BB101: Molecular and Cell Biology Mid-semester exam **Roll no:_____**

Instructions (READ THESE CAREFULLY BEFORE STARTING):

1. The exam will be for 1 hour 20 minutes. The maximum marks are 25.
2. Do not ask any invigilators to clarify anything. If you have a question, ask Swati Patankar.
3. Answer only in the space provided. Any answer outside the space provided will not be corrected.
4. Write and draw only in pen; answers written and drawn in pencil will not be corrected.
5. For multiple choice questions, the only answers that will be corrected are those where you circle the answers (answers with ticks, writing the answer on the side, etc will not be corrected).
6. There are no partial marks for this exam, so read the questions carefully, think and then write your answers so that they are clear and to the point.
7. Have fun!

Insight magazine: Posted on 9th October 2011

Food poisoning @ IITB

Reporters: Anubhav Mangal, Anupam Chatterjee, Archana Das, Rahul Pramod, Sibaprasad Mohanty, Sourabh Biswas

Around 300 students from H12, 13 and 14 reportedly fell sick after consuming the Chinese dinner at the hostel mess on Sunday, September 25 out of which around 16 were hospitalised.

You are now an expert in Biology and are called upon as one of the members of the committee that is examining the case. You find that the Chinese dinner contains bacteria called *Salmonella* that is known to cause food poisoning. You do some further tests on the bacteria.

Qs 1a) The first test you perform is Gram staining of these *Salmonella* bacteria. You find it is a rod shaped, Gram-negative bacteria. Draw a schematic of the plasma membrane and cell wall of Gram-positive and Gram-negative bacteria. (2 marks)

Qs 1b) You now decide to treat the suffering students with antibiotics. You have the choice of the following antibiotics from the IITB hospital.

Antibiotic name	**Target in the bacterial cell**
Penicillin	Peptidoglycan
Erythromycin	Translation
Rifamycin	Transcription

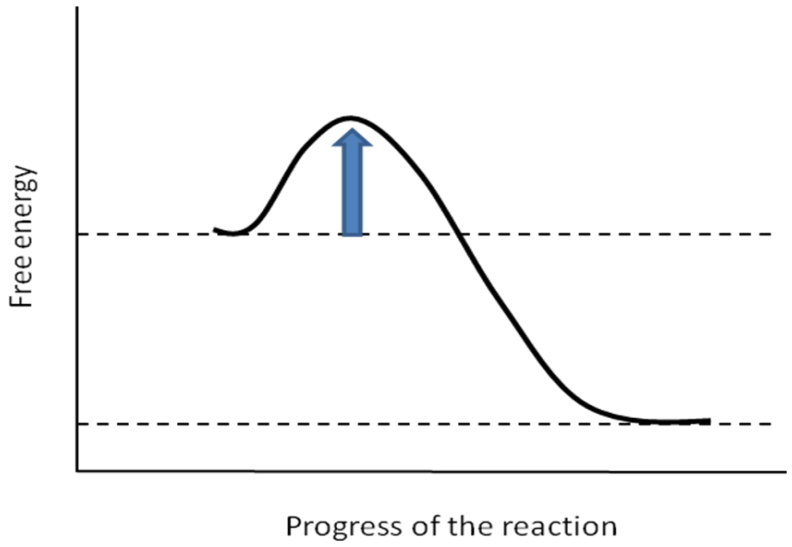
You treat the 16 hospitalized students with Penicillin and find to your surprise that they do not recover from the food poisoning because the Gram negative *Salmonella* bacteria are not killed efficiently by Penicillin. Based on your answer in Qs 1a, propose an explanation for why Penicillin is not effective for Gram negative bacteria. (2 marks)

