Biomolecules

(Some Important Problem of NCERT)

Q. 1. What are the two stages of photosynthesis in a green plant? Give the basic equation of photosynthesis.

Ans. The photosynthesis in plants occur in two stages *i.e.,*

(*i*) Light reactions. Which occur only in presence of light, and

(*ii*) Dark reaction. Which occur in dark because they do not depend on light energy.

During photosynthesis green plants absorb energy from the sun to makes glucose and oxygen from CO_2 and H_2O.

$$\mathbf{6CO_2 + 6H_2O + 2800\ kJ \xrightarrow{Sunlight\ /\ Chlorophyll} C_6H_{12}O_6 + 6O_2}$$

In *light reaction* solar radiation in absorbed by the pigment chlorophyll and is used to synthesize energy rich molecule ATP and liberate oxygen.

In *dark reactions* the energy rich molecules convert atmospheric CO_2 into glucose and storage molecules such as starch.

The above process can thus be represented as

Light reactions: $H_2O + CO_2 \xrightarrow{-hv\ /\ Chlorophyll}$ organic molecule + heat + ATP + O_2

Dark reaction: $6CO_2 + 6H_2O \xrightarrow{-ATP} C_6H_{12}O_6 + 6O_2$

The synthesis of each molecule of glucose consumes 187 molecules of ATP.

Q. 2. What are reducing and non-reducing sugars? What is the structural features characterizing reducing sugars?

Ans. **Carbohydrates.** Maltose, cellulose, Glucose

Hormones. Insulin, Adrenaline, Estrone

Vitamins. Reboflavin, Thiamine.

Those sugars which reduce *Fehling's solution* and Tollen's reagent are called *reducing sugars* and those which do not reduce these are called ***non- reducing sugars.***

In *reducing sugars,* free *aldehydic* and *ketonic gropes* are present but in non – reducing sugars these free aldehydic or ketonic groups are not present.

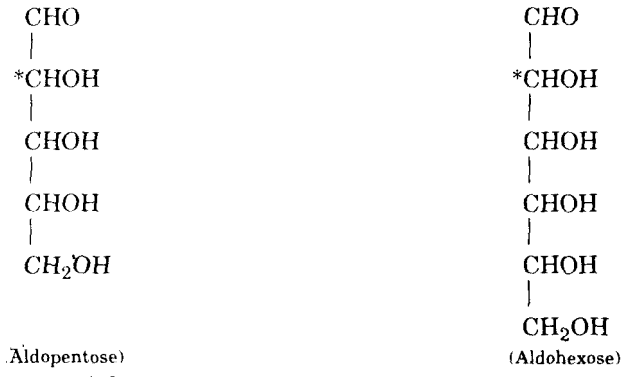
Examples. Reducing sugars : glucose, fructose, galactose

Non – reducing sugatrs : Maltose, lactose, sucrose.

Q. 3. Draw open chin structure of aldopentose and aldohexose. How many asymmetric

carbons are present in each?

Ans.



In each of these **one** asymmetric carbon is present.

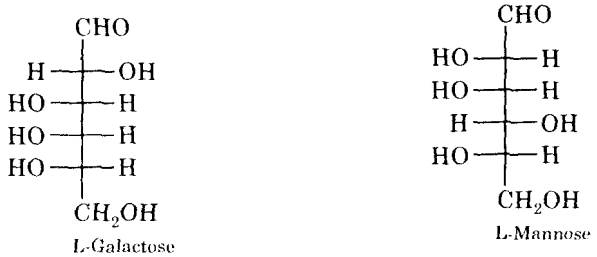
Q. 4. Draw simple Fischer projections of D – and L – glucose. Are these enantiomers?

Ans.

Yes, these are *enantiomers.*

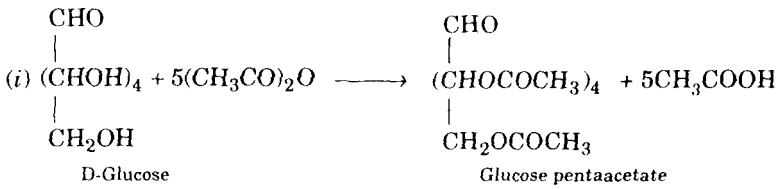
Q. 5. Draw Fisher projections of L – galactose and L – mannose.

