

**Kusuma School of Biological Sciences**  
**PhD Entrance Examination December 2016**

**Date: December 7<sup>th</sup>, 2016**

**Maximum marks: 50**

**Time: 1 hour**

Name: \_\_\_\_\_

Mobile number \_\_\_\_\_

Instructions

- Use the separately attached answer sheet to answer multiple-choice questions (Do NOT answer the multiple choice questions on the question paper)
- Marks: +2 for a correct answer and –1 for an incorrect answer
- Part B is compulsory (though it is NOT graded) – answer part B in the question paper
- Please check if there are a total of 6 pages in this booklet including the answer sheet for the MCQs

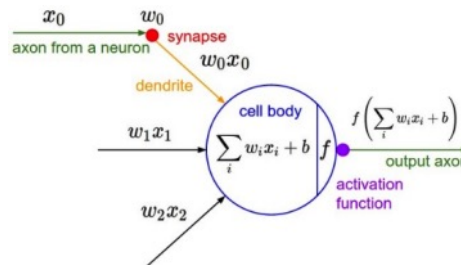
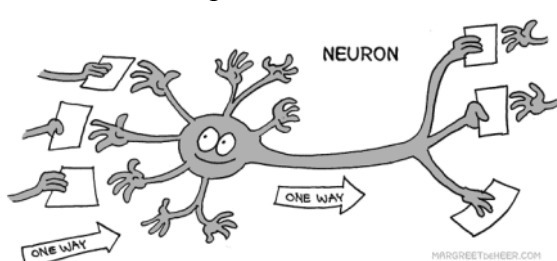
PART A: Choose THE MOST APPROPRIATE answer for each question

1. Imprinted genes are expressed in a parent-of-origin-specific manner. Ms. X inherited a faulty copy (mutated) of an imprinted gene (AB) on chromosome 8 from her father and Mr. Y inherited a faulty copy (mutated) of the same imprinted gene (AB) from his mother. The imprinted gene AB is expressed only from the maternal allele. Expression of mutated protein AB or the complete lack of expression of protein AB is linked to disease. The genomes of Ms. X and Mr. Y do not have any other genetic or epigenetic abnormalities. Which of the following statements is TRUE?
  - A) Ms. X will be diseased
  - B) Mr. Y will be diseased
  - C) Both Ms. X and Mr. Y will be diseased
  - D) Neither Ms. X nor Mr. Y will be diseased
  
2. You are a scientist working on a neurological disorder which is associated with *protein X*. You have a neuronal cell line that expresses *protein X*. The mRNA coding for *protein X* is 4 kb in length and contains a few m<sup>6</sup>A (methylated adenine) bases. Recent reports indicate that m<sup>6</sup>A is linked to reduced half-life of transcripts. You decide to use siRNA against the *FTO* gene (a gene that actively removes the m<sup>6</sup>A from RNA) in the neuronal cell line. The siRNA worked as expected. In the same cells that were transfected with siRNA against the *FTO* gene you measure mRNA levels for *protein X* using a real-time PCR assay. You are likely to find
  - A) reduced levels of *protein X* mRNA
  - B) increased levels of *protein X* mRNA
  - C) no change in the levels of *protein X* mRNA
  - D) no change in the levels of *protein X* mRNA but reduced levels of *protein X*.
  
3. A liver biopsy is considered the gold-standard for the diagnosis of liver cancer. A new non-invasive screening test for liver cancer correctly diagnosed nine out of every ten biopsy-proven liver cancer cases. When 1000 individuals who showed no evidence of liver cancer based on liver biopsies were tested using the new screening test, 50 tested positive. Which of the following statements is TRUE about the new screening test?
  - A) The new screening test has higher sensitive than specificity
  - B) The new screening test has the same sensitivity and specificity
  - C) The new screening test has higher specificity than sensitivity
  - D) The sensitivity and the specificity calculations require data on the incidence of liver cancer in the given geographical area.
  