Qs 2) You next treat the students with Erythromycin and they all recover except two. Unfortunately, one of these students seems to have a drug resistant *Salmonella* infection. Upon further study, the bacteria are seen to have acquired foreign DNA. As a Biology expert, you know drug resistance be explained by evolution driven via natural selection. One of the 4 concepts in natural selection is variation. Give 2 ways by which the drug resistant bacteria can acquire genetic variation. (2 marks)

i)

ii)

Qs 3) You have studied that antibiotics act on bacterial enzymes. Drawn below is a graph of free energy vs. progress of the reaction in presence of the enzyme that is the target of Erythromycin. On the graph draw and clearly label the reactants, products, transition state and activation energy. (2 marks)
Next, on the same picture, draw the graph that would be obtained if you added Erythromycin to the reaction. (2 marks)



Qs 4a) You now try and help the last student who did not respond to the Erythromycin drug. You find that he does not have *Salmonella* infection. Instead, he has a viral infection that is giving him a stomach upset. Why does Erythromycin not kill viruses? (2 marks)

Qs 4b) You isolate the virus from the student and find that the genome has the following composition: %A = 23, %G = 27, %C = 27 and %U = 23. Circle the most probable genome that this virus contains. (1 mark)

A) double-stranded DNA
B) single-stranded DNA
C) double-stranded RNA
D) single-stranded RNA

Qs 4c) Based on the genome that you predicted in Qs 4b, what protein will the virus inject into the host cell to carry out its replication and complete its life cycle? (1 mark)

Qs 5) At the same time that the food poisoning outbreak took place, during your visit to the IITB hospital, you find that your good friend had a bad accident and is need of blood. His blood group is B and he gets a transfusion. You find out later that his mother's blood group is A. Which of the following statements about his parents is correct? Circle the correct answer. (1 mark)

A) His father's blood group is O
B) His mother is heterozygous for the trait
C) His mother is homozygous dominant for the trait
D) His father's blood group cannot be B or AB

Indian Dental Association to organize oral cancer screening camp
Jaideep Shenoy, Times of India | Sep 1, 2014
Indian Dental Association has organized oral cancer screening across India to raise awareness about oral cancer from September 1 to 7. The screenings will highlight ill effects of tobacco consumption and is supported by organizations including Indian Cancer Society.

Qs 6) You have been studying a cancer of the mouth that is found in Indians who chew tobacco. You grow the cancer cells and study them further for metabolism. After performing experiments to study respiration of these cells, you find that their mitochondria are not working efficiently and they show defective respiration (by the way, this has been reported by other scientists and is called the 'Warburg Effect'). What stages of respiration take place in the mitochondrion? (2 marks)

Qs 7) If mitochondria are not working in cancer cells, how many molecules of ATP will they generate from one molecule of glucose? (1 mark)

Qs 7b) What metabolic pathway did the cancer cells choose after generation of pyruvate? (1 mark)

Qs 8) As you want to cure this cancer, you now start working on an anti-cancer drug that inhibits the cells' ability to pull the sister chromatids apart. Circle the stage of mitosis at which the drug would act. (1 mark)

A) Prometaphase
B) Metaphase
C) Anaphase
D) Telophase

Qs 9) You study the cancer cells further and find that they transcribe the genes required for spreading in the body (metastasis) when a signalling molecule is added. What is the property of cancer cells which allows them to spread in the body? (1 mark)

You want to know more about the signal transduction pathway that is activated by this signalling molecule to design anti-cancer drugs against metastatic tumours. You treat cancer cells with the signalling molecule and also add an inhibitor of G-protein coupled receptors. You find that this inhibitor has no effect on the transcription of genes for metastasis. Inhibitors of calcium, IP3 and cAMP signalling also do not have any affect. What could be the signalling pathway used by the cancer cells for metastasis? (1 mark)

Qs 10) Einstein is one of heroes from the field of Physics for you and your friend. You tell your friend that it is possible (with an extremely low probability) that a carbon atom present inside your body was once present inside Einstein's body. Your friend does not believe you. Show how this could happen, with chemical equations. (3 marks)