



CHAPTER 23

Biotechnology



- Exercise Short Answers
- Important Short Answers



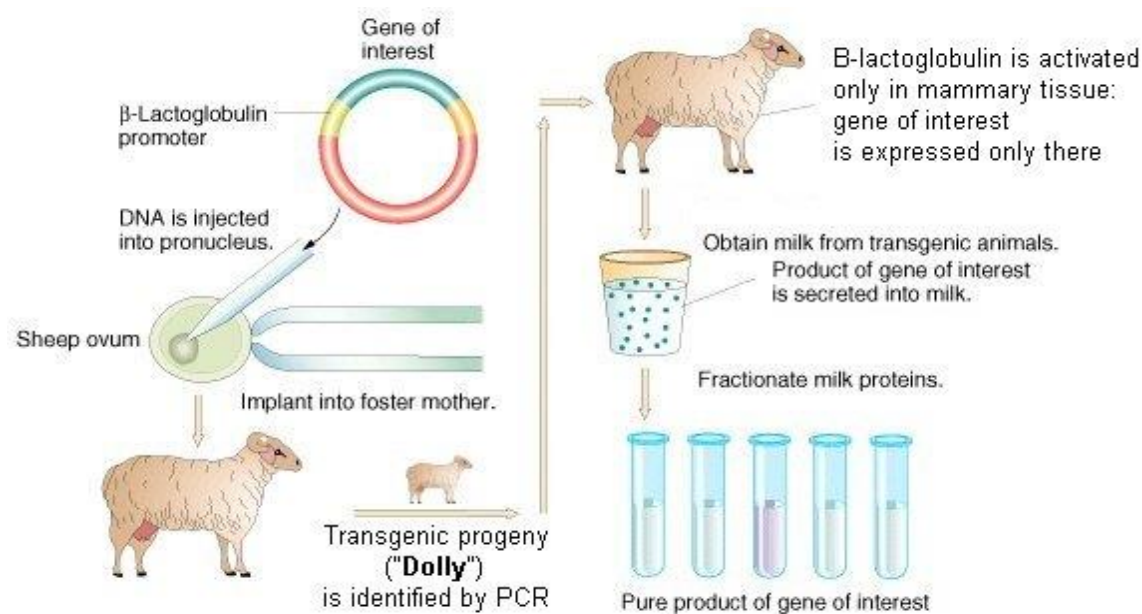
- Exercise MCQ's
- Important Additional MCQ's
- Past MDCAT MCQ's

Exercise Short Answer

Q:1 How and why transgenic animals that secrete a product are often cloned?

Ans: How transgenic animals that secrete a product are cloned:

After enucleated eggs have been injected with 2n nuclei of adult cells, they can be coaxed (persuaded or induced gradually) to begin development. The offspring have the genotype and phenotype of the adult that donated the nuclei, therefore, the adult has been cloned.



Why transgenic animals that secrete a product are cloned:

They are cloned to produce more larger and better quality of animals.

They are cloned to produce drugs for the treatment of cystic fibrosis, cancer, blood diseases and other diseases.

Q:2 Explain two primary goals of human genome project. What are possible benefits of the projects?

Ans: Human genome project has following two main goals:

a) First goal is construction of a genetic map:

The aim is to show sequence of genes along the length of each type of chromosomes. The map for each chromosome is incomplete presently.

b) Second goal is to construct the base sequence map:

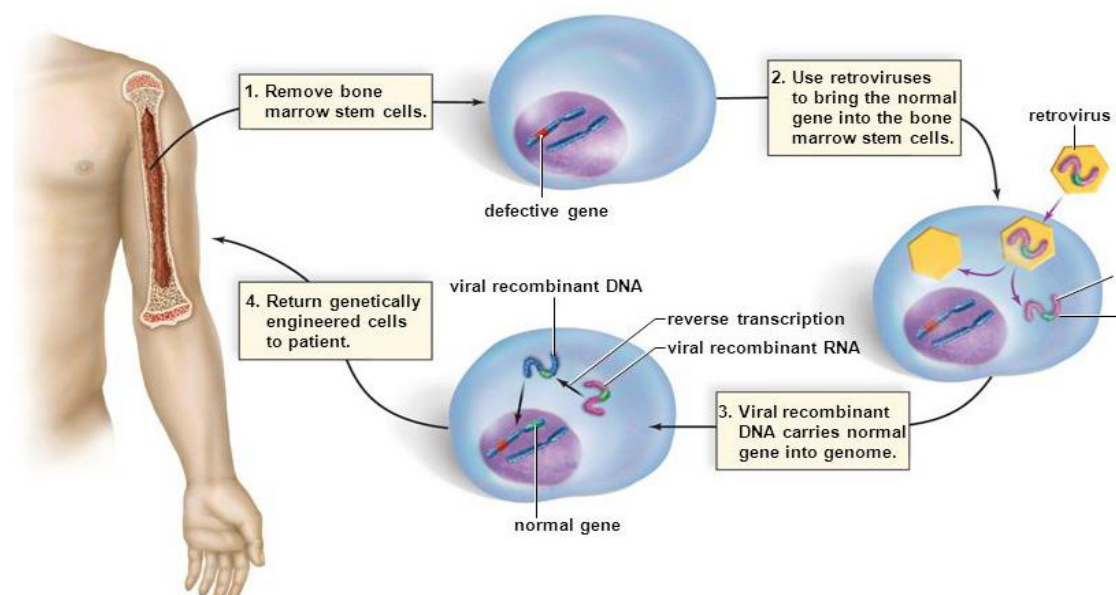
There are three billion base pairs in human genome and it is estimated that it could take an encyclopedia of 200 volumes, each with 1000 pages, to list all of these. Yet this goal has been reached and all chromosomes have been sequenced.

Q:3 Explain and give examples of ex-vivo and in-vivo gene therapies in human.

Ans: Gene therapy: Gene therapy is the insertion of genetic material into human cells for the treatment of a disorder.

Ex-vivo gene therapy:

In ex-vivo gene therapy, normal gene is given to certain cells of the patient, outside the body of the patient and then these cells are returned to the patient.

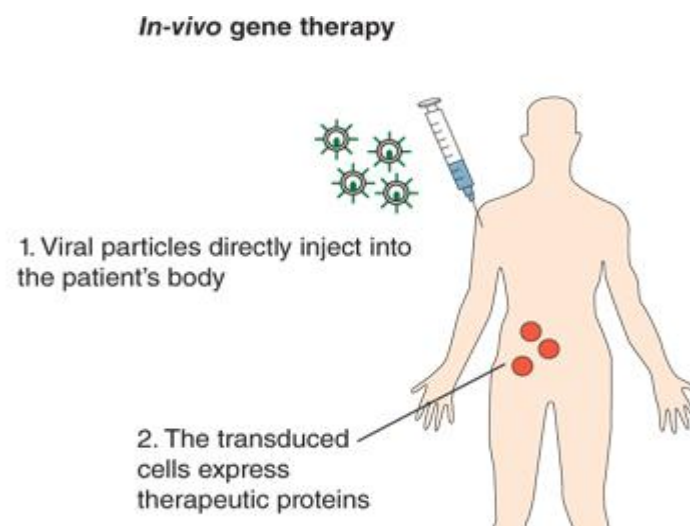


Examples of ex-vivo:

- Treatment of cystic fibrosis
- Treatment of blockage of coronary artery

In-vivo gene therapy:

In-vivo bone marrow stem cells are removed from the blood and infected with retrovirus (RNA virus) that carries a normal gene for the enzyme then the cells are returned to the patient.



Examples of in-vivo:

- Treatment of severe combined immunodeficiency syndrome (SCID)
- Treatment of hypercholesterolemia
- Treatment of cancer

Important Short Answers

Q:1 Define biotechnology. Give its application.

Ans: Biotechnology: It is the use of a natural biological system with the help of special techniques to produce a product or to achieve an end product desired by human.

OR

Use of living organisms, their system or processes for the welfare of mankind is called biotechnology.

OR

The molecular genetics which enables us to manipulate genetic material for the welfare of mankind.

Uses of biotechnology:

- To obtain drugs as insulin, vaccines, antibodies, interferon etc.
- To clean up environmental pollutants
- To kill insect, pests
- To get transgenic animals and plants
- To increase soil fertility
- Gene therapy in human

Q:2 Differentiate between Molecular scissors (restriction enzymes) and Molecular vectors.

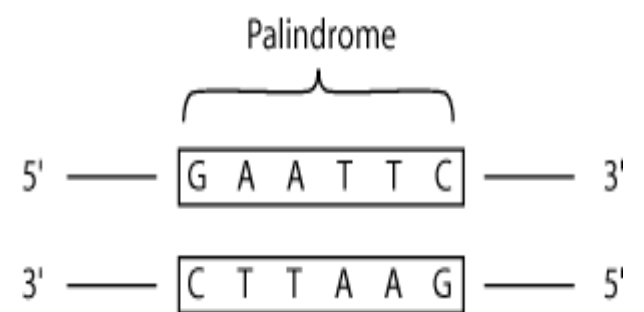
Molecular scissors (Restriction enzymes)	Molecular vectors (Plasmid, Viruses)
• These are natural enzymes of bacteria, which they used for their own protection against viruses. They are called restriction enzymes because they restrict the growth of enzyme.	• These are molecules which carry gene of interest.
• They cut down viral DNA. • These enzymes can be isolated and used in biotechnology to cut the gene of interest.	• Through molecular vector recombinant DNA is introduced into host cell.
• Example: EcoR1	• Examples: Plasmid (Extra chromosomal circular DNA in bacteria) used as vector.

