BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI - Second Semester 2017-18

BIO F111 – General Biology – Comprehensive Exam - (Open Book)

Date: 10/05/2018 Duration: 2 hrs. Max Marks: 60 (30%)

Read the following instructions carefully: **1.** The paper has four sections: A, B, C and D. Do not jumble the answers in one section with those of another. **2.** Answer to the point and underline the important words in your answer. **3.** In questions requiring justification, marks would be awarded *only if* you give proper justification. **4.** It's preferable you write the answer (correct one, of course) in your own language, rather than simply reproducing statements from book/question.

Quote of the Day: "*I have learnt so much from my mistakes. I'm thinking of making a few more…*" NEVER GIVE UP.

The GEN BIO EXPRESS is here. Let's begin the journey. All aboard!

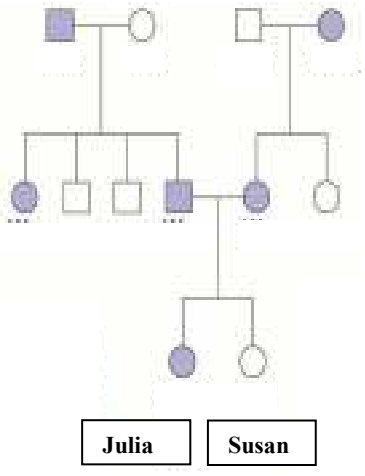
Section A

A1. In tricarboxylic acid cycle, the reaction for the formation of citric acid is catalyzed by citrate synthase (*Still remember!*). In case this enzyme is non-functional in a particular cell, then what will be the total number of following molecules generated (per glucose metabolized) by this cell? Justify briefly in each case. [**3M]**

(a) ATP, by substrate level phosphorylation (b) NADH (c) $FADH_2$

A2. In light reaction, the energized electrons pass down from one photosystem to another. When the electrons reach another photosystem, in which compartment of photosynthetic pigment there will be an acidic pH and why? **[3M]**

A3. (*Time for a pedigree question. It's easy, believe us!*) One day, two sisters Julia and Susan noticed that their hair pattern is a little different from each other. Julia had a pointed hairline on the forehead, which they came to know as a genetic trait known as Widow's Peak. Susan does not have it. They also came to know that it is an autosomal trait. They traced back this trait through their family history using pedigree analysis. The pedigree given shows three generations of their family in which some individuals have this trait (shaded).



(i) Analyzing the pedigree can you comment on the inheritance pattern (dominant or recessive)? Justify briefly. **[3M]**

(ii) What will be the genotypes of Julia and Susan? Justify. (Use H/h symbols to write appropriate genotypes.) **[3M]**

A4. You are a pigeon breeder (*Don't take it to heart; it's just an assumption!*). In order to make maximum money as a pigeon breeder, you must sell mainly glossy winged, red feathered pigeons. Lucky for you, as glossy wings (G) and red feathers (R) are dominant in pigeons (plain wings and brown feathers are recessive). You have a female homozygous glossy winged, red feathered pigeon (you bred her yourself!) She is

so beautiful that she has won prizes in several pigeon beauty contests. You recently purchased a male pigeon that has glossy wings and red feathers from a shady pigeon dealer, who claimed it was homozygous. Before you breed this male with your prize winning female, you want to be sure that it is homozygous for both traits. What experiment will you perform to be able to decide what the genotype for both traits of the male pigeon is? Show how this experiment will help your decision. **[3M]**

Section B

B1. Read this. "*The HIV virus*  *which is the main causative agent of AIDS does not attack the T-cytotoxic or the B-cells; still the person is severely compromised in his/her immune response*." Justify the statement with proper reasoning? **[3M]**

B2. A case study shows that post-operative infection rates were considerably higher in patients who underwent strong corticosteroid injection during knee replacement surgery when compared to controls. The persons who underwent surgery with corticosteroid injection were not carrying any prior infection as well. The controls were also matched for age, gender, obesity, diabetes and smoking status and were absolutely healthy. Infection rates were evaluated a few months post operation. Based on your General Biology classes, do you think that there is a scientific basis to high infection rates in the above context or the reports of the case study should be discarded and not considered for future clinical applications? Justify. **[3M]**

B3. A researcher  was working with 2 types of cells: Type1 was wild type (i.e. had normal P53) and Type2 was P53 mutant. He added a cell cycle blocker 'thymidine' which blocks the cell cycle at G1 phase. He observed that after addition of inhibitor, Type1 cells went to growth arrest and subsequently died by apoptosis. On the other hand, the Type2 cells continued to grow! Why were the two responses different? Justify briefly. **[3M]**

B4. (i) You and your younger brother  are on wildlife expedition to New Zealand  (*Hurray!*). During the expedition, you are delighted to spot a ground nest with eggs of the critically endangered bird, Kakapo. You tell your brother that the eggs are rich in proteins and fats. Your brother is confused as he believes that only glucose should be present, instead of proteins and fats in the egg, to nourish and support the developing embryo. Mention two functions each of proteins and fats <u>in the given context</u> (other than as energy sources).