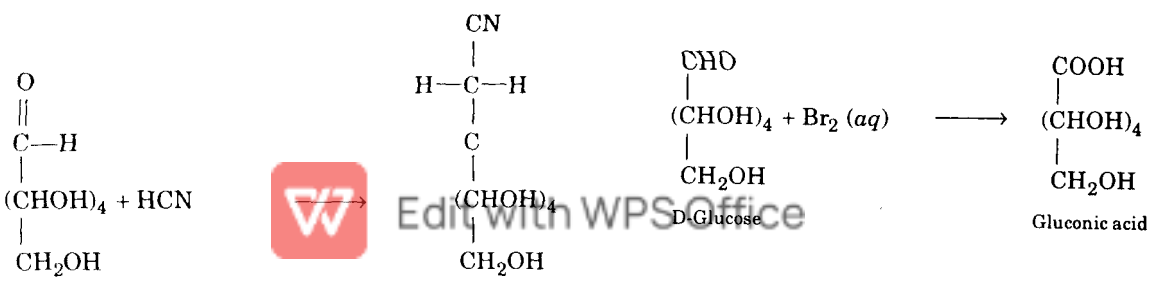
Ans.



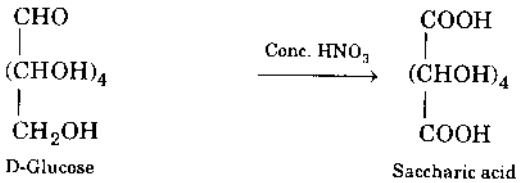
Q. 6. Write down the structures and names of the products obtained when D – glucose is treated with **(i)** acetic anhydride **(ii)** hydrocyanic acid **(iii)** bromine **(iv)** conc. HNO_3 and **(v)** HI

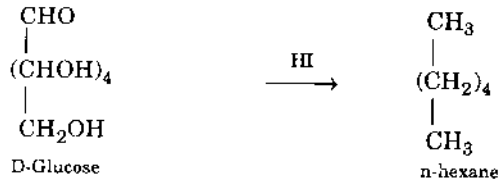
Ans. **(i)**





(ii) (iii) *Chemistry NCERT Problems- XII*

(iv) 

(v) 

Q. 7. Enumerate the reactions of glucose, which can not be explained by its open chain structure.

Ans. The open chain structure of glucose can not explain the following reactions.

(*i*) Though it contains a –CHO group yet it fails to give schiff's test. It also fails to react with $NaHSO_3$ and ammonia.

(*ii*) The penta – acetate of glucose does not react with hydroxylamine which indicates the absence of free – CHO group in it.

Q. 8. Explain mutarotation. Give its mechanism in case of D – glucose.

Ans. **Muta – rotation. D – (+)** glucose exists in two anomeric forms (i.e., α – D (+) glucopyrose and
β – D (+) glucopyrose). When these are separately dissolved in water, they undergoes change in specific rotation till it becomes constant after some time. **The change in specific rotatio**

$$\underset{[\alpha]_D^t = +112^\circ}{\alpha\text{-D(+) glucose}} \rightleftharpoons \underset{[\alpha]_D^t = +52.7^\circ}{\text{Equilibrium}} \rightleftharpoons \underset{[\alpha]_D^t = +19^\circ.}{\beta\text{-D(+) glucose}}$$

ation.

Q. 9. Amylose and cellulose are both straight chain polysaccharides containing only D – glucose units. What is the structural difference between the two?

Ans. The structural difference between the two is that the D – glucose units in case of amylose is joined by α – link and in case of cellulose by β – link.

In amylose α – glycosidic linkage is between C – 1 of one glucose and C – 4 of next glucose.

Q. 10. What are essential and nonessential amino acids? Give two examples of each.Give reason for the following.

(i) Amino acids have relatively higher melting point as compared to corresponding halo acids.

(ii) Amino acids are amphoteric in behaviour.

(iii) On electrolysis in acidic solution amino acids migrate towards cathode while in alkaline solution these migrate towards anode.

(iv) The monoamino monocarboxylic acids have two pK values.

Ans. **Essential Amino acids** are those amino acids which are not synthesized by our body. They must be part of our diet e.g., *valine*, *Leucine*, *Isoleucine*, *phenylalanine*.