Q:3 What are palindromic sequences?

Ans: Palindromic sequences: Bacteria produces a variety of such restriction enzymes, which cut the DNA at very specific sites characterized by specific sequence of four to six nucleotides arranged symmetrically in the reverse order. Such sequences are known as palindromic sequences.

OR

There are several restriction enzymes produced in bacteria that cut the DNA from particular places. These specific sites are characterized by particular sequences of 4 or 6 nucleotides. These nucleotides are arranged symmetrically in the reverse order and sound same if read in reverse order and are called palindromic sequences.



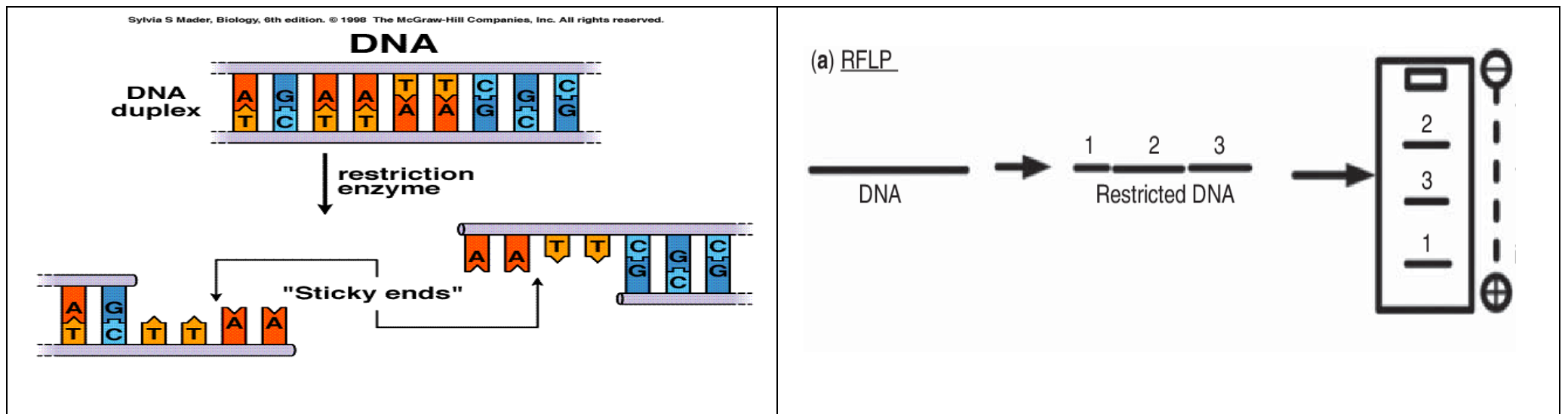
Examples: AGCT and TCGA, AAGCTT and TTCGAA.

Q:4 How genes can be isolated from chromosomes?

Ans: Genes can be isolated from the chromosomes by cutting the chromosomes on the flanking sites of the gene using special enzymes known as restriction endonucleases.

Q:5 Differentiate between Sticky ends and RFLP's.

Sticky ends	RFLP's
• The complementary ends but single stranded parts of the two DNA molecules at cleavage sites are called sticky ends. OR • The single stranded but complementary ends of the two DNA molecules are called "sticky ends" because they can bind by complementary base pairing.	• Restriction enzymes recognize very specific DNA sequence. Alleles of the same gene or surrounding sequence may have base pairs differences, so that DNA near one allele is cut into a different length fragment than DNA near the other allele.
• These sticky ends bind complementary base i.e. A-T and G-C paring. Sticky ends also help the insertion of foreign DNA into vector DNA.	• These different fragments separate on the bases of size and molecular weight on gel and are called RFLP's.



Q:6 Define recombinant DNA or Chameric DNA. How it is prepared?

Ans: Recombinant DNA:

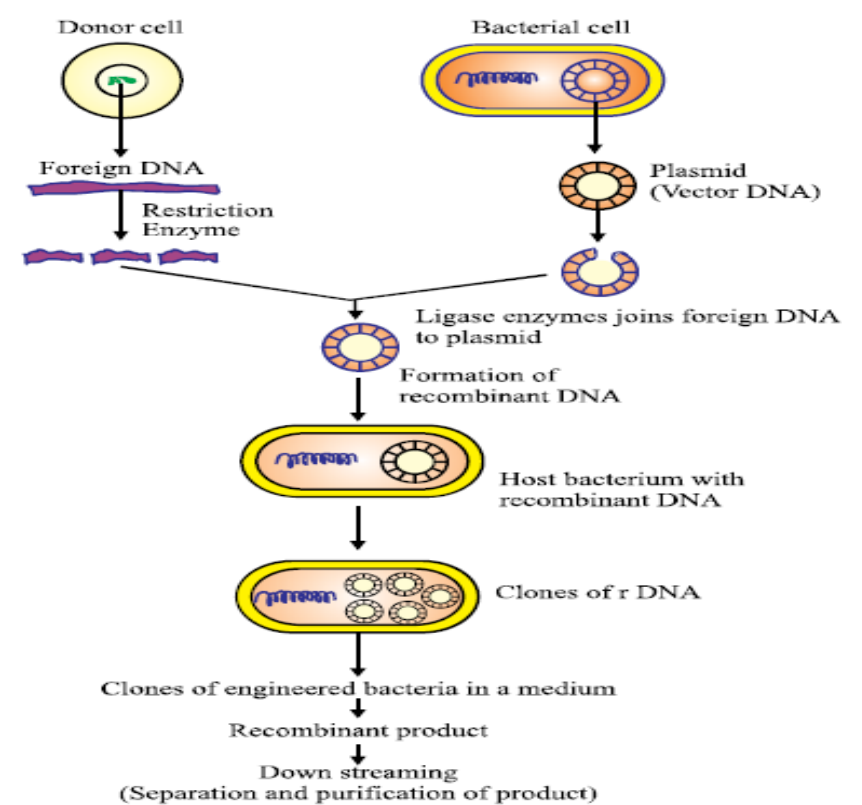
When the two different pieces of DNA have been joined together, it is known as recombinant DNA or Chameric DNA.

OR

Recombinant DNA is the name given to DNA formed after a piece from one organism is joined to a piece from another organism.

Preparation of recombinant DNA:

- Plasmid is cut with the enzyme i.e. restriction endonucleases.
- The gene of interest (like insulin) is then joined with sticky ends produced after cutting the plasmid.
- The gene of interest is joined with sticky ends by another particular enzyme i.e. DNA –ligase. The DNA ligase seals the foreign pieces of DNA into the vector.
- Thus the two different pieces of DNA have been joined together which is now called recombinant DNA or Chameric DNA.



Q:7 What is the use of DNA ligase?

Ans: The gene of interest (insulin) is the joined with the sticky ends produced after cutting the plasmid with the help of another special enzyme known as DNA ligase. This enzyme seals the foreign piece of DNA into the vector.

Q:8 What is PCR and write applications of PCR amplification.

Ans: PCR: The PCR is used to create millions of copies of a single gene or any specific piece of DNA quickly in a test tube. OR

A process by which DNA polymerase enzymes is used to copy a DNA sequence of interest repeatedly, making millions of copies of the same DNA in automatic machine called thermocycler.

Applications of PCR:

- PCR and DNA analysis can be used:
- To diagnose viral infections, genetic disorders and cancer
- In forensic laboratories to identify criminals
- To determine the evolutionary history of human population
- It has been possible to sequence DNA taken from a 76,000 years old mummified human brain and from 17 to 20 million years old plant fossils by using PCR.

Q:9 Enlist various steps involved in recombinant DNA technology also discuss that how can we get gene of interest?

Ans: Steps of recombinant DNA technology: In order to produce recombinant DNA the following are required:

- Gene of interest
- Molecular scissors
- Molecular carriers or vector
- An expression system

Gene of interest: Can be obtained in any of the three ways:

- To isolate from the chromosomes
- To synthesize it chemically
- To make it from mRNA

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Q:10 Where from PCR took its name? Why is called chain reaction?

Ans: PCR takes its name from DNA polymerase, the enzyme that carries out DNA replication in a cell. It is considered a chain reaction because DNA polymerase will carry out replication over and over again, until there are millions of copies of the desired DNA.

Q:11 Write the procedure of three method to get gene of interest:

Ans: Procedure:

I. Isolation by restriction enzyme:

The gene of interest can be isolated from chromosomes by cutting the chromosomes on the flanking sites of the gene using special enzymes known as restriction endonucleases.

II. Synthesis of gene chemically:

In case of small genes they can also be synthesized in the laboratory.

