

# IMPERIAL COLLEGE LONDON

## B.Sc. Examination 2016

This paper is also taken for the relevant examination for the Associateship of the Royal College of Science

## CELL BIOLOGY

**Friday 5th February 2016 10.00 - 13.00**

FOR FIRST YEAR STUDENTS IN BIOCHEMISTRY AND BIOTECHNOLOGY

Please use the **MCQ ANSWER SHEET PROVIDED FOR SECTION A** and a **SEPARATE ANSWER BOOK FOR EACH QUESTION IN SECTION B**. All parts of a question in Section B carry equal weighting unless otherwise specified.

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### SECTION A

Answer all **TWENTY FIVE** questions on the **separate MCQ answer sheet provided**. This section is worth 25% of the total marks. Candidates should allow up to 45 minutes for this section. **Some questions in this section have more than one correct answer**. Credit will be given for all correct answers, but you will be penalised with a negative mark for incorrect choices. You will not be penalised if you do not select an answer.

**1. Which of the following statements about  $\alpha$ -helical transmembrane domains is/are TRUE?**

- A) The arrangement of the atoms in the  $\alpha$ -helix maximises H-bonding between the backbone groups.
- B) The  $\alpha$ -helix contains an alternating arrangement of hydrophobic and hydrophilic amino acid residues.
- C)  $\alpha$ -helical transmembrane domains must be at least 25 amino acids in length.
- D)  $\alpha$ -helical transmembrane domains can be tilted relative to the membrane.
- E)  $\alpha$ -helical transmembrane domains are linked by regions of soluble protein.

**2. Which of the following is/are characteristics of the plasma membrane lipid bilayer?**

- A) The lipids that make up the bilayer are covalently linked.
- B) The bilayer is asymmetric.
- C) It is possible for lipids to move from one side of the membrane to the other spontaneously.
- D) Lipid molecules within the bilayer can be organised into discrete domains.
- E) The bilayer is a complex mixture of different lipids.

**3. Passive transport:**

- A) Can be described as facilitated diffusion.
- B) Requires energy in the form of ATP.
- C) Is dependent on the electrochemical gradient.
- D) Is only carried out by channels.
- E) Will only take place in lipid rafts.

**4. G-protein coupled receptors:**

- A) Are responsible for uptake of solutes into the cell.
- B) Bind neurotransmitters, hormones and drugs.
- C) Have 7  $\alpha$ -helical transmembrane domains.
- D) Undergo phosphorylation to prevent G-protein binding.
- E) Have a flexible membrane topology.

**5. You are given a polypeptide sequence which has a region of positively charged amino acids rich in lysine and arginine. Where is the most likely location of this protein in the cell?**

- A) Lysosomes.
- B) The extracellular matrix.
- C) The plasma membrane.
- D) The cytoplasm.
- E) The nucleus.

**6. Which of the following proteins is/are involved in gated transport and is/are found at a higher concentration in the cytoplasm than the nucleus?**

- A) Ran-GAP.
- B) Ras.
- C) Ran-GEF.
- D) Rho.
- E) Rac1.

**7. Where can protein-folding take place in a eukaryotic cell?**

- A) The Golgi apparatus.
- B) The nucleus.
- C) The cytoplasm.
- D) The endoplasmic reticulum.
- E) The extracellular matrix.

**8. Where do polypeptides go immediately after being fed into or through the endoplasmic reticulum translocon?**

- A) To lysosomes.
- B) Into the endoplasmic reticulum's membrane.
- C) To the nucleolus.
- D) Into the endoplasmic reticulum's lumen.
- E) To the plasma membrane.

**9. Where do you find cells with large regions of smooth endoplasmic reticulum?**

- A) The brain.
- B) The heart.
- C) The liver.
- D) The eye.
- E) Skeletal muscle.

**10. How does iron enter a eukaryotic cell?**

- A) Phagocytosis.
- B) Exocytosis.
- C) Pinocytosis.
- D) Translation.
- E) Receptor-mediated endocytosis.

**11. What does the Periodic acid-Schiff stain ('PAS') label in gut goblet cells?**

- A) Amino groups.
- B) Aldehydes.
- C) Hydroxyl groups.
- D) Water-soluble groups.
- E) Benzene derivatives.

**12. You find out that cells from a patient contain unusually high amounts of very long chain fatty acids (longer than C20). Which organelle do you think is likely to be failing in this patient?**

- A) Lysosomes.
- B) Endosomes.
- C) Peroxisomes.
- D) Endoplasmic reticulum.
- E) Mitochondria.

**13. Which of the following increase in cells undergoing apoptosis?**

- A) Separase activity.
- B) DNase activity.
- C) Mitochondrial membrane integrity.
- D) Protease activity.
- E) Metastasis.

**14. Which of the following is/are functions that a tumour suppressor may perform?**

- A) Promote cell proliferation.
- B) Promote apoptosis.
- C) Promote angiogenesis.
- D) Inhibit metastasis.
- E) Inhibit genomic stability.

