(1)

Q.P. Code: 53294

S.Y.B.Sc. Biotechnology Sem III Examination

Model Answers 2018-19

Biotechnology- Applied Chemistry

Total Marks: 75

Q 1 Do as directed (*Any fifteen*) **15**

1. Which of the following is an example of an addition reaction?

a. ethene to 1,2-dichloroethane b. 1-chloroethane to 1-bromoethane

c. 1-chloroethane to ethene

Ans. a. ethene to 1,2-dichloroethane

2. Which of the following is an essential element in the biological system?

a. Carbon b. Radium c. Helium

Ans. a. Carbon

3. Which of the following enzymes requires a co-enzyme?

a. amylase b. Kinase c. peptidase

Ans. b. Kinase

4. What is the oxygen binding protein in blood?

a. Myoglobin b. Hemoglobin c. Keratin

Ans. b. Hemoglobin

5. Which of the following is a reaction catalysed by peroxidase?

a. $H2O2 + AH2 \rightarrow 2H2O + A$ b. $2H2O2 \rightarrow H2O + O2$

c. $H2 + O2 \rightarrow H2O2$

Ans. a. $H2O2 + AH2 \rightarrow 2H2O + A$

6. The amount of starting material converted into product is determined by _____.

a. amount b. yield c. size

Ans. b. yield

7. When a site on the molecule is preferred for a reaction, it is known as____

a. chemoselectivity b. enantioselectivity c. regioselectivity

Ans. c. regioselectivity

8. A synthesis that involves condensation of products of previous reactions is called _____

a. linear synthesis b. convergent synthesis c. multicomponent synthesis

Ans. b. convergent synthesis

9. Microwaves passing through a sample lead to heating by _____

a. ionization b. collision c. light generation

Ans. b. collision

10. Ultrasounds in organic synthesis provide energy by _____

a. sun b. heat c. cavitation

Ans. c. cavitation

11. _____is an example of a polymer used as catalyst for synthesis reactions.

a. polyethylene glycol b. polyethene c. polyester

Ans. a. polyethylene glycol

12. In retrosynthesis, the steps of synthesis are determined by the structure of_____

a. reactant b. enzyme c. target molecule

Ans. c. target molecule

13. In multicomponent synthesis, there is always _____in entropy

a. increase b. decrease c. no change

Ans. b. decrease

14. Which of the following is a greenhouse gas?

a. oxygen b. nitrogen c. carbon dioxide

Ans. c. carbon dioxide

15. Prevention is better than _____

a. cure b. clean-up c. treatment

Ans. a. cure

16. Does a catalyst get consumed in a chemical reaction?

a. yes b. no c. sometimes

Ans. b. no

17. Products of green synthesis are _____

a. toxic b. biodegradable c. non-biodegradable

Ans. b. biodegradable

18. Glucose is an example of _____

a. green reactant b. green solvent c. enzyme

Ans. a. green reactant

19. Which of the following is a green solvent?

a. liquid Nitrogen b. liquid oxygen c. liquid carbon dioxide

Ans. c. liquid carbon dioxide

20. Which catalyst does not require protection and deprotection of functional group?

a. chemical catalyst b. biocatalyst c. water

Ans. b. biocatalyst

Q. 2 A What are substitution reactions? Explain the different types with a suitable example. 08

Ans. Substitution reaction is a chemical reaction during which one functional group in a chemical compound is replaced by another functional group.

Substitution reactions in organic chemistry are classified either as electrophilic or nucleophilic depending upon the reagent involved.

Nucleophilic substitution is a fundamental class of reactions in which a nucleophile selectively bonds with or attacks the positive or partially positive charge on an atom or a group of atoms. As it does so, it replaces a weaker nucleophile which then becomes a leaving group; The remaining positive or partially positive atom becomes an electrophile. The whole molecular entity of which the electrophile and the leaving group are part is usually called the **substrate**.

The most general form for the reaction may be given as where R-LG indicates the substrate.

Nuc: + R-LG → R-Nuc + LG:

Electrophiles are involved in **electrophilic substitution** reactions, particularly in electrophilic aromatic substitutions. Electrophilic aromatic substitution reactions are characteristic of aromatic compounds, and are important ways of introducing functional groups of benzene rings. In the SE1 course of action the substrate first ionizes into a carbanion and a positively charged organic residue. The carbanion then quickly recombines with the electrophile. The SE2 reaction mechanism has a single transition state in which the old bond and the newly formed bond are both present.

Q. 2 B Compare and contrast between haemoglobin and myoglobin. 07

Ans. Both are oxygen binding molecules

Both have heme – iron containing molecule that binds molecular oxygen

Hemoglobin	**Myoglobin**
Found in RBCs in blood	Found in muscle cells
Takes oxygen from lungs	Takes oxygen from blood
Has lower affinity for oxygen than myoglobin	Has higher affinity for oxygen than hemoglobin

OR

Q. 2 C Explain the role of metal ions in biological system. 08

Ans. Metal ions play important roles in the biological function of many enzymes. The various modes of metal-protein interaction include metal-, ligand-, and enzyme-bridge complexes. Metals can serve as electron donors or acceptors, Lewis acids or structural regulators. Those that participate directly in the catalytic mechanism usually exhibit anomalous physicochemical characteristics reflecting their entatic state. Carboxypeptidase A, liver alcohol dehydrogenase, aspartate transcarbamoylase and alkaline phosphatase exemplify the different roles of metals in metalloenzymes while the nucleotide polymerases point to the essential role of zinc in maintaining normal growth and development.