Non – essential Amino acids are those amino acids which are produced in our body *e.g., glycine*, *alanine*, *serine*, *crysteine*.

(i) Amino acids are more polar than haloacids and they form internal salts due to which they have high m.p.

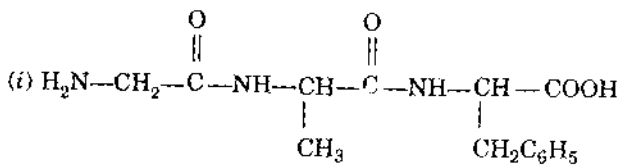
(ii) Amino acids have $-NH_2$ group (basic) and $-COOH$ group (acidic) so they are amphotetic in nature.

(iii) In acidic solutions amino acids form $H_3\overset{+}{N}-\underset{R}{\underset{|}{CH}}COOH$ which are attracted towards cathode where as in basic solution they form $H_2N-\underset{R}{\underset{|}{CH}}COO$ which is attracted towards anode.

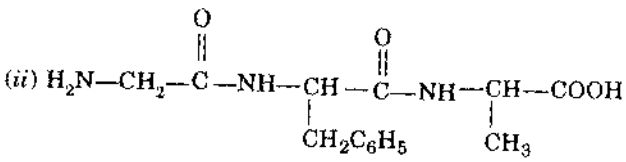
(iv) The monoamino monocarboxylic acids have two dissociation because they exist in two forms.

Q. 11. If three amino acids viz., glycine, alanine and phenylalanine react together, how many possible tripeptides can be formed? Write down the structures and names of each one. Also write their names using three and one letter abbreviations for each amino acid.

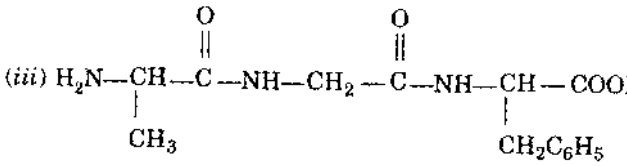
Ans. In all six triplets are formed.



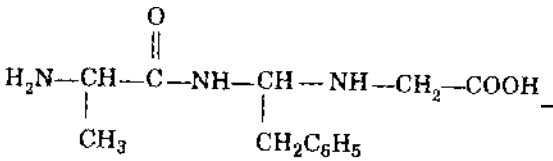
Glycine–Alanine–Phenylalanine
Gly-Ala-Phe.



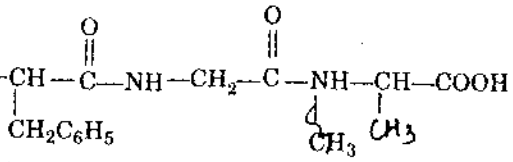
Glycine–Phenylalanine–Alanine
Gly-Phe-Ala



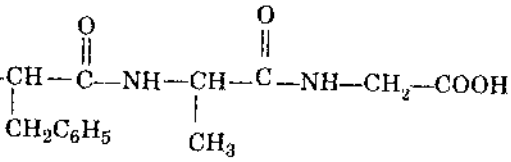
Alanine–Glycine–Phenylalanine
Ala-Gly-Phe



Alanine–Phenylalanine–Glycine
Ala-Phe-Gly

(v) 

Phenylalanine–Glycine–Alanine
Phe-Gly-Ala

(vi) 

Phenylalanine–Alanine–Glycine
Phe–Ala–Gly

Q. 12. What type of linkages are responsible for the formation of,

(i) Primary structure of proteins

(ii) Cross linking of polypeptide chians

(iii) α – Helix formation

(iv) β – Sheet structure

Ans. **(i)** Peptide bonds

(ii) Internal hydrogen bonds

(iii) All possible hydrogen bonds

(iv) Inter molecular hydrogen bonds.

Q. 13. Which forces are responsible for the stability of α – helix? Why is it named as 3.6_{13} helix?

Ans. The forces responsible for the stability of α – helix are *hydrogen bonds* between –NH and –C = O groups of peptide bonds. The structure having maximum hydrogen bonds shall be favoured.

α – helix is one of the most common ways in which a polypoptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix) with –NH group of each amino acid residue hydrogen bonded to –C = O of an adjacent turn of the helix. The tendency of polar group is to remain at the exterior of the molecule so as to form hydrogen bonds with water molecules.