III. Using reverse transcriptase:

Gene may be synthesized from mRNA by using the reverse transcriptase enzyme. This kind of DNA is called complementary DNA i.e. cDNA.

Q:12 When recombinant DNA technology is used and when PCR?

Ans:

- Recombinant DNA technology is used when a very large quantity of a gene is required.
- The polymerase chain reaction (PCR) is used to create a lesser number of copies within a laboratory test tube.

Q:13 Which enzyme is Taq polymerase?

Ans: It is DNA polymerase enzyme extracted from the bacterium *Thermus aquaticus*, which lives in hot springs. It is temperature - insensitive (thermostable). Commonly, this enzyme is known as Taq polymerase.

Q: 14 Differentiate between Genome and genomic library.

Genome	Genomic library
• Full set of genes in an individual or cell is called genome.	• Collection of bacterial or bacteriophage clones having gene of interest. OR • A collection of bacterial clones or bacteriophage clones in which each clone containing a specific segment of DNA from the source cell is known as genomic library.
• Genome normally is divided into number of chromosomes in an individual.	• Each clone containing a particular segment of DNA from the source cell.

Q:15 What is gene sequencing? Write main principle of gene sequencing.

Ans: Gene sequencing: In DNA or gene sequencing, scientists create many copies of a single-stranded DNA fragment that will be used to synthesize a new DNA strand. Then these will be used to determine sequence of nucleotides.

Main principle of gene sequencing:

- To generate pieces of DNA of different sizes all starting from the same point ending at different points.
- Separation of these different pieces of DNA on agarose gel.
- Reading of sequence from the gel.

Q:16 Write importance of human genome project or human genome map.

Ans: Importance of human genome project or human genome map:

The map for each chromosome is presently incomplete, and in many instances scientist relies on the placement of RFLP's.

- These sites eventually allow scientist to pinpoint disease causing genes because a particular RFLP's and a defective gene are often inherited together.
- For example it is known that persons with Huntington disease have a unique site where a restriction enzyme cuts DNA. The test for Huntington disease relies on this difference from the normal.
- It is possible one day to treat certain human ills by administering normal genes and their protein products to those who suffer from genetic disease.

Q:17 Name different organisms and organelles whose genomes have been sequenced?

Ans: It includes plant chloroplasts and animal mitochondria, large numbers of bacteria, many of the yeasts, a nematode worm, *Drosophila*, the model plant *Arabidopsis*, the mouse and human.

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Q:18 Differentiate between pSC 101 and pBR 322.

pSC 101	pBR 322
Plasmid pSC 101 has antibiotic resistance gene for tetracycline.	Plasmid pBR 322 has antibiotic resistance gene for tetracycline as well as ampicillin.
It enables the separation of colonies of bacteria in a medium containing ampicillin only.	It enables the separation of colonies of bacteria in a medium containing ampicillin or tetracycline.

Q:19 What is complementary DNA?

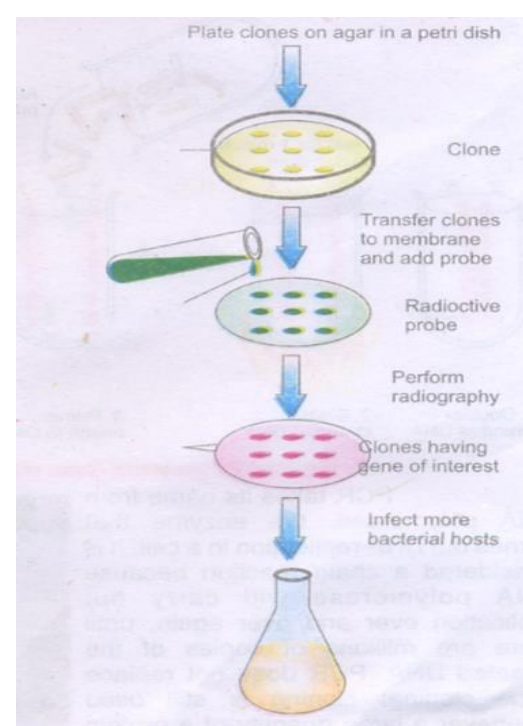
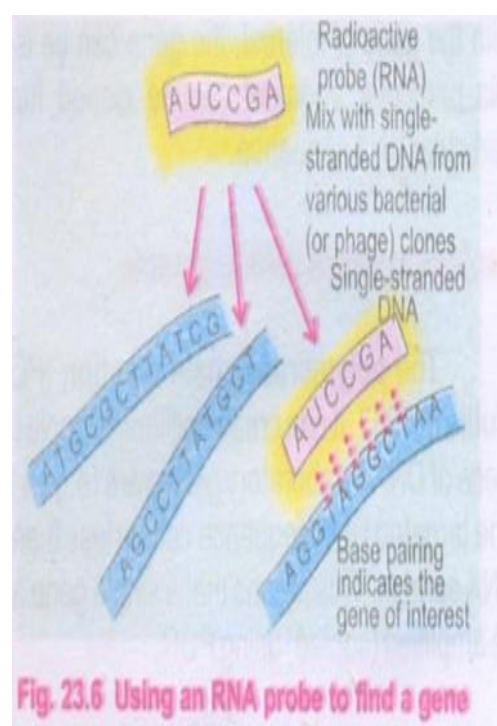
Ans: The gene of choice can also be synthesized in the laboratory from messenger RNA, using reverse transcriptase. This DNA molecule is called complementary DNA (cDNA).

Q:20 What is probe? Write role of probe to locate gene of interest.

Ans: Probe: A probe is a single stranded nucleotide sequence that will hybridize (pair) into a certain piece of DNA.

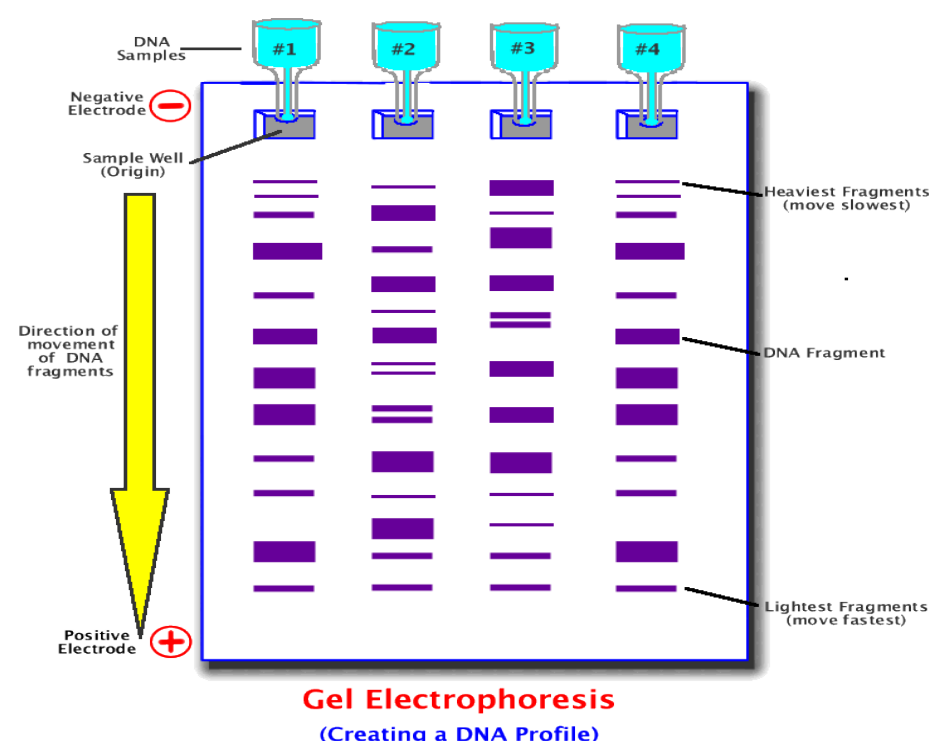
How to locate gene of interest:

- A particular probe can be used to search a genetic library for a certain gene.
- Location of the probe is possible because probe is either radioactive or fluorescent.
- Bacterial cell, each carrying a particular DNA fragment, can be placed onto agar in a petri dish.
- After the probe hybridizes into the gene of interest, the genes can be isolated from the fragment.
- Now this particular fragment can be cloned further or even analyzed for its particular DNA sequence.



Q:21 What is gel-electrophoresis?

Ans: Gel-Electrophoresis: It is the process by which the fragments of DNA can be separated according to their lengths, and the result is a number of bands that are so close together that they appear as a smear. However, the use of probes for genetic markers produces a distinctive pattern that can be recorded on x-ray film.



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Q:22 What are DNA analyzing and DNA finger printing & its uses.

Ans: DNA analyzing: It is a techniques employed by forensic scientists to assist the identification of criminal by their DNA profile.

DNA finger printing: DNA Finger printing is a method of identification that compares fragments of deoxyribonucleic acid (DNA).

Q:23 What are plasmids? Give its importance.

Ans: Plasmids: Plasmids are natural extra chromosomal circular DNA molecules which carry genes for antibiotic resistance and fertility etc.