- an interaction between the substrate and the metal ion to form a complex that acts as the true substrate. Substrate-metal complexation can occur prior or subsequent to the formation of the enzyme-substrate complex. This type of behavior is typically observed with metal-activated enzymes.
-The second scheme indicates that the metal first binds to the protein and then serves as a site of interaction with substrate. In this instance, the metal can function either as a binding site, as a component of the catalytic apparatus of the enzyme or both. An example of both such possibilities is given by the role of zinc in carboxypeptidase A.

-A third scheme would have the metal acting at a site on the enzyme remote from the active site. In such instances, the metal could either serve to maintain protein structure and only influence catalytic

activity indirectly or else it could regulate activity by stabilizing more or less active conformations of the protein.

Q. 2 D Describe the significance of metal complexes in medicine. 07

Ans. Metals are found in complexes with biomolecules to serve various biological roles.
1. As co-factors to enzymes
2. As a part of hormones
3. As transfer proteins
Metal ions are important in maintaining isotonicity.
(An example of each)
Deficiency of metal thus causes disorders. (any two examples)

Q. 3 A What are the criteria for ideal synthesis of an organic compound? 08

Ans. I) Starting Material: Raw material should be low cost and readily available
II) Steps involved
III) Cost effectiveness
IV) By-products

Q. 3 B What are multicomponent reactions? Explain with suitable examples. 07

Ans. An organic synthesis involving more than two components in a reaction vessel is called multi-component synthesis
Decrease in entropy
Reaction associated with sufficiently negative change in entropy.
Two typical reactions: Mannich reaction and Biginelli Reaction. (any one to be explained)

OR

Q. 3 C Explain the process of microwave assisted organic synthesis. 08

Ans. Microwave region of electromagnetic spectrum lies between IR and radiofrequencies.
Corresponding to wavelengths of 1 cm to 1m.
Lead to generation of heat due to high frequency electromagnetic waves exerting a force on charged particles.
Two types of microwave heating are conduction and dielectric polarisation. (Definition of both)
Reaction carried out in Teflon or polystyrene vessels.
Choice of solvent – high boiling point, high dielectric constant.
Temperature of reaction.
Solid support used for reaction – Silica, alumina etc.

Q. 3 D Describe the role of polymer support in a synthesis reaction. 07

Ans. Polymer provides support for one of the reactants of the reaction
It makes the recovery of product easier
It allows recycling of reagents
Polymer should be inert, insoluble non-volatile and odourless
High yields are obtained
Eg. Of polymer support (any two)

Q. 4 A Explain green synthesis in the industry. 08

Ans. A) Green starting materials – commodity chemicals from glucose
b) Green reagents
c) Green solvents
d) Enzymatic catalysts
(Definitions and examples of each point)

Q. 4 B What is the need for development of green chemistry 07

Ans. I) Definiton of green chemistry
Need – Hazardous waste accumulation
Toxic by-products
Global warming & greenhouse gases
Limitation of fossil fuels

OR

Q. 4 C What are green reagents? Give suitable examples. 08

Ans. Biodegradable, non-toxic reactants
Products are also biodegradable
No toxic by-products generated during reaction.
(Explain one example in detail)

Q. 4 D What do you understand by green chemistry? What is its relevance in today's world. 07

Definition : utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and applications of chemical products.
Reagents, reactants, catalysts, solvent
Relevance – non-toxic, biodegradable, reusable etc.

Q. 5 Write Short notes on ***any three*** of the following **15**

a. Elimination Reactions

Ans. An elimination reaction is a type of organic reaction in which two substituents are removed from a molecule in either a one or two-step mechanism. The one-step mechanism is known as the E2 reaction, and the two-step mechanism is known as the E1 reaction.
In most organic elimination reactions, at least one hydrogen is lost to form the double bond: the unsaturation of the molecule increases.

An important class of elimination reactions is those involving alkyl halides, with good leaving groups, reacting with a Lewis base to form an alkene.

When the substrate is asymmetric, regioselectivity is determined by Zaitsev's rule or through Hofmann elimination if the carbon with the most substituted hydrogen is inaccessible.

E2 stands for **bimolecular elimination.** The reaction involves a one-step mechanism in which *carbon-hydrogen* and *carbon-halogen* bonds break to form a double bond (*C=C Pi bond*).

(Any one example)

E1 is a model to explain a particular type of chemical elimination reaction. E1 stands for **unimolecular elimination** and has the following specificities.

- It is a two-step process of elimination: *ionization and deprotonation.*
  - Ionization: the carbon-halogen bond breaks to give a carbocation intermediate.
  - Deprotonation of the carbocation.
- E1 typically takes place with tertiary alkyl halides, but is possible with some secondary alkyl halides.

(Any one example)

b. Linear Synthesis

Ans. Synthesis in which the product is obtained through a series of single step reactions.
Product of one reaction is reactant for the next reaction
Eg. Synthesis of p-bromoaniline (explain the steps)

c. Selectivity in organic synthesis

Ans. Efficiency of a reaction is measured in terms of selectivity- ration of desired product formed to the amount of desired product expected.
i) Chemoselectivity: When only particular functional group reacts in preference over other functional groupsin the reactant. (Give eg.)
ii) Regioselectivity: When a particular site of a reactant undergoes a reaction in preference to similar other sites. (Give eg)

d. Green materials

Ans. Components of a green reaction.
Commodity chemicals from glucose.
Minimize use of carcinogenic starting material

By-products of biochemical reactions used for synthesis of chemicals with the help of enzymes as catalysts.
Eg. Of glucose to adipic acid.

e. Principles of green chemistry

Ans. Prevent waste formation
Maximize incorporation of all materials in the process
Reduce toxicity
Preserve efficacy of function
Use of Auxiliary substances
Energy requirement should be minimized
Raw material is renewable and feedstock
Unnecessary derivatization should be avoided
Catalytic reagents are highly efficient
End products should be biodegradable
Analytical methodologies to be developed
Minimize chemical accidents