The α – helix is known as 3.6_{13} helix since each turn of the helix has approximately 3.6 amino acids and a 13 member ring is formed by hydrogen bonding.

Q. 14. What is denaturation and renaturation of proteins?

Ans. **Denaturation of Proteins.** It involves reversible or irreversible precipitation of proteins. The complex three dimensional structure of proteins changes by change in pH, temperature, presence of salts or certain chemical compounds. Denaturation does not change primary structure but changes secondary and tertiary structures of proteins e.g., coagulation of albumin present in white part of egg when egg is boiled. On denaturation, the protein loses its biological property.

Renaturation of Proteins. In some cases it has beeen found that if disruptive agent is

removed the protein recovers its original physical and chemical properties and biological activity. This process is reverse of denaturation and called renaturation.

Q.15. Define enzymes. How do enzymes differ from ordinary chemical catalysts? Comment on the specificity of enzyme action. What is the most important reasons for their specificity?

Ans. **Enzymes.** These are essential *biological catalysts* which are required to catalyse *biological reaction e.g., maltase, amylase, lactase, invertase* etc. Most of the enzymes are protein molecules but some may be non – proteins.

The enzyme facilitates a biochemical reaction by providing alternative lower activation energy path and in this way they increase the rate of reaction.

Enzymes differ from ordinary catalysts in following ways:

(i) They are highly specific in their action on substrates

(ii) They are active at moderate temperature

(iii) They work at specific pH

(iv) They are produced in human body itself and are present inside human body (proteinous or non þ proteinous) where as ordinary catalysts are generally metals.

The most important reason for their specificity is that is *binds to the substrate in a specific manner.*

The enzymatic reaction proceed through the following stages:

(i) The formation of complex between enzyme and substrate (ES)

(ii) The conversion of the complex (ES) to an enzyme intermediate complex (EI)

(iii) The conversion of EI to a complex between enzyme and product (EP)

(iv) The dissociation of EP, leaving the enzyme unchanged.

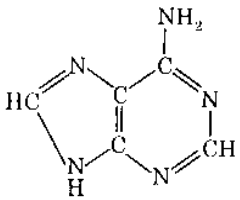
Q.16. What are the products obtained on complete hydrolysis of DNA? Write down the structure of pyrimidine and purine bases present in DNA.

Ans. On complete hydrolysis DNA yields a pentose sugar i.e., β – D – *deoxyribose,* two types of heterocyclic nitrogenous bases such as *purines* and *pyrimidines* alongwith *phosphoric acid*.

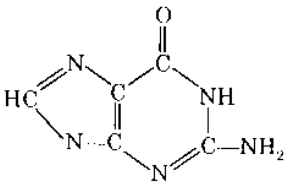
The Purine bases are : *Adenine (*A*), Guanine (*G*)*. The pyrimidine bases are:

Thymine (T), Cytosine (C). Their structures are:

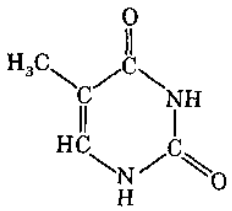
Adenine (A)



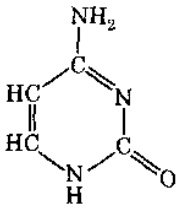
Gaunine (G)



Thymine (T)



Cytosine (C)



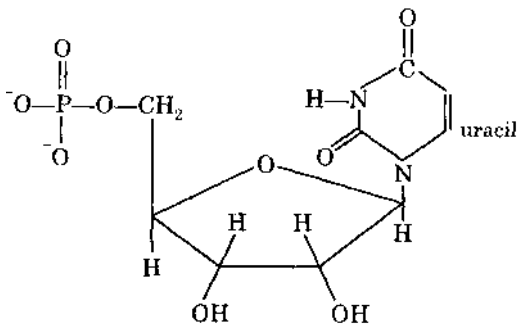
Q. 17. Enumerate the structural differences between DNA and RNA. Write down the structures of nucleoside, which is present only in RNA.

Ans. There are two main structural difference between DNA and RNA. These are:

(i) DNA has deoxyribose where as RNA has ribose sugar

(ii) DNA contaisn thymine (T) where as RNA contains uracil (U) instead of thiamine.

Nucleoside. The N – glycosides of purine or pyrimidine bases with pentose sugars are known as nucleosides.



