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Q.P. Code: 53293

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 a substitution reaction?

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

c. 1-chloroethane to ethene

Ans. b. 1-chloroethane to 1-bromoethane

2. Which of the following is a non-essential element in a biological system?

a. Uranium b. Magnesium c. Carbon

Ans. a. Uranium

3. Which of the following is not a co-enzyme?

a. Magnesium b. Iron c. Radium

Ans. c. Radium

4. What is the oxygen binding protein in muscles?

a. Haemoglobin b. Myoglobin c. Keratin

Ans. b. Myoglobin

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

a. $H_2O_2 + AH_2 \rightarrow 2H_2O + A$ b. $2H_2O_2 \rightarrow H_2O + O_2$

c. $H_2 + O_2 \rightarrow H_2O_2$

Ans. b. $2H_2O_2 \rightarrow H_2O + O_2$

6. Yield of a synthesis process is _____

a. amount of sample b. amount of sample converted to product

c. amount of sample converted to by-product

Ans. b. amount of sample converted to product

7. What is regioselectivity?

a. one functional group involved in reaction b. no functional group involved in reaction

c. one site involved in reaction

Ans. c. one site involved in reaction

8. A synthesis in which the product is through a series of single step reactions is called _____

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

Ans. a. linear synthesis

9. What is the inducer of the reaction in microwave assisted organic synthesis?

a. UV light b. visible light c. Microwaves

Ans. c. Microwaves

10. Energy for ultrasound assisted synthesis reaction comes from_____

a. bubble formation b. bubble collapse c. number of bubbles

Ans. b. bubble collapse

11. Which of the following is a polymer used as a catalyst in synthesis reactions?

a. polythene b. polystyrene c. polyester

Ans. b. polystyrene

12. Target molecule analysis is used in which synthetic process?

a. linear synthesis b. convergent synthesis c. retrosynthesis

Ans. c. retrosynthesis

13. What determines the feasibility of a multicomponent reaction?

a. change in entropy b. change in enthalpy c. change in temperature

Ans. b. change in enthalpy

14. What is an effect of release of CFCs in the atmosphere?

a. decrease in ozone b. increase in ozone c. decrease in CO

Ans. a. decrease in ozone

15. The amount of by-product generated in green synthesis is_____

a. less b. more c. not important

Ans. a. less

16. Which of the following reactions lead to generation of biodegradable end products?

a. organic synthesis b. green synthesis c. inorganic synthesis

Ans. b. green synthesis

17. Which of the following is not a green reactant?

a. Benzene b. Glucose c. Sugars

Ans. a. Benzene

18. Which of the following is a characteristic of green solvents?

a. colourless b. odourless c. non-toxic

Ans. c. non-toxic

19. Which of these is a biocatalyst?

a. enzymes b. water c. zinc

Ans. a. enzymes

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20. Baker's yeast is a catalyst for which of the following process?

a. enzyme production b. alcohol production c. benzene production

Ans. b. alcohol production

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

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)

Q. 2 B Explain the structure and function of Myoglobin. 07

Ans. Monomeric oxygen binding hemoprotein found in heart and skeletal muscle.
Single polypeptide attached to heme moiety
Heme contains protopyrphyrin IX with iron at its centre.
Protoporphyrin IX has four pyrrole rings to which four methyl, two propionyl and two vinyl groups are attached.
Functions as a reservoir for oxygen.
Promotes transport of oxygen to rapidly respiring muscle cells.
Has higher affinity for oxygen than haemoglobin.

OR

Q. 2 C What are the essential and non-essential elements in biological systems. Give their significance. 08

Ans. Essential elements are required for functioning of living systems.

Their deficiency or decreased concentration causes metabolic malfunctions.

They act as cofactors of enzymes - Mg, Zn, Cu

Stabilize membranes - Na

Affect membrane permeability - Ca

Signal transduction and cell to cell signalling- Ca, K

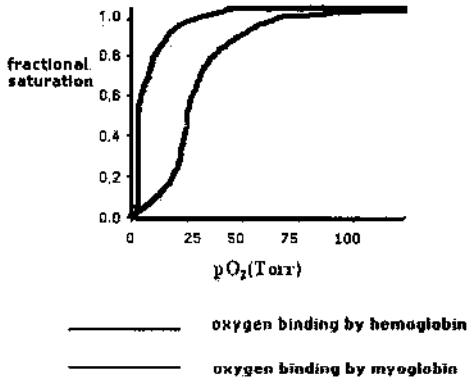
Non-essential elements are not required for functioning of living systems, or their function is not yet known

They tend to accumulate in biological systems as they cannot be used or removed and thus lead to toxicity

Eg. Lead, Arsenic, Tin Uranium etc

Q. 2 D What is dioxygen binding? Explain with suitable diagrams and examples. 07

Ans. Represents cooperative binding of oxygen to haemoglobin.
Sigmoidal Shape curve.
Binding of oxygen to one heme group increases the binding of oxygen to other hemes. Thus affinity of haemoglobin for the last oxygen is 100 times greater than the binding to the first oxygen to haemoglobin.
Similarly release of oxygen from one heme facilitates release of oxygen from others



Q. 3 A Explain selectivity and yield during ideal synthesis of an organic compound. 08

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)
Yield: The amount of starting material converted to product is defined as yield of a reaction.