[3M]

(ii) While exploring  plant species, both of you are amazed to see a pitcher plant ( an insect eating plant) whose modified cup-shaped leaves are filled with fluid containing some decomposing insects. You explain to your brother (*So intelligent of you!*) that the insects are being digested by the plant enzymes and the released nutrients nourish the plant. What could be the cellular process through which the enzymes appear in the fluid? Secondly, how would the intracellular architecture in the leaves be different from that in the stem (in the given context)? **[3M]**

Section C

C1. (i) "*After attainment of puberty, in a single reproductive cycle, before ovulation, more than one follicle always starts maturing in a healthy female's ovary/ovaries each month*." Is this statement true or false? Justify, stating what is the immediate fate of the follicle/s after they start developing. **[2M]**
(ii) Also mention the names of a protein and a lipid based hormone that primarily play a role in the development of the follicle/s preceding ovulation. **[2M]**

C2. In recent years, stem cell-based skin care products are proposed which contain embryonic stem (ES) cells. It is supposed that the stem cell replacement will decrease the wrinkles and so ageing effect (*Wow!*). However, some researchers feel that it may be dangerous to use embryonic stem cells. What may be the one major risk associated with the use of ES cells? Justify briefly. **[3M]**

C3. Based on the knowledge of molecular tools used in genetic engineering, match the analogies with the tools, giving suitable justification for each. **[2M]**

(i)  (ii) 

(iii)  (iv) 

(a) Taq DNA Polymerase (b) restriction enzyme (c) ligase (d) Cloning vector

C4. Assume that in the year 2025, the first expedition of humans to Mars discovers several Martian  life forms thriving in hydrothermal vents that exist below the planet's surface (*How exciting!*). Several teams of molecular biologists extract proteins and nucleic acids from these organisms and make some momentous discoveries. *Their first discovery is that the proteins in Martian life forms contain only 14 different amino acids instead of the 20 present in life forms on Earth! Their second discovery is that the DNA and RNA in these organisms have only two different nucleotides instead of the four nucleotides present in living organisms on Earth!!* **[3M+3M]**

(i) Assuming that transcription and translation work similarly in Martians and Earthlings, what is the minimum number of nucleotides that must be present in the Martian codon to specify all the amino acids in Martians?
(ii) Assuming that the Martian code proposed above has translational start-and-stop signals, would you expect the Martian genetic code to be degenerate like the genetic code used on Earth?

Section D

D1. (*Sh…Shh…*) You are on a secret mission  to Amazonia (*The Amazon rainforest in Brazil*). You are super excited (*We too!*) about the mission and due to this overexcitement, before getting into the deep forest, you have only taken 1 kg of pure starch as food source. Given that one gram of starch contains 259 starch molecules and one starch molecule is composed of 39 maltose residues. Based on this information, answer the following questions:

(i) Consider the statement: "*When you consume starch, it is mainly digested in your mouth, stomach and small intestine to form smaller subunits*." Is this statement true or false? Justify your choice briefly. **[3M]**

(ii) Suppose each day, you are consuming 100 gm of starch, which is required for your normal function. How many glucose molecules will be generated by your digestive system (from this starch) on each day? Show calculations. **[3M]**

D2. During the summer just after the exam, you decided to visit a distant relative of your family, Jagdish, who lives in Kasauli  , Himachal Pradesh (*You really need such a one* ☺). One morning, Jagdish was feeling sick, so you took him to a physician, who suggested a urine test. When the report came in the evening, the pathologist who did the test said that Jagdish had high protein content in the urine. This surprised you! With your knowledge of the subject, briefly explain the probable reason behind Jagdish's condition and the kind of changes that could have taken place in his excretory system (kidneys). **[3M]**

D3. Here is an excerpt from the diary of Dr. Megha, a motivated researcher and teacher: "*I was constantly stressed for my exams and public speaking, since my childhood; I'd often encounter fever, nausea, and similar symptoms. This trend continued until my PhD exams. Then came a moment when I was selected to give a talk on an international platform. When I heard that, I told, "I can't, I won't!" My PhD advisor asked me, "Why are you afraid of giving a twelve minutes presentation? It is once in a lifetime opportunity!" I said, "What if I fail to answer questions, my voice chokes and I can't deliver my 100%? It'll bring such a shame to me, and you as my mentor, plus I lose my friends, my parents won't like me and I'd be labeled a loser for lifetime!" He smiled, and told me "Nothing of these will happen, just breathe in and breathe out, and tell yourself, I can do it, no one can do this presentation better than me, at this moment!!" I followed what he said and; Boom!! my presentation was a huge success!*" 

Now, describe the parts of nervous system involved in the situation before and after Megha's following the tips from her advisor, explaining briefly how those tips helped her responses. **[3M]**

D4. According to dictionary definition, "*Positive Feedback* 

is the enhancing or amplification of an effect by its own influence on the process which gives rise to it." Explain how "positive feedback" is used for transmission of nerve impulse through a neuron. **[3M]**

That's all, students. Wish you a very happy summer vacation!
A special question for you: "What would you do if you knew you could not fail?" Seeking an answer to this question can help you in finding your passion and mission in life. Give it a try!