The nucleoside, *uridine* is present only in RNA. Its structure is

Q. 18. What are complementary bases? Draw structure to show hydrogen bonding between adenine and thymine and between guanine and cytosine.

Ans. Complementary base pairs in **DNA** are

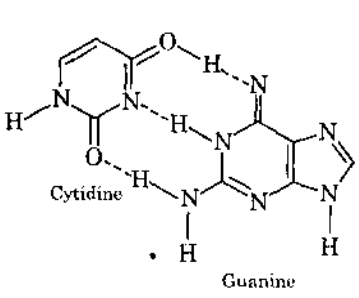
(i) A = T **(ii)** T = A **(iii)** C ≡ G and **(iv)** G ≡ C.

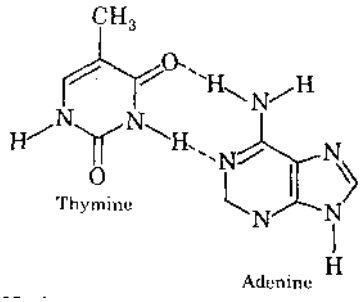
Complementary base pairs in **RNA** are

(i) A = U **(ii)** U = A **(iii)** C ≡ G and G ≡ C

The hydrogen bonding between two strands is highly specific. **T** and **A** pair up *through two hydrogen bonds* and C and G pair up through *three hydrogen bonds.* These bases are called supplementary bases.

The structures showing hydrogen bonding are:





Hydrogen bonds are formed between complementary base pairs.

Q. 19 What is the melting temperature (*Tm*) of DNA? A DNA molecule with more number of GC base pairs than AT base pairs has higher. Tm than the one with lesser number of GC base pairs than AT base pairs. Explain why?

Ans. The temperature at which two strands of **DNA** get separated is called its **melting temperature.**

Since **G ≡ C** pairs has *three hydrogen bonds* where as **A = T** pair has *two hydrogen bonds* because of this there is strong bonding and so higher melting temperature of DNA with more number of
G ≡ C pairs than A = T base pairs as compared to one with lesser number of G ≡ C base pairs than A = T base pairs.

Q. 20 When RNA is hydrolyzed there is no relationship among the quantities of four bases obtained unlike DNA. What does this fact indicate about the structure of RNA?

Ans. On complete hydrolysis **RNA** yields, a pentose sugar (*i.e.* D – ribose) and heterocyclic nitrogeneous bases such as purines (Adenine and guanine) and pyramidine bases (uracil and cytosine) and phosphoric acid.

There is no inter – relationship between the quantities of four base obtained by hydrolysis of RNA *because RNA has a single helix structure*.

Q. 21 How does DNA replicate? Give the mechanism of replication. How is the process responsible for preservation of heredity?

Ans. In the DNA double helix, the sequence of base in one chain is complementary to the sequence in the other chin, therefore one controls the other.

At the time of cell division two strands of DNA double helix partly unwind and each serve as a template for the synthesis of a new DNA molecule. DNA replication follows the base pairing rules by which A pairs with T and G pairs with C.

Due to this each daughter molecule is an exact replication of the parent molecule. The DNA replication is semi – conservative i.e., only half of the parent DNA is conserved and only one strand is synthesized. DNA replication takes place only in S' – 3' direction.

Q. 22 Genetic code is degenerate. Comment.

Ans. The note worthy features of *genetic code* are:

(i) It is universal.

(ii) It is *degenerate i.e.,* more than one codons code for an amino acid.

(iii) It is commaless.

(iv) The third base of the codon is less specific.

There is a single code for all living organisms. This is a strong indication that life started on earth about 3 billion years ago and *only once the genetic code established* has remained unchanged since then.

Q. 23. Answer the following about protein synthesis,

(i) Name the location where protein synthesis occurs.

(ii) How do 64 codons code for only 20 amino acids?

(iii) During translation which one of the two – end functional groups of the polypeptide is formed first?

(iv) Which of the of the two bases of the codon are most important for coding, the first two or last two?

Ans. **(i)** It occurs at the *ribosome in cytoplasm.*

(ii) Since protein molecule can yontain a maximum of 20 different types of amino acids, it is like a large sentence written in a language of 20 letters, but the hereditary message is written in a language of only 4 letters; it is written in a code with each word of three letters (triplet ; codon) standing for a particular amino acid.