4. Mutation of codon AGG to CGG will be a
  - A) nonsense mutation
  - B) synonymous mutation
  - C) silent mutation
  - D) anonymous mutation

5. Protein concentration is usually calculated by measuring absorption at 280 nm and 220 nm. Which of the following statements is NOT correct?
- Absorption at 280 nm is more reliable for detecting intact proteins.
  - Aromatic residues in the protein are sensitive to absorption at 280 nm.
  - Peptide bonds in the protein are sensitive to absorption at 220 nm.
  - Absorption at 220 nm is more reliable for detecting intact proteins.
6. Which of the following chromatography techniques is most appropriate for purifying a protein with a pI of 8.0, which has been equilibrated with a pH 6.5 buffer
- Anion exchange chromatography
  - Cation exchange chromatography
  - Hydrophobic interaction chromatography
  - None of the above
7. Which of the following biologics is banned for sports persons by anti-doping agencies:
- Insulin
  - Glucagon
  - Clotting Factor VIIa
  - Erythropoietin
8. Which of the following is employed for developing photonic biomimetic nanostructure
- Diatoms
  - Catfish
  - Escherichia coli*
  - Xanthomonas oryzae*
9. Glucose can either be stored in form of a polymer called glycogen or can be immediately broken down to give energy essential for survival of a cell. Which one of the following statements must be true for the cell to survive?
- Only glucose concentration, and not the affinities (for glucose) of molecules involved in the first steps of glycogen formation or energy production, determines the fate of glucose inside the cell
  - The molecule involved in the first step towards glycogen formation has a lower affinity for glucose compared to the molecule involved in the first step towards energy production.
  - The molecule involved in the first step towards glycogen formation has higher affinity for glucose compared to the molecule involved in the first step towards energy production.
  - The molecule involved in the first step towards glycogen formation has the same affinity for glucose compared to the molecule involved in the first step towards energy production.
10. Sultan and Aarfa had a biological child (i.e. not adopted) with a blood group of O-. Out of the two parents, only the father (Sultan) can be a blood donor for the child – i.e. Aarfa cannot be a blood donor for the child. Which of the following statements is the only one with the possibility of being true?
- Both Sultan and Aarfa have a blood group of O-.
  - Aarfa has either of the following blood groups: A+ or B+ or AB+ or O+
  - Aarfa has either of the following blood groups: A+ or A- or B+ or B- or AB+ or AB- or O+ or O-
  - None of the above.
11. From the information given in question number 10 and assuming no child was adopted, which of the following statements about the child's grandparents (total four – two paternal and two maternal) is the only one with the possibility of being true?
- Neither of the child's grandparents can have a blood group of AB.
  - Maximum one (out of four) of the child's grandparents can have a blood group of AB.
  - Maximum two (out of four) of the child's grandparents can have a blood group of AB.
  - All four of the child's grandparents can have a blood group of AB.

12. Active site residues of an enzyme are one His, one Asp and one Glu. The approximate pKa values for the ionisable groups of the above three amino acids, when they are free in solutions, are: Amino-termini – His = 9.0, Asp = 10.0, Glu = 9.5; Side-chains – His = 6.0, Asp = 3.9, Glu = 4.1; and, Carboxylic-termini – His = 1.8, Asp = 2.0, Glu = 2.1. If His needs to be protonated, and, Asp and Glu need to be in deprotonated form for the enzyme to be active, which of the following is closest to the pH at which maximum activity of the enzyme that can be achieved, assuming neither of the active site residues are at the N- or C- termini?  
A) 5.0    B) 6.0    C) 4.0    D) 3.0
13. Which of the following statements about the determination of the three-dimensional structure of proteins by X-ray crystallography is correct?  
A) The experiment is carried out in solution  
B) The experiment is performed to separate proteins  
C) The experiment calculates electron densities around the atoms of a protein  
D) The experiment involves directly imaging proteins
14. In order to infect a cell, a virus must  
A) inject its protein into the cell while the nucleic acid remains attached to the host cell surface.  
B) have a special protein on its surface that can interact with a protein on the surface of the host cell  
C) actively burrow through the cell wall or cell membrane of the host cell to reach the cell's nucleus.  
D) produce a special extension of its cytoplasm when it comes into contact with the appropriate host cell.
15. Histone acetylation can disrupt the interaction between adjacent nucleosomes  
A) because acetylated nucleosomes are targeted for degradation  
B) because it causes nucleosomes to release the DNA.  
C) because it prevents histone H1 from forming a bridge between histone H1 in two adjacent nucleosomes.  
D) because it prevents the N-terminal tail of histone H4 interacting with the H2A-H2B dimer in the next nucleosome.
16. The diffraction pattern of copper metal was measured with X-ray radiation of wavelength of 1.414 Å. The first order Bragg diffraction peak was found at an angle  $\theta$  of 45°. The d-spacing between the diffracting planes in the copper metal is  
A) 0.500 Å    B) 1.000 Å    C) 1.414 Å    (E) 2.828 Å
17. For an enzyme that follows Michaelis-Menten kinetics, by what factor does the substrate concentration have to increase to change the rate of reaction from 20% to 80%  
A) A factor of 2    B) A factor of 4    C) A factor of 8    D) A factor of 16
18. With a pure tubulin concentration of 1.4 mg/ml, microtubules grow at a rate of about 2  $\mu\text{m}/\text{min}$ . At this growth rate how many  $\alpha\beta$ -tubulin dimers (8nm in length) are added per second to the ends of a microtubule consisting of 13 protofilaments?  
A) 54    B) 12    C) 24    D) 26