Examples:

- One of the plasmids discovered earlier PSC 101 has antibiotic resistance gene for tetracycline
- PSR 322 has antibiotic resistance genes for tetracycline as well as ampicillin.

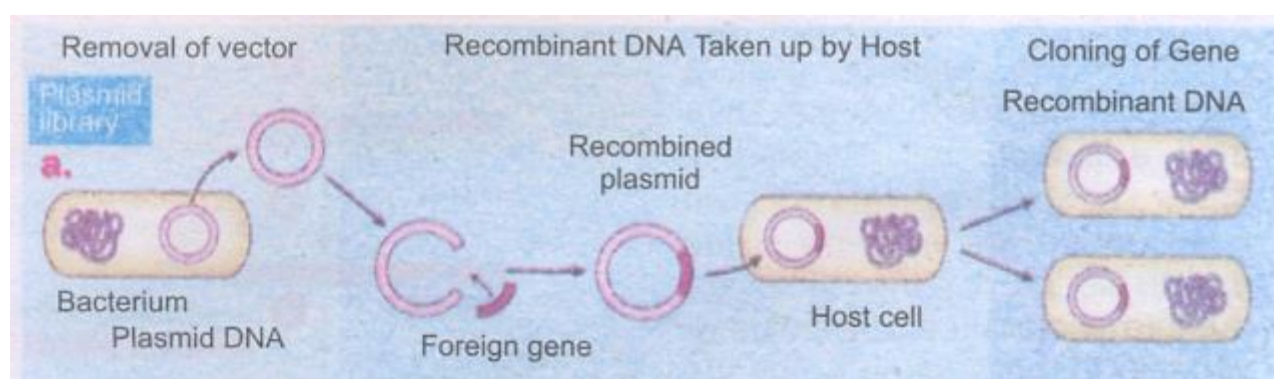
Importance of plasmids:

- It division in bacteria may or may not agree with the division of bacteria.
- So the gene is replicated with much faster rate than bacterial genome.

Q:24 Describe plasmid as a vector.

Ans: Plasmid as a vector: A plasmid which carries an inserted piece of DNA into a bacterium for replication and expression of desired DNA is called vector.

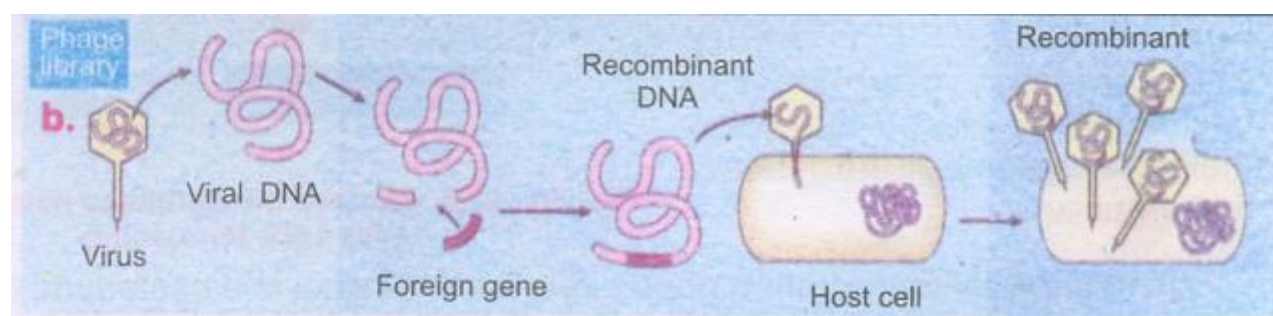
- Bacterial cells take up recombinant plasmid, especially, if they are treated with calcium chloride to make them more permeable.
- As the cell reproduces, a bacterial clone forms, in this way, each new cell contains at least one plasmid.
- Thus each of bacteria has the gene of interest. This gene will express itself and make a specific product i.e. protein etc.
- From this bacterial clone, the cloned gene can be isolated for further analysis or protein product can be separated.



Q:25 Describe phage DNA as a vector.

Ans: Phage DNA as a vector:

- Lambda phage (a phage virus) may also be used as a vector.
- After lambda phage attaches to host bacterium, recombinant DNA is released from the virus and enters the bacterium.
- Here, it will direct the reproduction of many more viruses.
- Each virus in bacteriophage clone contains copy of gene being cloned.



Q:26 What are various methods of gene or DNA sequencing?

Ans: There are two methods of gene or DNA sequencing:

1. Snager's method:

One is Sanger's method in which dideoxyribonucleoside triphosphates are used to terminate DNA synthesis at different sites. Hence also called di-deoxy method.

- It is used commonly now days.

2. Maxam-Gilbert method:

In this method DNA threads are chemically cut into pieces of different sizes.

- It is old method not used now days.

Q:27 What are transgenic organisms?

Ans: Transgenic organisms: Organisms that have had a foreign gene inserted into them are called transgenic organisms.

- Today bacteria, plants, and animals are genetically engineered to produce biotechnology product.

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Q:28 Define transgenic bacteria. What are the uses of transgenic bacteria?

Ans: Transgenic bacteria: Bacteria that have a foreign gene inserted into them are called transgenic bacteria.

Uses of transgenic bacteria: Transgenic bacteria are used:

- To produce various drugs, vaccines, enzymes, hormones etc.
- To produce insect toxins in plants
- To clean up the beaches
- To remove sulphur from coal
- As biofilters to control air pollution
- To produce phenylalanine for nutrasweet
- In mining of ores.

Q:29 What are bioreactors and biofilters.

Ans: Bioreactors: Recombinant DNA technology is used to produce bacteria that produce in large vents called bioreactors.

- If the foreign gene is replicated and actively expressed, a large amount of protein product can be obtained.

Biofilters: The transgenic organisms used to prevent airborne chemical pollutants from being released into the air are said to be biofilters.

- For example use of such bacteria in industry.
- Industry has found that bacteria can be used as biofilters. They can remove sulphur from coal before it is burned and help to clean up toxic waste dumps.

Q:30 Name some biotechnology product produced by bacteria?

Ans: Biotechnology products produced by bacteria are as follows:

- 1) Insulin
- 2) Human growth hormone
- 3) Tissue plasminogen activator
- 4) Hemophilia factor VIII
- 5) Hepatitis

Q:31 Define transgenic animals. How they are beneficial.

Ans: Transgenic animals: Animals that have a foreign gene inserted into them are called transgenic animals.

Benefits of transgenic animals:

- Bovine growth hormone is produced by transgenic animals.
- Large fishes, cows, pigs, rabbits, and sheep are produced.
- Drugs against cancer, cystic fibrosis etc. can be produced.
- Antithrombin III is produced to prevent blood clot during surgery.

Q:32 How gene therapy has been used for the treatment of cancer?

Ans: In clinical trials researchers have given genes to cancer patient that either make healthy cells more tolerant of chemotherapy or make tumors more vulnerable to it. Once the bone marrow stem cells were protected it was possible to increase the level of chemotherapy to kill the cancer cells.

Q:33 How gene therapy has been used for the treatment of coronary artery angioplasty?

Ans: The balloon catheter is coated with a plasmid that contains a gene for vascular endothelial growth factor. The expression of the gene, which promotes the proliferation of blood vessels to bypass the obstructed area, has been observed in at least one patient.

Q:34 Describe tissue culture and protoplasts.

Ans: Tissue culture: Tissue culture is the growth of a tissue in an artificial liquid culture medium.

Protoplast: The plant cells that have had the cell wall removed are called protoplasts.

Q:35 Differentiate between Cystic fibrosis and Severe combined immunodeficiency syndrome SCID's

Cystic fibrosis	Severe combined immunodeficiency syndrome SCID's
• It is hereditary disease in which the patients lack a gene that codes for Trans-membrane carriers of the chloride ions.	• A disease in which children lack an enzyme adenosine deaminase (ADA).
• The patient dies due to the infection in respiratory tract because of the excess secretion of mucous.	• This enzyme is involved in maturation of T and B cells. • T & B cells are components of immune system. So patients are subjected to life threatening infections.

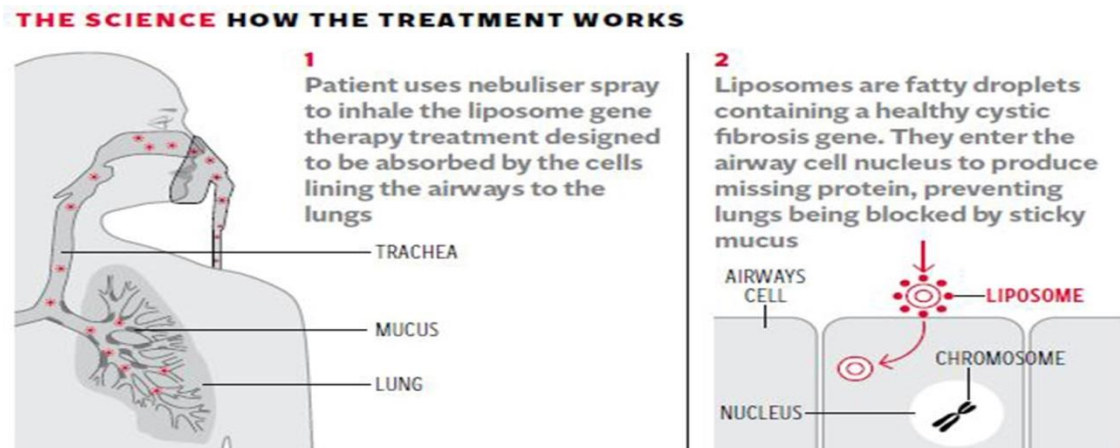
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- It may be cured by in-vivo gene therapy.
- SCID is treated with ex-vivo gene therapy.

