1. Explain the following terms: (10%)
(1) transcytosis
(2) lipid raft
(3) Barr body
(4) RNA editing
(5) checkpoints of cell cycle

2. Lysosome is a comprehensive digestive organelle, and its function requires the efficient sorting and delivery of a large and diverse collection of hydrolytic enzymes. Lysosomal hydrolases are synthesized as enzymatically inactive, higher-molecular-weight precursors, called prohydrolases, and then processed into active hydrolases. Describe the biosynthesis pathway of lysosomal hydrolases from ER to lysosome. (10%)

3. The eukaryotic proteasome is a major cellular compartment for proteolysis. Abnormal and misfolded proteins are substrates of proteasomes, as are many normal, though short-lived proteins. What is the underlying mechanism for proteasome to degrade a wide variety of proteins? What are the roles of ATP in the proteasome-mediated degradation? (10%)

4. The first indications that protein phosphorylation might be an important regulator of enzyme activities emerged at a time when the regulatory roles of non-covalent interactions of various substances (substrates, co-factors, end products, etc.) were already well established. In particular, the allosteric influence of end products, interacting with regulatory subunits of multi-subunit enzymes, provides precise control over metabolic pathways made up of many steps. The regulation of the activation state of phosphorylase by 5'-AMP (positive) and glucose-6-phosphate (negative) is a pertinent example. Although neither of these metabolites takes part in the reaction catalyzed by phosphorylase, the presence of glucose-6-phosphate indicates metabolic sufficiency whereas 5'-AMP indicates hunger. Both can be described as allosteric effectors. Then it emerged that the addition of a single phosphate group to phosphorylase *b* also switches the enzyme between inactive and active states. Thus, in addition to allosteric influences, covalent modification by phosphorylation (and dephosphorylation) also affects enzyme activity. Although these two regulatory processes operate through similar conformational changes, phosphorylation is primarily a response to extracellular influences expressed through hormone receptors, while allosteric effectors allow the system to respond to intracellular conditions. Briefly explain this paragraph. (5%)

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5. Integrins are the main cellular receptors for the extra-cellular matrix, and are heterodimers of two transmembrane polypeptides called α and β chains. Integrins are also signal transduction receptors, relaying information about adhesive ligands to control cell growth and structure. Explain the signal transduction pathway mediated by integrin-matrix ligand interaction that modifies cellular adhesion, locomotion, and gene expression. (5%)

6. The eukaryotic plasma membrane is composed of a lipid bilayer and membrane proteins, and provides a barrier to diffusion of ions and polar molecules. However, integral proteins in the plasma membrane provide selective passages for larger molecules across membranes, and can be classified into three classes: pumps, carriers, and channels. Describe the distinct properties of these three classes of proteins in controlling membrane permeability. (10%)

7. A study, led by Ian Craig of King's College London, of 4,000 sets of British identical twins has been conducted to learn the differences between twins. In the study, researchers found that in some traits linked to intelligence, such as verbal skills and good social behavior, male twins were more alike than female twins. Please explain the observation. (10%)

8. Please describe what reactive oxygen species are, how they are produced and how cells respond to the presence of reactive oxygen species. (10%)

9. Please describe the structure and function of gap junction. (10%)

10. Please compare the two organelles; mitochondria and peroxisomes. (10%)

11. Please explain how directional transport of macromolecules can be achieved in the cells. (10%)