NCERT Solutions for Class 12 Biology Chapter 11 Biotechnology Principles and Processes

Q1. Can you list 10 recombinant proteins which are used in medical practice? Find out where they are used as therapeutics (use the internet).

Answer:

Recombinant proteins are proteins produced as a result of recombinant DNA technology. In this technology, there is the transfer of some specific gene from one organism to another by using molecular tools such as biological vectors, restriction enzymes etc. Some of the proteins produced through RDT and are being used for therapeutic uses are as follows:

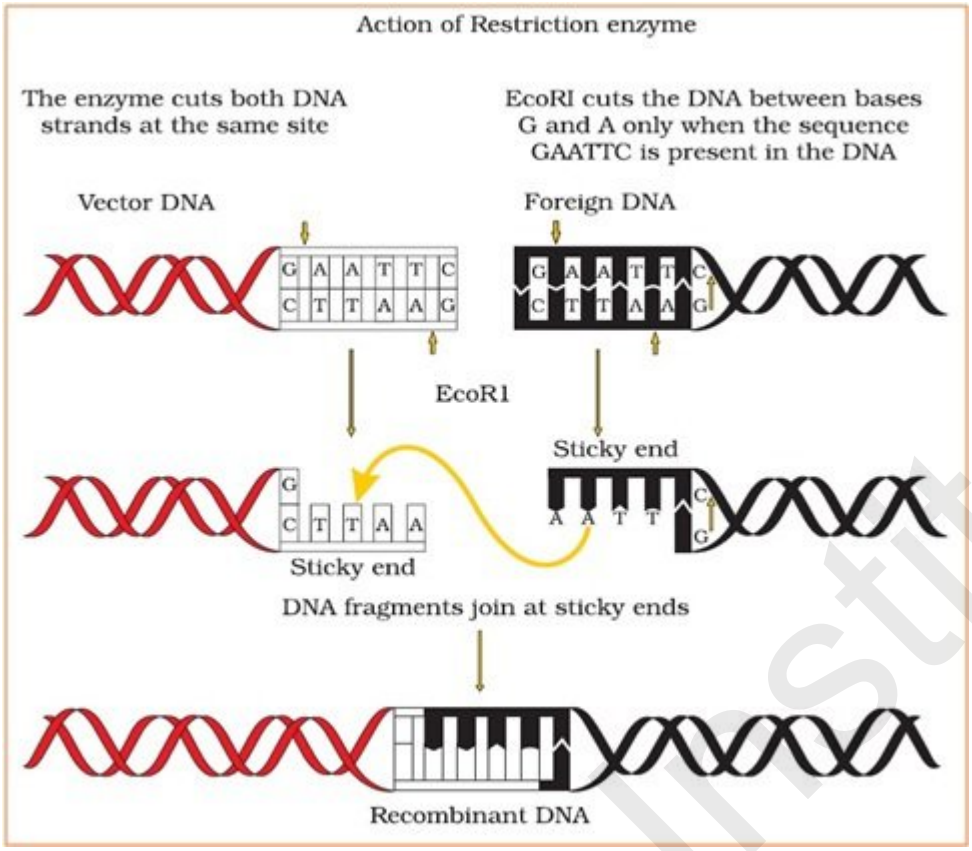
S.No	Name of the recombinant protein	Therapeutic use of the recombinant protein
1.	DNAase I	To treat cystic fibrosis
2.	Antithrombin III	To prevent the formation of the blood clot
3.	Insulin	To treat type I diabetes mellitus
4.	Interferon α	Used for chronic hepatitis C

5.	Interferon AZA	Used for herpes and virus enteritis
6.	Coagulation factor VIII	To treat haemophilia A
7.	Coagulation factor IX	To treat haemophilia B
8.	Interferon B	To treat multiple sclerosis
9.	Human growth hormone recombinant	To promote growth in humans
10.	Tissue plasminogen activator	To treat the myocardial infection

Q2. Make a chart (with diagrammatic representation) showing a restriction enzyme, the substrate DNA on which it acts, the site at which it cuts DNA and the product it produce

Answer:

The following chart shows the action of the restriction enzyme EcoRI, the substrate DNA on which it acts and the site where it cuts



Q4. What would be the molar concentration of human DNA in a human cell? Consult your teacher.

Answer:

The molar concentration of DNA in a human cell will be total no. of chromosomes multiplied by 6.023×10^{23}

Hence, the molar concentration DNA in each diploid cell in humans is $46 \times 6.023 \times 10^{23} = 2.77 \times 10^{23}$ moles

Q5. Do eukaryotic cells have restriction endonucleases? Justify your answer.

Answer:

No, eukaryotic cells do not possess restriction enzymes. All the restriction endonucleases have been developed and isolated from different strains of bacteria. The bacteria possess these restriction endonucleases as a defence mechanism to restrict the growth of viruses. Their own DNA remain safe from these enzymes because it is methylated. The eukaryotic cell has RNA interference as a defence mechanism against foreign DNA. Thus, eukaryotic cells do not have restriction endonucleases.

Q6. Besides better aeration and mixing properties, what other advantages do stirred tank bioreactors have over shake flasks?

Answer:

The advantages of stirred tank bioreactors over shake flasks are as follows:

1. Stirred tank bioreactors are utilised for large-scale production of biotechnological products, unlike the shake flask method which is used for small-scale production of products.