Q:36 What is the possible treatment for cystic fibrosis.

Ans: Possible treatment for cystic fibrosis: An in-vitro method of treatment is being tried:

- Liposomes are microscopic vesicles that spontaneously form when lipoproteins are put into a solution and coated with the gene needed to cure cystic fibrosis.
- Then the solution is sprayed into patient's nostrils.
- Due to limited gene transfer yet been successful.



Q:37 Plant cells are said to be totipotent. What do you mean by this?

Ans: Plant cells are totipotent which means that each cell has the full genetic potential of the organism and therefore a single cell could become a complete plant.

- This term was introduced by German botanist Gottlieb Haberlandt in 1902.

Q:38 How the term totipotent given by Gottlieb Haberlandt is modified by Steward.?

Ans: Contribution of F.C Steward: In 1958 Cornell botanist F.C. Steward grew a complete carrot plant from a tiny piece of phloem.

- He provided the cells with sugars, minerals and vitamins but he also added coconut milk. (Later it was discovered that coconut milk contains the plant hormone cytokinins).
- When the cultured cells began dividing they produced a callus of an undifferentiated group of cells. Then the callus differentiated into shoots and roots and developed into complete plants.

Q:39 Define transgenic plants. How they are beneficial.

Ans: Transgenic plants: Plants that have a foreign gene inserted into them are called transgenic plants.

Benefits of transgenic plants:

- They are resistant to pests and herbicides.
- Protein and starch contents can be improved.
- Photosynthetic rate can be improved.
- Biodegradable plastic (Poly hydroxyl butyrate) can be produced by plants.
- Human hormone, clotting factor etc. can be produced in seeds.
- A type of antibody used against cancerous cells can be obtained from corn.
- An antibody made by soya beans can be used as treatment for genital herpes.

Q:40 What is aspartame and biodegradable plastic and its origin?

Ans: Aspartame: Aspartame is a dipeptide sweetener known as Nutrasweet.

- It is made from Phenylalanine.
- This Phenylalanine can be obtained from transgenic bacteria.

Biodegradable plastic: It is chemically a polyhydroxy-butyrate.

- A weed called mouse eared cress has been engineered to produce this biodegradable plastic.

Q:41 Differentiate between Micro-propagation and Anther culture.

Micro-propagation	Anther culture
It is a commercial method of producing millions of identical seedlings in a limited amount of space.	Anther culture is a technique in which mature anthers are cultured in a medium of vitamins and growth regulators. Haploid embryos are produced.
It is done by meristem culture. If correct proportion of auxins and cytokinins are added to a liquid medium many new shoots will develop	These can be grown as haploid plants or can be used for chromosomal

from a single shoot tip.

doubling to obtain diploid plant but homozygous for all their alleles.

Q:42 What is familial hypercholesterolemia?

Ans: Familial hypercholesterolemia It is a condition that develops when liver cells lack a receptor for removing cholesterol from the blood. The high levels of blood cholesterol make the patient subject to fatal heart attack at a young age.

Q:43 What is Meristem culture?

Ans: Meristem Culture: It is used correct proportions of auxins and many new shoots will develop from more shoots forms, which are

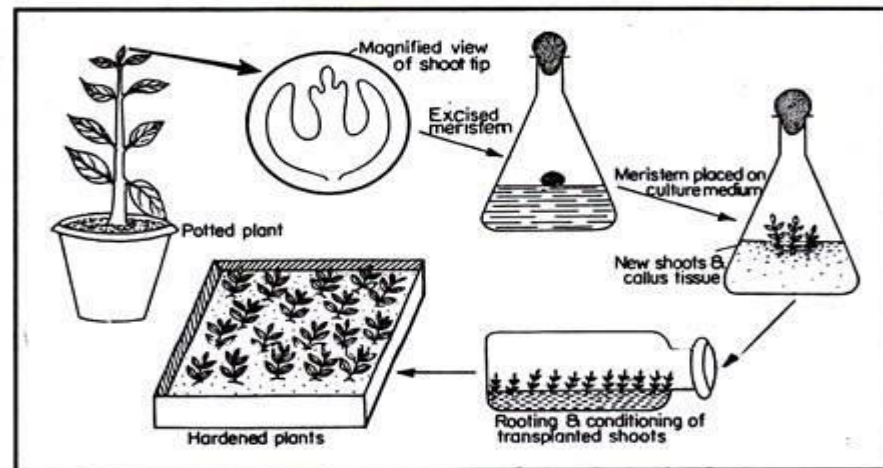


Fig 2.3

Flow diagram illustrating the technique of shoot tip or meristem culture

to accomplish micro-propagation. If the cytokinin are added to a liquid medium, a single shoot tip. When these are removed genetically identical.

Q:44 describe clonal plants and somaclonal variation.

Ans: Clonal plants: The shoots which develop by meristem culture are genetically identical the adult plants that develop from them are called clonal plants because all have the same traits.

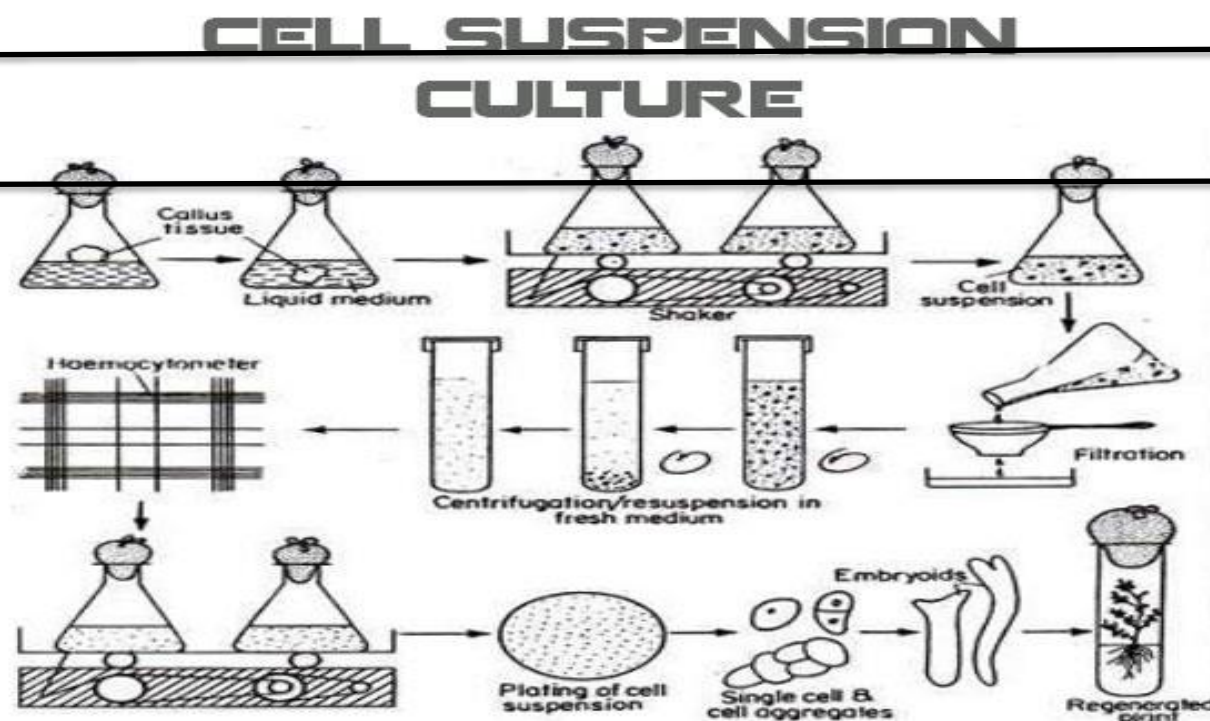
Somaclonal variations: Plants embryos vary somewhat arise during the production are called somaclonal

generated from the somatic because of mutations that process. These variations variations.

Q:45 What is cell suspension

Ans: Cell suspension culture

In this technique, first cultures are cut into small liquid nutrient medium so that of cells break off and form a produce the same chemicals as



culture technique?

technique:

of all rapidly growing pieces and shaken in a single cells or small clumps suspension. These cells will the entire plant.

Q:46 What is luciferase and luciferin?

Ans: Luciferase: The luciferase is firefly enzyme whose gene was inserted into tobacco protoplast.

Luciferin: The adult plants glowed when sprayed with the substrate luciferin.

Q:47 What is particle gun?