**15. Which of the following is/are important in M phase of the mammalian cell cycle?**

- A) Sister chromatid condensation.
- B) Cohesin proteolysis.
- C) Microtubule attachment to sister chromatids via kinetochores.
- D) Anaphase promoting factor inactivation of separase.
- E) Cytokinesis.

**16. Proteins encoded by oncogenes are often:**

- A) Mutated versions of normal cellular proteins.
- B) Deleted in cancer.
- C) Involved in promoting viral replication.
- D) Proteins involved in arresting cell division.
- E) Constitutively active mutants.

**17. Which of the following is/are components of the Gram-negative peptidoglycan?**

- A) N-acetyl glucosamine (NAcGlc).
- B) D-lysine.
- C) Diaminopemelic acid.
- D) L-methionine.
- E) D-alanine.

**18. Concerning the antibiotics vancomycin and penicillin, which of the following is/are TRUE?**

- A) Both inhibit transpeptidation during peptidoglycan synthesis.
- B) Resistance always develops due to enzymes that degrade the antibiotics.
- C) Resistance to both can be due to alterations in the cell wall structure.
- D) Both bind to terminal D-Ala –D-Ala residues of the peptide precursors, preventing crosslinking.
- E) They only act on Gram-positive bacterial species.

**19. Which of the following is/are TRUE?**

- A) Louis Pasteur disproved spontaneous generation.
- B) Robert Koch developed postulates for proving that a specific microorganism causes a disease.
- C) Alexander Fleming discovered vancomycin.
- D) Antoni van Leeuwenhoek discovered the Archaea.
- E) Craig Venter sequenced the first bacterial genome.

**20. Two component systems operate in many bacterial species. In such systems:**

- A) The sensor protein contains histidine kinase activity.
- B) The response regulator is always located in the inner membrane.
- C) Transfer of phosphate occurs between proteins.
- D) Transfer of histidine occurs between proteins.
- E) The response regulator can control transcription of genes.

**21. Many bacteria can use quorum sensing, a universal language, to sense their environment. Which of the following is/are TRUE?**

- A) Quorum sensing can operate in marine bacterial species associated with fish.
- B) Quorum sensing allows bacteria to measure their population density and to control gene expression.
- C) Autoinducers are chemicals required for the synthesis of light sensing machinery.
- D) Acyl homoserine lactone (AHL) and peptides can be autoinducers.
- E) An autoinducer produced by one species cannot operate in another species.

**22. Which of these statements about the critical concentration or  $C_c$  is/are TRUE?**

- A) The  $C_c$  is the concentration at which the rate of subunit loss to rate of gain is equal.
- B) The  $C_c$  is the concentration at which filaments have reached their required length.
- C) Both ends (pointed and barbed) of an actin filament have the same critical concentration.
- D) The ends (pointed and barbed) of an actin filament have different critical concentrations.
- E) When the cytosolic concentration of actin is above the  $C_c$ , filaments will grow.

**23. Which of the following cytoskeletal regulators is/are a tubulin filament nucleator?**

- A) Gamma-TuRC.
- B) Arp2/3.
- C) Formin.
- D) Dynein.
- E) Myosin.

**24. Which of the following is/are a minus (-) end directed cytoskeletal motor protein?**

- A) The canonical Myosin II in the muscle.
- B) The unusual Myosin VI in vesicular membrane traffic.
- C) The unique class of Myosin XIV in the malaria and related parasites.
- D) Kinesin 5 in organization of the spindle.
- E) Dynein in the flagellum.

**25. How do Listeria bacteria move around a host cell?**

- A) By attaching themselves to microtubule growing ends.
- B) By tapping into host cell actin polymerization.
- C) By binding to a myosin motor.
- D) By mimicking Arp2/3 dependent nucleation of actin filaments.
- E) By mimicking Gamma-TuRC dependent nucleation of microtubules.

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## **SECTION B**

### **ANSWER THREE QUESTIONS.**

**This section is worth 75% of the marks. Please use a SEPARATE answer book for each question. You should devote approximately 45 minutes to each question.**

26. With the use of diagrams explain the forces behind the formation of the lipid membrane. Explain the characteristics of the membrane that is formed and how the cell adapts to maintain membrane fluidity.

27. Describe how skeletal muscles contract after acetylcholine binds to its receptors on the muscle cell membrane.

28. Describe the structure, contents and functions of lysosomes.

29. Describe the structure of the nuclear pore complex. (50%) Describe how proteins larger than 60kD can enter and exit the nucleus. (50%)

30. How are cyclin-dependent kinases regulated and how do they control the mammalian cell cycle?
31. Eukaryotic cells need actin filaments in different regions of the cell with very different properties to carry out their many functions. Making reference to this concept, describe the two main mechanisms by which actin filaments are nucleated in the eukaryotic cell and why the cell needs nucleation at all. (75%) Describe how the nucleation process is mimicked by intracellular pathogens (e.g. *Listeria* spp.) to either gain entry or move between infected and uninfected cells. (25%)
32. Compare and contrast the structures and activities of the bacterial flagellum and the type IV pilus.

*End of paper*