19. The majority of the peptide bonds are trans in nature. Cis-peptide bonds occur rarely, but are favoured when one of the residues is -  
 A) Glycine      B) Proline      C) Any acidic amino acid      D) Any basic amino acid
20. The most effective immune response against *Mycobacterium tuberculosis* infection is expected to be -  
 A) B-cell mediated      B) T-cell mediated      C) Immunoglobulin mediated  
 D) Complement mediated
21. An enzyme can be irreversibly inhibited by binding iodoacetic acid. Which of the following residues is most probably present in the active site?  
 A) Serine      B) Glutamic acid      C) Lysine      D) Cysteine
22. A neuron receives signals from other neurons, processes it and responds with an all-or-none output. The Figure below represents. A good mathematical function  $f$ , shown in the right panel, that would represent this behaviour is:



- A)  $f(t) = \int_0^{\infty} w_i x_i dt$   
 B)  $f(x) = \int_0^{\infty} w_i x_i dx$   
 C)  $f(x) = \frac{1}{1+e^{-x}}$   
 D)  $f(x) = \frac{x}{x+e^{-x}}$

23. At a chemical synapse, one neuron releases neurotransmitter molecules into a small space (the synaptic cleft) that is adjacent to another neuron. These molecules then bind to receptors on the postsynaptic cell's side of the synaptic cleft. Finally, the neurotransmitters must be cleared from the synapse through one of several potential mechanisms including enzymatic degradation or re-uptake. If R is number of free receptors per cell, L is the ligand concentration and C is the number of receptor-ligand complex, and  $k_f$  and  $k_r$  are the rates of forward and reverse reactions, then the kinetic equation that best describes this mechanism is



- A)  $\frac{dC}{dt} = k_f RL - k_r C$       B)  $\frac{dC}{dt} = k_f RL - k_r CL$       C)  $\frac{dC}{dt} = k_f RL - k_r RC$       D)  $\frac{dC}{dt} = k_f RC - k_r L$

24. The equation of the straight line passing through (1, 2) and perpendicular to the line  $x + y + 7 = 0$  is  
 A)  $x + y - 1 = 0$       B)  $x - y - 1 = 0$       C)  $x - y - 3 = 0$       D)  $x + y - 2 = 0$

25. Three squares of chess board are selected at random. The probability of getting 2 squares of one colour and other of a different colour is

- A)  $\frac{3}{8}$       B)  $\frac{8}{21}$       C)  $\frac{21}{32}$       D)  $\frac{16}{21}$



**PhD Entrance exam, Kusuma School of Biological Sciences, 7<sup>th</sup> December 2016**  
**MCQ Answer Sheet**

NAME \_\_\_\_\_ Mobile No. \_\_\_\_\_

Choose your answer and fill-in the box completely

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D