Ans: Particle gun:

In 1987, John C Sanford and Theodore M. Klein developed a method of introducing DNA into a plant tissue - culture callus. They constructed a device, called the particle gun that bombards a callus with DNA - coated microscopic metal particles. Then genetically altered somatic embryos develop into genetically adult plants.

Q:48 Describe arabidopsis and agrobacterium.

Ans: Arabidopsis: Arabidopsis is salt tolerant plant which has been developed by genetic engineers.

Agrobacterium: Foreign DNA is inserted into the plasmid of the bacterium, ~~Agrobacterium; which normally infects the plant cells.~~

Q:49 How transgenic animals are developed?

Ans: Techniques have been developed to insert genes into the eggs of animals. It is possible to micro inject foreign genes into eggs by hand, but another method uses vortex mixing. The eggs are placed in an agitator with ~~DNA and silicon - carbide needles, and the needles make tiny holes through~~ which the DNA can enter. When these eggs are fertilized, the resulting offsprings are transgenic animals.

Q:50 What are three steps of Polymerase chain reaction.

Ans: There are three main stages:

Denaturation:

- When the double-stranded template DNA is heated to separate it into two single strands.
- This step is generally carried out at 92°C-96°C for 1 minute.

Annealing:

- When the temperature is lowered to enable the DNA primers to attach to the template DNA.
- Annealing of primer to each strand is carried out at 45°C-55°C.

Extension:

- When the temperature is raised and the new strand of DNA is made by the Taq polymerase enzyme.
- It is carried out at temperature of 72°C.

Q:51 Differentiate between Hybridization and Cloning.

Hybridization	Cloning
• Hybridization is a method of sexual reproduction.	• Cloning is a method of asexual reproduction.
• Hybrids animals are usually sterile.	• Cloned animals are fertile.
• Hybrid organism contains DNA from male and female parent.	• Cloned organism contains DNA from only one type of parent.
• Hybridization gives rise to genetically different organisms from its parent known as hybrid.	• Cloning gives rise to an identical copy of a parent organism known as a clone.
• Hybrid has superior characters over its parents (improved hybrid vigor).	• Clones are 100% identical to their parent.

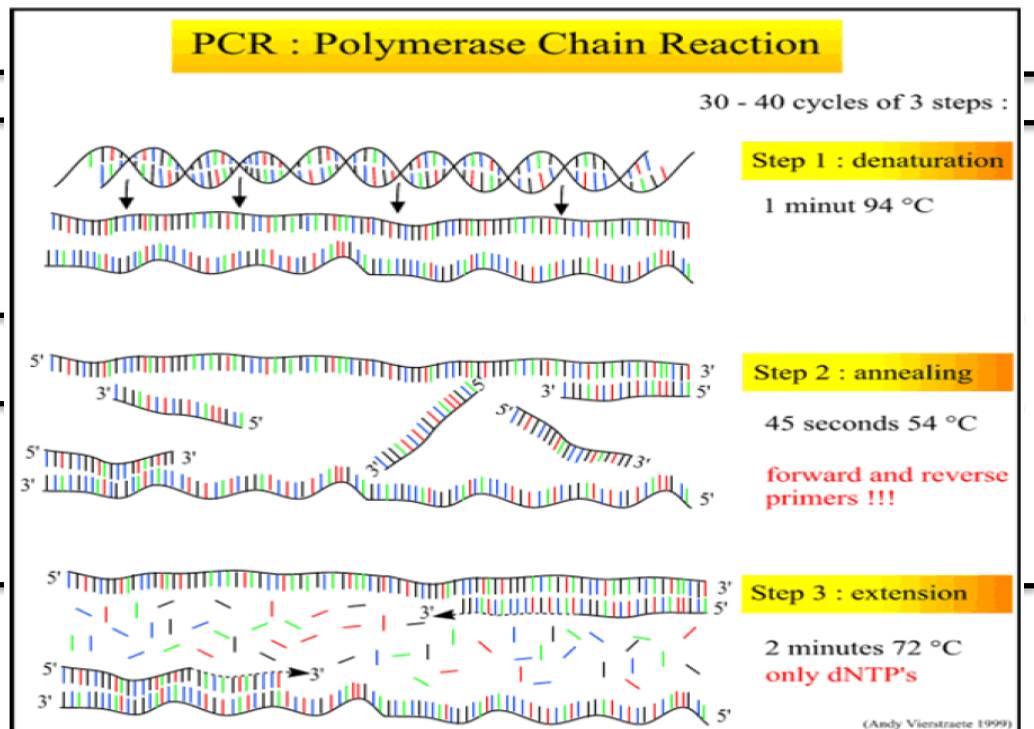


Figure 1: Basics of PCR Cycling.

Exercise Short Answer

❖ Encircle the correct answer from the multiple choices.

- 1) Which of these is true statement?
 - a) Both plasmid and viruses can serve as vectors
 - b) Plasmids can carry recombinant DNA but viruses cannot
 - c) Vectors carry only the foreign gene into the host cell
 - d) Both a & d correct
- 2) Which of these is benefit to having insulin produced by biotechnology?
 - a) It is just as effective
 - b) It can be mass produced
 - c) It is non-allergenic
 - d) It is less expensive
 - e) All of these are correct
- 3) Restriction fragment length polymorphism (RFLP's):
 - a) Are achieved by using restriction enzymes
 - b) Identify individuals genetically
 - c) Are the basis for DNA finger prints
 - d) Can be subjected to gel electrophoresis
 - e) All of these are correct
- 4) Which of these would you not expect to be a biotechnology product?
 - a) Vaccine
 - b) Modified enzyme
 - c) DNA probes
 - d) Protein hormones
 - e) Steroid hormone
- 5) What is the benefit of using a retrovirus as a vector in gene therapy?
 - a) It is not able to enter cells
 - b) Both b & c are correct
 - c) It eliminates a lot of unnecessary steps
 - d) It prevents infection by other viruses
 - e) It incorporates the foreign gene into the host chromosomes
- 6) Gel electrophoresis
 - a) Cannot be used on nucleotides
 - b) Measures the size of plasmids
 - c) It eliminates a lot of unnecessary steps
 - d) Measure the change and size of proteins and DNA fragments
 - e) All of these are correct
- 7) Which of these is incorrect method?
 - a) Protoplast – plant cell engineering
 - b) RFLP's – DNA fingerprinting
 - c) DNA polymerase – PCR
 - d) DNA ligase – mapping human chromosomes

Answer key:

1	a	2	e	3	e	4	c
5	b	6	d	7	d		

Important Additional MCQ's

❖ **Encircle the correct answer from the multiple choices.**

Recombinant DNA Technology

- | | | | | |
|--|------------------------------|-----------------------------|----------------------|---------------------|
| 1) Commonly used restriction enzyme is: | a) Plasmid | b) pSC 101 | c) pBR 322 | d) EcoR1 |
| 2) A commonly used restriction enzyme is: | a) EcoR1 | b) EcoR2 | c) EcoR3 | d) EcoR4 |
| 3) EcoR1 is commonly used as: | a) Gene | b) Restriction enzyme | c) Bacteriophage | d) Bacteria |
| 4) Which of the enzymes act molecular scissors: | a) DNA ligase | | | |
| | b) Restriction endonuclease | | | |
| | c) DNA polymerase | | | |
| | d) RNA polymerase | | | |
| 5) The enzyme which are used to cut out the gene of interest are known as: | a) DNA ligase | | | |
| | b) DNA polymorphism | | | |
| | c) RNA polymerase | | | |
| | d) Restriction endonuclease | | | |
| 6) Recombinant DNA contains DNA from: | a) 2 different sources | b) 3 different sources | c) 2 same sources | d) 3 same sources |
| 7) Enzymes restriction endonucleases were isolated from: | a) Viruses | b) Fungi | c) Bacteria | d) Protozoa |
| 8) First restriction enzyme was isolated by: | a) Kary Mullis | b) Hamilton O. Smith | c) Maxam Gilbert | d) Hamilton John |
| 9) In the recombinant DNA technology, plasmids are used as: | a) Genetic material | b) Vectors | c) Enzymes | d) Probes |
| 10) PSc 101 has antibiotic resistance gene for: | a) Tetracycline | b) Ampicillin | c) Neomycin | d) Ergotine |
| 11) PBR 322 has antibiotic resistance genes for: | a) Tetracycline & Ampicillin | b) Streptomycin only | c) Tetracycline only | d) Ampicillin only |
| 12) Natural extrachromosomal circular DNA molecules carrying genes for antibiotic resistance and fertility: | a) Recombinant DNA | b) Chimaeric DNA | c) Lambda phage | d) Plasmids |
| 13) Recombinant DNA is introduced into the host cell by means of a: | a) Vector | b) Phage | c) Bacterium | d) Fungus |
| 14) The enzyme which joints the two pieces of DNA, is: | a) DNA polymerase III | b) Restriction endonuclease | c) DNA ligase | d) Taq polymerase I |
| 15) Lambda phage is: | a) Virus | b) Bacterium | c) Plasmid | d) Host cell |
| 16) Which enzyme is used to join the desired gene into the plasmid DNA during genetic engineering: | a) DNA helicase | b) DNA polymerase | c) DNA ligase | d) Taq polymerase |
| 17) The two different pieces of DNA joined together, is called as: | a) Dimeric DNA | b) Chimaeric DNA | c) Trimeric DNA | d) Tetrameric DNA |
| 18) In recombinant DNA technology are tools for manipulating DNA: | a) Viruses | b) Enzymes | c) Chromosomes | d) Genes |
| 19) Genome library is a collection of bacterial or bacteriophage. | a) Genotype | b) Genome | c) Gene pool | d) Clones |
| 20) A probe is single stranded nucleotide sequence that hybridizes into certain pieces of: | | | | |