Percentage yield = $\frac{Actual\ (practical) yield\ of\ the\ product}{Expected\ (theoretical) yield\ of\ the\ product}$ X 100

Theoretical yield = $\frac{Mol.Wt. of\ product}{Mol.Wt. of\ reactant}$ X Wt. of reactant used

Q. 3 B What is convergent synthesis? Explain with a suitable example. 07

Ans. The final product is obtained as a result of reaction between compouns obtained separately from two different routes.
A+B+....→ P
C +D +....→ Q
P + Q → final product
One example discussed in detail

OR

Q. 3 C Explain the use of ultrasound in organic synthesis? 08

Ans. Ultrasound are sound waves having frequencies higher than those to which the human ear can respond.
Lies between 5 MHz to 500 MHz
Requires an ultrasonic transducer
Types of sonochemistry reactions: 1. Homogenous Reactions – water is sonicated, cavitation induces homolytic cleavage of water.
2. Heterogenous Liquid-liquid reaction – ultrasound waves generate extremely fine emulsions resulting in large interfacial contact

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3. Heterogenous Solid-Liquid Reaction
Synthetic applications: 1. Esterification
2. Saponification
3. Hydrolysis
4. Substitution
5. Addition reaction
(Briefly explain each type)

Q. 3 D Describe the process of retrosynthesis. 07
Ans. Developing a synthetic protocol by deconstruction of the target molecule.
From the structure of the target molecule the starting material is elucidated
A feasible synthetic pathway is then developed to generate the target molecule from the reactants
Explain one example is detail.

Q. 4 A Explain the principles of green chemistry. 08
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

Q. 4 B What is green synthesis? Explain the steps. 07
Ans.A) Green starting materials – commodity chemicals from glucose
b) Green reagents
c) Green solvents
d) Enzymatic catalysts
(Definitions and examples of each point)

OR

Q. 4 C What are green materials? Give suitable examples. 08
Ans. Definition
Reagents, reactants, catalysts, solvent
Examples of each

Q. 4 D What is the significance 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

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

Ans. An **addition reaction**, is reaction where two or more molecules combine to form a larger one (the adduct).

Addition reactions are limited to chemical compounds that have multiple bonds, such as molecules with carbon–carbon double bonds (alkenes), or with triple bonds (alkynes). Molecules containing carbon—hetero double bonds like carbonyl (C=O) groups, or imine (C=N) groups, can undergo addition, as they too have double-bond character.

There are two main types of polar addition reactions: electrophilic addition and nucleophilic addition.

An **electrophilic addition** reaction is an addition reaction where, in a chemical compound, a π bond is broken and two new σ bonds are formed. The substrate of an electrophilic addition reaction must have a double bond or triple bond.

The driving force for this reaction is the formation of an electrophile X^+ that forms a covalent bond with an electron-rich unsaturated C=C bond. The positive charge on X is transferred to the carbon-carbon bond, forming a carbocation during the formation of the C-X bond. *Any one example*

A **nucleophilic addition** reaction is an addition reaction where a chemical compound with an electron-deficient or electrophilic double or triple bond, a π bond, reacts with electron-rich reactant, termed a nucleophile, with disappearance of the double bond and creation of two new single, or σ, bonds. The reactions are involved in the biological synthesis of compounds in the metabolism of every living organism, and are used by chemists in academia and industries such as pharmaceuticals to prepare most new complex organic chemicals, and so are central to organic chemistry. Addition reactions require the presence of groups with multiple bonds in the electrophile: carbon–hetero-atom-multiple bonds as in carbonyls, imines, and nitriles, or carbon–carbon double or triple bonds. *Any one example*

b. Metalloenzymes

Ans. Enzymes using metals as cofactors. Three types

- 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.

c. Multicomponent reaction in synthesis

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)

d. Green solvents

Ans. Supercritical carbon dioxide and water

Regular solvents like chlorinated hydrocarbons cause environmental hazards.

Green solvents are eco-friendly and benign.

Liquid carbon dioxide at 31 degrees C and 73 atm.- non-toxic, non-flammable, renewable and inexpensive.

Used in polymerization, essential oil production, coffee decaffeination and waste recycling

e. Applications of green chemistry

Ans. Synthesis of nitroanilines

Synthesis of halobenzoic acid

Synthesis of alcohols

Synthesis of alkanes

(one reaction each)