2. In stirred tank bioreactors, a small sample can be taken out for testing.

3. Stirred tank bioreactors have foam breakers to control the foam.

4. Stirred tank bioreactors have temperature and pH control systems.

Q7. Collect 5 examples of palindromic DNA sequences by consulting your teacher. Better try to create a palindromic sequence by following base-pair rule

Answer:

Palindromic sequences in the DNA molecule refer to groups of bases forming the same sequence when read either backwardly or forwardly. The recognition sites of restriction

endonucleases are palindromic sequences. Five examples of palindromic DN sequences are given below

1. ACTAGT/TGATCA

2. AAGCTT/TTCGAA

3. GGATCC/CCTAGG

4. AGGCCT/TCCGGA

5. ACGCGT/TGCGCA

Q8. Can you recall meiosis and indicate at what stage a recombinant DNA is made?

Answer:

In meiosis, during the pachytene stage of Prophase I, crossing-over takes place and recombinant DNA is formed by combining portions of male and female DNA.

Q9. Can you think and answer how a reporter enzyme can be used to monitor transformation of host cells by foreign DNA in addition to a selectable marker?

Answer:

In recombinant DNA technology selection of transformed and non transformed cells can be done using reporter genes that encode for reporter enzymes. During the RDT experiment, the foreign gene is joined with a reporter gene. The reporter gene should be such that it produces a visible expression. For example, Lac Z gene which codes for enzyme beta-galactosidase is used as a reporter gene. The activity of this gene is not found in transformed cells as the product formed by its catalysation is not formed in

transformed cells and bacterial colonies appear white. In non-transformed cells, this gene shows its activity and the catalysed product is formed, as a result of this, bacterial colonies appear blue. Thus, reporter enzyme can be used to monitor the transformation of host cells by foreign DNA in addition to a selectable marker.

Q10. Describe briefly the following: (a) Origin of replication

Answer:

Origin of replication- This refers to the DNA sequence, from where replication of DNA starts. By linking a DNA sequence with the origin of replication, it can be allowed to replicate in the host cells. Origin of replication also controls the copy number of linked DNA sequence.

(b) Bioreactor

Answer:

Bioreactors - These are large vessels (100-1000 litres) that are used for large-scale production of biotechnological products such as proteins, enzymes etc. from raw materials. In a bioreactor, optimum conditions such as temperature, pH, vitamins, oxygen, salts etc. are maintained. Stirred bioreactors are the most commonly used bioreactors. Stirred bioreactors can be simple stirred tank bioreactors or sparged tank bioreactors.

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(c) Downstream processing

Answer:

Downstream processing- The process of separation and purification of biotechnological products is called downstream processing. The processes in downstream processing vary depending on the quality of the product. Before the release of the product, it undergoes clinical trials and quality control testings.

Q11. Explain briefly : (a) PCR

Answer:

Polymerase Chain Reaction (PCR)- The molecular technique to amplify a gene and obtain its several copies is referred to as PCR. The process of PCR has certain requirements i.e. a thermostable enzyme called Taq polymerase (obtained from *Thermus aquaticus*), primers (short stretches of DNA), dNTPs, a template strand etc. The process of PCR takes place in three steps.

1. Denaturation- The double-stranded DNA helix is opened up by breaking their H-bonds at high temperature.

2. Annealing- The primers are allowed to hybridise to complementary regions of DNA. This step takes place at 45-55 C temperature.

3. Extension- The primers are extended with the help of Taq polymerase enzyme and the cycle is repeated several times to obtain the desired number of copies.

(b) Restriction enzymes and DNA

Answer:

Restriction enzymes and DNA- Restriction enzymes are those enzymes which cut DNA at particular places. Restriction enzyme first scans the DNA template and look for its recognition site. Once it finds the recognition site, it binds at that region of DNA and cut each of the two strands in their sugar-phosphate backbone. The sites at which restriction enzymes cut DNA are called as recognition sites of DNA. These are palindromic sequences i.e. they read similar from the backward and forward direction.

(c) Chitinase

Answer:

Chitinase - The enzyme that catalyses the breakdown of chitin polysaccharide which is usually found in the cell wall of fungi. Chitinase is mainly used during DNA isolation from fungi.

Q12. Discuss with your teacher and find out how to distinguish between

(a) Plasmid DNA and Chromosomal DNA

Answer:

The differences between plasmid DNA and chromosomal DNA are as follows:

Plasmid DNA	Chromosomal DNA
Circular, extra-chromosomal DNA which is capable of self-replication and is found in bacteria is called plasmid DNA.	The entire DNA (excluding extrachromosomal DNA) present in the cell constitutes chromosomal DNA

It is found only in bacteria	IT is found in both bacteria and other eukaryotic cells.

(b) RNA and DNA

Answer:

The differences between RNA and DNA are as follows:

RNA	DNA
RNA contains ribose sugar	DNA contains deoxyribose sugar
In RNA, adenine and uracil are found as pyrimidines	In DNA, adenine and uracil are found as pyrimidines
It has catalytic properties and is less stable than DNA	DNA is non-catalytic and is stable than RNA

(c) Exonuclease and Endonuclease

Answer:

The differences between exonuclease and endonuclease are as follows:

Exonuclease	Endonuclease

These are nuclease (enzymes) that cut DNA from its ends.	These are nucleases that cut DNA from internal sites on DNA