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- a) Carohydrate b) Amino acid c) RNA d) DNA

21) A single stranded nucleotide sequence that will hybridize into a certain piece of DNA is:

- a) Primer b) Probe c) Genome d) Both a & b

PCR, DNA Finger Printing and DNA Sequencing

22) The Polymerase Chain Reaction (PCR) was developed by Kary B. Mullis in:

- a) 1983 b) 1993 c) 1973 d) 1963

23) The Polymerase Chain Reaction (PCR) was developed in 1983 by:

- a) Theodore M. Klein b) Gottlieb Haberlandt c) Kary B. Mullis d) J. Criag. Venter

24) PCR takes its name from..... enzyme that carries out replication in a cell:

- a) Restriction enzymes b) DNA polymerase c) DNA ligase d) DNA polymerase

25) In which process multiple copies of desired genes are produced?

- a) Polymerase chain reaction
b) DNA finger printing
c) Analyzing DNA
d) DNA polymerase

26) During PCR how DNA double helix is produced?

- a) By heat treatment
b) By use of enzyme DNA polymerase
c) By use of enzyme DNA helicase
d) By use of enzyme DNA ligase

27) Taq polymerase is an enzyme present in:

- a) Fungi b) Bacteria c) Algae d) Virus

28) Thermus aquaticus is a/an:

- a) Fungi b) Bacteria c) Algae d) Virus

29) In DNA Finger Printing, the use of Produces distinctive pattern of autoradiography or x-ray film:

- a) Restriction enzyme
b) Microsatellites
c) Macrosatellites
d) Probes for genetic marker

30) Genome fragments can be separated according to their length during the process:

- a) Catalphoresis b) Gel electrophoresis c) Cloning d) PCR

31) Cases of disputed parenthood can be solved with the help of:

- a) DNA finger printing b) RNA finger printing c) Cloning d) Gene sequencing

32) DNA finger prints can be prepared from:

- a) Plasma b) Lymph c) Serum d) Blood

33) Which statement is not true about PCR?

- a) Developed by Kary Mullis
b) Take its name from DNA polymerase
c) Is not very specific
d) Taq polymerase is used

34) DNA analysis is done to:

- a) Diagnose viral infections b) Identify criminals c) Determine evolution d) All of these

35) A method of DNA sequencing in which DNA threads are chemically cut into pieces of different sizes is:

- a) Sanger's method b) Maxam-Gilbert method c) Hamilton's method d) Vortex method

36) The important application of DNA finger printing is in:

- a) Cytology b) Forensic science c) Genetic engineering d) None

37) The diagnosis of viral infections, genetic disorders and cancer is done by:

- a) Laboratory test b) Eliza test c) PCR amplification d) All of these

38) During DNA sequencing, separation of different pieces of DNA is made on:

- a) Agarose gel b) Agar c) Dextrin d) Carrageenan

39) Substance used to terminate DNA at different points in Sanger's method is:

- a) Deoxyribonucleotide triphosphate
b) Dideoxyribonucleotide triphosphate
c) Deoxyribonucleotide triphosphate
d) Dideoxyribonucleoside triphosphate

Human gene project, Transgenic bacteria and Transgenic plants

40) A full set of genes of an individuals is called its:

- a) Genomic library b) Recombinant DNA c) Gene pool d) Genome

41) The base pairs in human genome are:

- a) Two billion b) Three billion c) Four billion d) Five billion

42) Person with Huntington's disease have a unique site where a restriction enzyme cuts:

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- a) DNA b) RNA c) Lipids d) Proteins
- 43) Organisms that have had a foreign gene inserted into them are called:**
a) Transgenic organism b) Hermaphrodite c) Polygenosis d) Transmuted organisms
- 44) It makes bacterial cell more permeable to take up recombinant plasmids:**
a) Potassium chloride b) Cesium chloride c) Calcium chloride d) Sodium chloride
- 45) Aspartame is:**
a) Dipeptide b) Tripeptide c) Pentapeptide d) Polypeptide
- 46) Which of the following is an example of benefits of transgenic organisms produced through genetic engineering?**
a) Production of antibiotics
b) Production of insulin
c) Production of anti-rabies vaccine
d) Production of anti-malarial drugs
- 47) Which of the following is produced by transgenic plants as well as transgenic bacteria:**
a) Antibodies
b) Hepatitis B vaccine
c) Insulin
d) Human growth hormone
- 48) Antibody used for the treatment of genital herpes is obtained from:**
a) Corn b) Soya bean c) Rice d) Wheat
- 49) Which of these would you not expect to be a biotechnology product:**
a) DNA probe b) Protein c) Steroid d) Vaccine
- 50) Antibody made by soya bean is used as treatment for:**
a) AIDS b) Herpes Simplex c) Genital Herpes d) Hepatitis
- 51) A weed called mouse eared cress is engineered to produce a biodegradable plastic called:**
a) Biodegradable plastic b) Phenylalanine c) Luciferin d) Digitoxin
- 52) Polyhydroxy butyrate is called:**
a) Biodegradable plastic b) Antithrombin II c) Luciferin d) Nutra sweet
- 53) Soya bean have been made resistant to common:**
a) Herbicide b) Fungicide c) Pesticide d) Insecticide
- 54) Which one is not biotechnology product:**
a) Hepatitis B vaccine
b) Tissue plasminogen activator
c) Human growth hormone
d) Hemophilia factor-1
- 55) Human genome is _____ times larger than any other genome sequenced so far:**
a) 45 b) 35 c) 25 d) 15
- 56) Transgenic plants are produced when foreign genes are introduced into:**
a) Mature plant embryo
b) Immature plant embryo
c) Roots
d) Leaves
- 57) Protoplasts are plant cells from which:**
a) Cell walls are removed
b) Nucleus is removed
c) New organelles are added
d) Vacuoles are taken out
- 58) Some transgenic bacteria produce a dipeptide sweetener called:**
a) Ultra sweet b) Disweet c) Monosweet d) Neutrasweet
- 59) Transgenic bacteria are produced in large vats called:**
a) Transducer b) Biomultiplier c) Bioreactor d) Culture media

Transgenic Animals, Hybridization and cloning

- 60) The use of transgenic form animals to produce pharmaceutical is termed as:**
a) Gene therapy b) Genetic drift c) Gene farming d) Gene pharming
- 61) Antithrombin III is a biotechnology product produced in:**
a) Sheep b) Goat c) Mice d) Cow
- 62) Urine is preferable vehicle for a biotechnological product than:**
a) Milk b) Blood c) Plasma d) Tissue fluid
- 63) Tobacco plant produces flowers in:**
a) Spring b) Summer c) Autumn d) Winter
- 64) Adult transgenic plants glowed when sprayed with the substrate:**
a) Luciferin b) Myoglobin c) Hemoglobin d) Methionine
- 65) The enzyme luciferase is produced by an insect called:**

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- a) Housefly b) Firefly c) Butterfly d) Tsetse fly

66) In vortex method of transgenic animals gene is inserted:

- a) By hand
b) Into egg
c) Both by hands and into eggs
d) Is not applicable

67) Cumulus cells are those that

- a) Remain with follicular cells after ovulation occurs
b) Form corpus luteum
c) Form lining of the ovary
d) Cling to the egg after ovulation occurs

Tissue Culture Technology and Gene Therapy

68) In 1958, F.C. Steward grew a complete carrot plant from tiny piece of:

- a) Pith b) Cortex c) Xylem d) Phloem

69) Growth of a tissue in an artificial liquid culture medium is termed as:

- a) Cloning b) Genetic engineering c) Tissue culture d) Gene therapy

70) Young tissues retaining the potential to divide:

- a) Meristem b) Xylem c) Phloem d) Cork

71) Meristem is:

- a) Pathogen free b) Bacteria free c) Fungi free d) Virus free

72) Somatic embryos encapsulated in a protective hydrated gel are called:

- a) Artificial flower b) Artificial leaves c) Artificial seeds d) Artificial fruits

73) Cell suspension cultures of digitalis lantana produce:

- a) Anti-toxin b) Digitoxin c) Polludrin d) Quinine

74) Children with severe combined immune-deficiency syndrome (SCID) lack enzyme:

- a) Adenosin deaminase (ADA) b) LH c) FSH d) Vasoperssin

75) The enzyme adenosine deaminase is missing in person suffering from:

- a) Cystic fibrosis
b) Hypercholesterolemia
c) Severe combined immune-deficiency syndrome (SCID)
d) Parkinson's disease

76) In cystic fibrosis transmission of which is faulty, resulting into the production of disease:

- a) Chloride b) Calcium c) Fluoride d) Magnesium

77) Cystic fibrosis patients lack a gene that codes for trans-membrane carrier of:

- a) Magnesium ion b) Sodium ion c) Calcium ion d) Chloride ion

78) Two methods for gene therapy are:

- a) In-vivo and ex-vitro b) Ex-vivo and in-vivo c) Both a & b d) None of these

79) Which of the following is correct about SCID?

