Benha University
Faculty of Science
Physics Department

Model answer (621BPH)

Pre-Master Exam
23/5/2016
Biophysics

Answer only **Four** questions (Total 120 marks)

1- a) Explain the function of basic elements in the cycle of negative feedback control system . (10)
Sketch a block diagram showing the stages of a negative feedback and explain the role of each element in the function.

b) Prove that the control system to attain homeostasis, the system must return to the set point as long as $g\,\Delta t \leq \frac{\pi}{2}$. (10)
Consider a segment of the oscillatory behavior of a control system during its correction of an error with time and then apply the gain formula: "correction = -g.error "and continue derivation for a delay time "Δt" until reach the result .

c) A realistic control system uses a gain g =1 for correcting an error A = 2 in the set point of a controlled variable as shown in the table. Complete the table for the successive values of correction and sketch graphically the plot of A versus time of correction. Comment on the result. (10)

Error A	**2**								
Correction of A									

Use the gain formula " correction = -g.error " to calculate the correction and rest of error of each step in the table, then sketch the relation between error and time of correction.One can elucidate :oscillatory unchanged error ,the critical condition of negative feedback and homeostasis, the system must choose another gain to reach homeostasis.

2- a) Discuss the role of positive feedback process in generation and propagation of nerve signals**.** (10)
Draw the structure for a segment of an axon with different gated channels and explain the mechanism of initiation of an in pulse by electric field theory and explain the role of each gated channel in this propagation in the basis of positive feedback.

b) "The positive feedback is a vicious cycle mechanism" discuss this expression and give examples to show that positive feedback is sometimes useful. (10)
In a positive feedback system, the feedback is used to increase the size of the input. By nature, such systems are unstable, and they are most often associated with pathological conditions.

Usually positive feedback does not lead to stability of the system because it derives it in the same direction of error. This sometimes causes vicious circles and death. Then explain examples of child birth, blood clotting and propagation of nerve impulse.

c) Define what is meant by the space parameter of a nerve axon. (10)
A segment of nerve axon has: 1cm long, 6um diameter, 10nm membrane thickness,42.5 M Ω membrane resistance and 2 Ω cm axoplasm resistivity. Calculate;

i) Its space parameter.
ii) Number of membrane channels (the channel diameter = 4nm)

The space parameter "λ" is the distance over the length of an axon at which the axoplasm resistance is equal to the membrane resistance.
Use equations:

$$\lambda = \sqrt{\frac{rR_m}{2\rho}}, \qquad N_{ch} = \frac{R_{ch}}{R_M}$$

3- a) Give a brief account on the regulation of the body temperature and explain why during fever the body feel cold and shivering despite that it is too hot. (10)
Explain how the body temperature regulation happens by the feedback mechanisms of the nerves, then sketch block diagram showing that how the thermoregulatory center (Hypothalamus) sends impulses to several different effectors to adjust body temperature.
Draw schematically the relation between temperature change with time during fever and explain fever onset an fever termination.

b) Account on the general features of chemical communication and explain the spread of a single olfactory puff in still air. (10)
Account on the movement of molecules between slender and receiver through; current flow in air, diffusion and movement of receiver towards the signal. Show a snapshot of odorant concentration (C) versus distance from the source (r) at different times since emission (t).

c) A single puff spreads in air and water by common Q/K =1250 and diffusion constants for air and water are 0.25and o.000025 cm^2 /sec respectively. Compare between the parameters of active space in air and water. (10)
Use the following equations to solve the problem

$$r_{max} = 0.527\left(\frac{Q}{K}\right)^{\frac{1}{3}}$$

$$t_{r\,max} = \frac{0.046}{D}\left(\frac{Q}{K}\right)^{\frac{2}{3}}$$

$$t_{fadeout} = \frac{0.126}{D}\left(\frac{Q}{K}\right)^{\frac{2}{3}}$$

4-a) The function of the following:

- **Endoplasmic reticulum(ER):** which is a network, that manufactures, processes, and transports chemical compounds for use, inside and outside of the cell. It is connected to the nuclear envelope, providing a connection between the nucleus and the cytoplasm. It may be:

Smooth (ER), a system of membranes that involved in carbohydrate and lipid synthesis.

Rough (ER), a system of membranes that possesses ribosomes where proteins are synthesized.

Mitochondria: are in all cells (organism with visible nuclei), (50- 5000 mitochondria/cell). They are the main power generators, converting oxygen and nutrients into energy…….

Cytoskeleton: composed of filaments and microtubules, anchors the organelles and gives the cell its shape. They move the organelles within the cell and membrane imbedded proteins around where they are nedded.

b) The formation of the ATP molecules and account on the ATP hydrolysis. Its used in energetic reactions for temporary energy storage in the cell. Normally, ATP is formed from the combination of adenine with pentose sugar together with three phosphate groups.

$$ATP+H2O\leftrightarrow ADP+P+Energy$$

c) this statement is correct, equal one (1) when substituted by these values in the relation $(A+G)/(T+C)=1$

5-a) Define both hydrophilic and hydrophobic molecules, giving examples and discussing their function. Both them are found in cell membrane that surrounds the cells is rich in proteins and other lipids such as cholesterol.

Hydropholic: It is not dissolve in water and nature of the lipids dictates many of their uses in biological systems.

Hydrophilic: ends of these molecules face the water- filled environment inside the cells and the watery environment outside the cells.

b) basic building block of nucleic acids and hence sketch a diagram illustrates the DNA formation. nucleic acids chains in DNA is found in page 35 fig (17) and the DNA formation is made up of four nucleotides. Each nucleotide consists of a sugar(deoxyribose) bound on one side to a phosphate group and bound on the other side to a nitrogenous base fig.(18).

c) The formation of RNA molecules and hence differentiate between them and the DNA. Ribonucleic acid (RNA) is a long polymer of nucleotides found in the nucleus but mainly in cytoplasm of a cell.

differentiate between them and the DNA are in table (5) in page (41).

Good luck