the leading front edge of the plasma membrane change over time? How does its distance from the F-actin minus end change over time?
- A) Decreases; decreases
 - B) Decreases; remains constant
 - C) Decreases; increases
 - D) Increases; decreases
 - E) Increases; remains constant

Answer: _____

11. What is the major microtubule-organizing center in animal cells?
- A) The γ -tubulin ring complex
 - B) The centrosome
 - C) The cell cortex
 - D) The primary cilium
 - E) The spindle pole body

Answer: _____

12. Which of the following events occurs in mitotic metaphase?
- A) Nuclear envelope breakdown
 - B) Nuclear envelope reassembly
 - C) Chromosome attachment to spindle microtubules for the first time
 - D) Chromosome alignment at the spindle equator
 - E) Mitotic spindle assembly

Answer: _____

13. A cell has been subjected to ultraviolet irradiation, causing a significant number of mutations in the genome. Which of the following would you NOT expect to occur as a result?
- A) Activation of the protein kinase ATR
 - B) Activation of the protein kinase Chk1
 - C) Inactivation of the protein phosphatase Cdc25
 - D) Binding of p53 to Mdm2
 - E) Stabilization of p53

Answer: _____

14. Formin nucleates the growth of parallel actin bundles in the cell. Additionally, myosin motor activity is positively regulated by phosphorylation. The monomeric G protein RhoA is important in cytokinesis, because it directly or indirectly ...
- A) activates formins and inactivates myosin light-chain phosphatase.
 - B) inactivates formins and activates myosin light-chain kinases.
 - C) activates formins as well as myosin light-chain phosphatases.
 - D) inactivates formins as well as myosin light-chain kinases.
 - E) None of the above.

Answer: _____

15. v-FLIPs are viral proteins that were first identified as modulators of apoptosis; they contain two death effector domains, which are also found in some initiator caspases such as procaspase-8. These v-FLIP proteins can be recruited to the DISC through the binding of the death effector domain to similar domains in the adaptor proteins, but are otherwise catalytically inactive. What do you think is the effect of v-FLIP expression in the host cell?
- A) It promotes apoptosis mainly via the extrinsic pathway.
 - B) It inhibits the extrinsic pathway of apoptosis.
 - C) It activates only the mitochondrial pathway of apoptosis.
 - D) It inhibits the intrinsic pathway of apoptosis.
 - E) It enhances the caspase cascades in both the intrinsic and extrinsic pathways.

Answer: _____

16. Which of the following cell junctions uses cadherin cell adhesion molecules to anchor the actin cytoskeleton?
- A) Tight junction
 - B) Adherens junction
 - C) Desmosome
 - D) Hemidesmosome
 - E) Gap junction

Answer: _____

17. In the active state of the integrin dimer, ...
- A) both intracellular and extracellular binding sites are exposed.
 - B) the intracellular binding sites are inaccessible, while the extracellular binding sites are exposed.
 - C) the intracellular binding sites are exposed, while the extracellular binding sites are inaccessible.
 - D) both intracellular and extracellular binding sites are inaccessible.

Answer: _____

18. Genetically knocking out both copies of the *p53* gene in rats ...
- A) is embryonic lethal.
 - B) results in a lower malignancy rate, but the rats are otherwise seemingly normal.
 - C) results in a higher rate of cancer onset, but the rats are otherwise seemingly normal.
 - D) increases cell death by apoptosis, leading to developmental defects.
 - E) does not have any effect unless the rats live outside of the laboratory and are exposed to various types of stress.

Answer: _____

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19. The *Rb* gene in retinoblastomas is similar to the *Apc* gene in polyposis colon carcinomas in that both genes ...
- A) are tumor suppressors.
 - B) are mutated in one copy in all cells of patients with a hereditary form of the cancer.
 - C) are in a locus that shows loss of heterozygosity in the hereditary form of the cancer.
 - D) should be inactivated in both copies to cause the nonhereditary form of the cancer.
 - E) All of the above.

Answer: _____

20. The gene clusters known as the *Bithorax* complex and the *Antennapedia* complex contain ...
- A) a subset of segment-polarity genes.
 - B) segmentation genes.
 - C) homeobox-containing genes.
 - D) genes encoding chromatin repressors.
 - E) genes encoding chromatin remodelers.

Answer: _____