- a) Common in children as well as in adults
b) It is an immune disorder
c) Is due to deficiency of adenosine diaminase
d) Both b and c

80) Tissue culture does not involve:

- a) Growth of tissue in artificial medium
b) Asexual reproduction
c) Use of meristem
d) Use of generative nucleus in pollen culture

81) Plants are totipotent because:

- a) Each cell has full genetic potential of the organism
b) A single cell could become a complete plant
c) Both a and b
d) Because they have lesser potential for tissue culturing

82) Coconut milk contains the plant hormone:

- a) Auxins b) Cytokinins c) Gibberallins d) All of these

83) Cell suspension cultures of:

- a) Cinchona produces quinine
b) Digitalis lanata produce digitoxin
c) Both a and b
d) None of these

84) A device that bombards a callus with DNA coated microscopic metal particles is:

- a) DNA gun b) DNA shooter c) Particle gun d) All of these

Answer key:

1	d	2	a	3	b	4	b	5	d	6	a	7	c	8	d	9	b	10	a
11	a	12	d	13	a	14	c	15	a	16	c	17	b	18	b	19	d	20	d
21	d	22	a	23	c	24	d	25	a	26	a	27	b	28	b	29	d	30	b
31	a	32	d	33	c	34	d	35	b	36	b	37	c	38	a	39	d	40	d
41	b	42	a	43	a	44	c	45	a	46	b	47	b	48	b	49	c	50	c
51	a	52	a	53	c	54	a	55	c	56	b	57	a	58	d	59	c	60	d
61	b	62	a	63	a	64	a	65	b	66	b	67	d	68	d	69	c	70	a
71	d	72	c	73	b	74	a	75	c	76	a	77	d	78	b	79	b	80	d
81	b	82	b	83	c	84	c												

Past MDCAT MCQ's

2008

1) The cell suspension culture of produces quinine:

- a) Soybean b) Digitalis lanata c) Cinchona ledgeriana d) Luceferin

2009

2) Temperature-insensitive (thermostable) enzyme used in PCR is:

- a) DNA polymerase I b) DNA ligase c) DNA polymerase III d) Taq polymerase

3) Cloning is a form of:

- a) Parthenogenesis b) Sexual Reproduction c) Apomixis d) Asexual Reproduction

4) Antigens to treat Non-Hodgkin's lymphoma are produced by:

- a) Wheat Plant b) Tobacco Plant c) Rice Plant d) Corn Plant

2010

5) Gene can be synthesized in laboratory from messenger RNA by using:

- a) Restriction enzymes
b) Vector
c) cDNA (complementary DNA)
d) Reverse transcriptase

6) Antibiotic resistance gene for tetracycline and ampicillin are present in the plasmid:

- a) pSC 101 b) pBR 322 c) pCR 101 d) pBR 233

7) Cloning is a form of:

- a) Sexual Reproduction
b) Vegetative Propagation
c) Asexual Reproduction
d) Genetic Recombination

2011

8) Prosomes are used in gene therapy against:

- a) Hypercholesterolemia
b) Cystic Fibrosis
c) Coronary Artery Angioplasty
d) Severe Combined Immunodeficiency Syndrome (SCID)

9) Genetically engineered cells are introduced into bone marrow cells in the treatment of:

- a) Hypercholesterolemia
b) Cystic Fibrosis
c) Severe Combined Immunodeficiency Syndrome
d) Coronary Artery Angioplasty (SCID)

10) The common vectors used in recombinant DNA technology are:

- a) Probes b) Plasmids c) Palindromes d) Prions

11) The enzyme used to isolate gene from DNA is:

- a) Helicase b) Restriction Enzyme c) Reverse Transcriptase d) DNA Polymerase

12) Which one of the following enzymes is temperature insensitive?

- a) DNA Polymerase I b) DNA Polymerase III c) Taq Polymerase d) RNA polymerase

2012

13) In recombinant DNA technology are tools for manipulating DNA:

- a) Viruses b) Enzymes c) Chromosomes d) Genes

14) In DNA finger printing process, the use of produces distinctive pattern on autoradiography or X-ray film:

- a) Restriction enzyme
b) Macrosatellites
c) Microsatellites
d) Probes for genetic markers

15) In the recombinant DNA technology plasmids are used as:

- a) Genetic material b) Vectors c) Enzymes d) Probes

16) In which process, multiple copies of the desired genes are produced?

- a) Polymerase chain reaction b) Analyzing DNA c) Gene sequencing d) DNA finger printing

17) The enzyme adenosine deaminase is missing in person suffering from:

- a) Cystic fibrosis
b) Severe combined immunodeficiency syndrome
c) Hypercholesterolemia
d) Parkinson's disease

2013

18) The DNA molecule formed from messenger-RNA by reverse transcriptase is called?

- a) Complementary DNA b) Chimeric DNA c) Recombinant DNA d) Plasmid DNA

19) The agent which separates the two strands of DNA in PCR is?

- a) DNA ligase b) Heat c) Primer d) Helicase

20) Cystic fibrosis patient lack a gene that codes for trans-membrane carrier of?

- a) Na⁺ ions b) Ca⁺⁺ ions c) Cl[—] ions d) K⁺ ions

21) The phage commonly used as a vector in genetic engineering is?

- a) Lambda phage b) T2 phage c) Gamma phage d) T4 phage

22) Restriction endonucleases are naturally occurring enzymes of:

- a) Viruses b) Fungi c) Bacteria d) Plants

2014

23) pBr 322 have antibiotic resistance gene for:

- a) Ampicillin and aspirin
b) Ampicillin and Tetracycline
c) Streptomycin and metronidazole
d) Penicillin and metronidazole

24) Cystic Fibrosis affects which one of the following cells of the body?

- a) Epithelial cells b) Plasma cells c) Endothelial cells d) Blood cells

25) The enzymes which act as molecular scissors in recombinant DNA technology is:

- a) Exonucleoses b) Endonucleases c) Polymerases d) Reverse transcriptase

26) Which of the following is the correct sequence of PCR?

- a) Heating → Cooling → Add Primer → Copying of strand
b) Heating → Add Primer → Cooling → Copying of strand
c) Add Primer → Heating → Cooling → Copying of strand
d) Cooling → Add Primer → Heating → Copying of strand

27) When two different pieces of DNA are joined together, the result is which one of the following?

- a) Complementary DNA
b) Mutated DNA
c) Recombinant DNA
d) Cloned DNA

2015

28) In cystic fibrosis, liposomes-microscopic vesicles are sued which are coated with:

- a) Healthy Gene b) Protein c) Chromosome d) Carbohydrate

29) The DNA formed by the reverse transcription is called:

- a) rDNA b) cDNA c) dDNA d) DNA

30) Bacterial cells take up recombinant plasmids when they are treated with:

- a) CaCl₂ b) KCl c) NaCl d) NaOH

31) Which one of the following is made up of radioactively labelled nucleotides?

Prof. Ijaz Ahmed Khan Abbasi (Lecturer Biology PGC)

- a) Phage DNA b) Recombinant DNA c) Genomic Library d) Gene Probe

32) A technique in transgenic animals in which desired gene is inserted into the eggs of animal is called:

- a) Embryonic Stem Cell mediated Transfer
b) Retro-virus mediated gene Transfer
c) Microinjection
d) Virus vectors

2016

33) The modified plasmid or phage DNA is called:

- a) Clone DNA b) cDNA c) Recombinant DNA d) rD

34) Restriction endonucleases cleave the of duplex DNA.

- a) Nitrogenous base b) Phosphodiester bond c) Base sugar d) Hydrogen bond

2017

35) Restriction enzyme EcoR1 cuts DNA to produce:

- a) Blunt ends b) Sticky ends c) Non-palindromic endsd) Split ends

36) Restriction endonucleases are produced by:

- a) Fungi b) Bacteria c) Algae d) Viruses

37) DNA segments of different lengths can be separated by a process of:

- a) Western blotting b) Autoradiography c) Northern blotting d) Gel electrophoresis

38) The is the 1st heat stable component used in PCR:

- a) Taq-isomerase b) Taq-polymerase c) Taq-helicase d) Taq SSBp

39) Patients of cystic fibrosis (CF) produse thick mucus because of faulty:

- a) Trans-membrane carrier b) Na⁺ ions c) Cl⁻ ions d) Mucus membrane

Answer key:

1	c	2	d	3	d	4	b	5	d
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21	a	22	c	23	b	24	a	25	c
26	a	27	b	28	a	29	b	30	a
31	d	32	b	33	c	34	b	35	b
36	d	37	b	38	a	39	c	40	c
41	d	42	c	43	a				