This is true since there are only sixteen different doublets of four nucleotides (4^2) but there are 64 triplets (4^3). More than one **codon** can code for same amino acid *e.g.,* CUU and CUC both can code *leucine*. Proline is encoded by CCU, GCA, CCG and CCC.

(iii) N – terminal is formed first i.e., –NH group is formed first.

(iv) First two bases of codon are most important for coding.

Q. 24 How are lipids classified? Give an example of each class.

Ans. On the basis of their composition lipids are classified as

(*i*) Simple lipids or glycerides. This is the most abundant group of lipids in plants and animals. These lipids are trimesters of glycerol with long chain fatty acids. These trimesters are known as glycerides.

These include **fats** and **waxes.**

Fats are trimesters of glycerol.

Waxes are esters of alcohol other than glycerol e.g., Beewax (Mericyl palmitate).

(*ii*) Complex lipids. Those lipids which yield fatty acids, alcohols and other compounds on hydrolysis are called **complex lipids.** They include **phospholipids** and **Glycolipids.**

Phospholipids. These contain additional group e.g., a phosphoric acid, nitrogen containing bases and other substituents.

They for structure of cell membrane. **Glycolipids** are esters of fatty acids with carbohydrates and many contain nitrogen but they do not contain phosphorus.

(iv) Derived lipids. These are derived from simple lipids and compounds lipids by hydrolysis. They include *fatty acids*, *fatty alcohols*, *mono* – and *di* – *glycrides*, *steroids*, *terpenes* and *carotenoids*. These are some times present as waste products of metabolism.

Glycerides and cholesterol esters are also called **neutral lipids** since they do not carry any charge.

Q. 25 An unsaturated fatty acid having formula $C_{17}H_{33}COOH$ has a double bond at C – 9. Amongst two stereoisomers of the acids i.e. cis and trans, which do you expect to have higher m.p.? Explain why?

Ans. Trans – stereo isomer will have a higher melting point because it can fit into the crystal lattice more readily than a cis – form.

Q. 26. 'Hormones are chemical messengers'. Explain.

Ans. **Hormone** is a secretion of ductless gland. They transfer the informations from one group of cells to distant tissues or organs. Hormones are delivered directly to the blood stream and are carried to various target organs and so generally their site of action is away from their origin. Hormones control metabolic activities. They are required only in trace amounts and are highly specific in their action.

Q. 27 Comment briefly on the chemical nature of insulin and its physiological activity.

Ans. **Insulin.** It is a protein in which 51 (21 and 30) amino acids are arranged in two polypeptide chains which are cross – linked at two places by disulphide bonds.

Insulin has profound influence on carbohydrate metabolism. It facilitates entry of glucose and other sugars into cells, by increasing penetration o cell membranes and augmenting phosphorylation of glucose. This results in decreases in glucose concentration in blood and so insulin is called *hypoglycermic factor*. It promotes anabolic processes and inhibits catabolic activities. Its deficiency in human beings causes *diabetes melitius*.

Q. 28. Define and classify vitamins. Give at least two examples of each type.

Ans. **Vitamins.** The organic compounds (other than carbohydrates, proteins, fats or a group of biomolecules) which are essential for maintaining a normal health, growth and nutrition are called **vitamins.**

They are required only in minute quantities and their absence causes speicific deficiency diseases.

Classification of vitamins:

(i) Water insoluble vitamins. These are vitamins A, D, E and K. These are **fat soluble vitamins.**

(ii) Water soluble vitamins. These are vitamins B complex (B_1, B_2, B_5 or nicotinic acid, B_6, B_{12}, pentothenic acid, biotin or vitamin H and folic acid) and vitamin C.

Note: Vitamin H (i.e., biotin) is neither soluble in fat nor in water.

Q. 29 Name the deficiency diseases caused due to lack of vitamin A, C, E, B_1, B_{12}, B_6 and K.

Ans.

	Vitamin	*Deficiency Disease*
1.	A	Xerophthalmia i.e., hardening of cones of eye
2.	C	Scruvy
3.	E	Sterility
4.	B_1	Beri – Beri
5.	B_{12}	Pernicious anaemia
6.	B_6	Dermatitis, convulsions
7.	K	Hemmorrhagic conditions.