12. Genetic Engineering and Genomics

12.0 : Introduction

Q.1. What is Genetic engineering ?

Ans: Genetic engineering also called genetic modification, is the direct human manipulation of an organisms genome using modern DNA or synthetic genes into the organism of interest.

OR

It is the science which deals with synthesis of artificial genes and their insertion into a new genome or existing cell for improvement of living being.

Q.2. What is genetic engineering ? Give its applications.

Ans: A science which deals with synthesis of artificial gene and its insertion into new genome or existing cell for improvement of living being.

Applications :

i) **In Medicine :**
Bacteria may be used as living factories for the synthesis of many substances by introducing desired genes into them. e.g. Insulin, growth hormones, interferons, vitamins, antibiotics, etc.

ii) **Study of defective genes and genetic disorders :**
The technique can be used in the study of defective genes in the embryonic stage.

iii) **Medical diagnosis of diseases :**
This technology helps in diagnosis of genetic as well as infectious diseases like muscular dystrophy, hepatitis, etc

iv. **Gene therapy :**
It is the replacement of a defective gene by a normal gene. Many genetic disorders like haemophilia, sickle-cell anaemia, colour blindness, alkaptonuria etc. are due to defective genes. Such genetic disorders can be cured by replacing defective genes with normal genes.

v) **In Industry :**
Genetically engineered microbes have been used to improve the efficiency of food production. For example, rennin an enzyme used in making cheese.

vi) **Pollution:** Genetic engineering also has potential in controlling pollution.

vii) In Agriculture: To produce transgenic plants which are resistant to fungal, viral, bacterial infections, pest, pesticides.

viii) **Solution of disputed parentage :**
Disputed parentage can be more accurately solved by recombinant DNA technology than by blood tests.

ix) **Nitrogen Fixation :**
The nitrogen fixing gene, (Nit) gene, can be transferred from the bacteria like azotobacter to higher plants. This would help the plants in biological nitrogen fixation.

12.1 : DNA Fingerprinting

Q.3. What is DNA fingerprinting ?

Ans: The techniques developed to identify a person with the help of DNA restriction analysis is known as DNA profiling or more popularly known as DNA fingerprinting.

Q.4. Which factors are responsible for differences between parents and children?

Ans: Recombination of paternal and maternal genes and infrequent mutations are responsible for differences between parents and children.

Q.5. What are variable number of tandem repeats or VNTRs ?

Ans: VNTRs are short nucleotide sequences that repeat in DNA and vary in number from person to person, but are inherited. They contain unusual sequences of 20 - 100 base pairs.

Q.6. Who isolated VNTRs ?

Ans: VNTR's were first isolated and identified by A. Wyman and R. White in 1980 at university of Utah.

Q.7. Give the name of process involved in DNA fragmentation. **[Mar 2013]**

Ans: Restriction digestion is the name of the process involved in DNA fragmentation.

Q.8. What is 'restriction digestion'? **[Mar 2014]**

Ans: Restriction endonuclease cut DNA at specific locations making many pieces of DNA having variable length, this process is called 'restriction digestion'.

Q.9. Who discovered technique of D A fingerprinting ?

Ans: British genetists Alec Jeffreys discovered technique of DNA fingerprinting.

Q.10. What is D A fingerprinting? Explain the principle of DNA fingerprinting and write its applications. [Mar 09]

OR

What is DNA fingerprinting? Mention its applications.

Ans: DNA fingerprinting:

i) Identification of a person with the help of DNA restriction analysis is called DNA fingerprinting,
ii) It was developed by Alec Jeffreys in 1984-85.
iii) It is also called DNA profiling or D A typing.

Principle of DNA fingerprinting :

i) DNA fingerprinting is a technique developed for identifying individuals by their DNA.
ii) The human haploid genome contains roughly three billion nucleotides.
iii) Though chemical structure ofD A is always the same, the order of base pairs differs.
iv) Assemblage ofthe three billion nucleotides is a unique genetic identity for every individual.
v) Each strand of DNA is composed of an active genetic information called euchromatin (codes for proteins) and junk DNA or junk genes called heterochromatin (play no role).
vi) The heterochromatin contains very short, repeated sequences of nucleotides ranging between 20-100 base pairs. These sequences are called Variable Number of Tandem Repeats (VNTRs or Minisatellites).
vii) Each individual has some definite set ofVNTRs inherited from hislher parents.
viii) The uniqueness of an individual's VNTRs provides the scientific marker of identity known as DNA fingerprint.

Applications of DNA fingerprinting :

i) It is useful in forensic science (crime detecting) to identify a criminal.
ii) It provides evidence acceptable in court.
iii) It is a sure method in solving paternity and maternity disputes.
iv) It is useful in the tumour analysis in medical research.
v) It helps to solve the problems in immigration.
vi) It helps in settling insurance claims
vii) It helps in agriculture.

Q.11.Enlist the applications of DNA fingerprinting.

Ans: *Refer Q.10*

Q.12. Describe the technique of DNA fingerprinting.

OR

What is D A finger printing? Describe various steps involved in the same.

Ans:DNA fingerprinting is a comparative process employing samples such as blood, hair with root, semen, skin cells, saliva etc. It involves the following steps.

i) **DNA isolation /Extraction :** DNA is extracted from a suitable sample like blood, semen, hair root or other cells of the body.
ii) **DNA amplification :** If the DNA quantity is small it is subjected to invitro replication by a technique called PCR(polymerase chain reaction) to obtain more copies of DNA.
iii) **DNA fragmentation/Restriction digestion :** The extracted DNA is treated with specific enzymes called restriction endonucleases enzyme. These enzymes cut DNA at specific sites only. This process is called restriction digestion.
iv) **Electrophoresis :** Broken DNA fragments are of variable size and exhibit restriction fragment length polymorphism (RFLP).

These fragments are separated by electrophoresis on the agarose gel. Due to this, VNTRs are separated forming specific bands.

v) **DNA probing :** The bands are made clearer by using radioactive DNA of known sequence. This radioactive DNA is called probe. These bands are visualized under ultra violet light. This represents fingerprint.

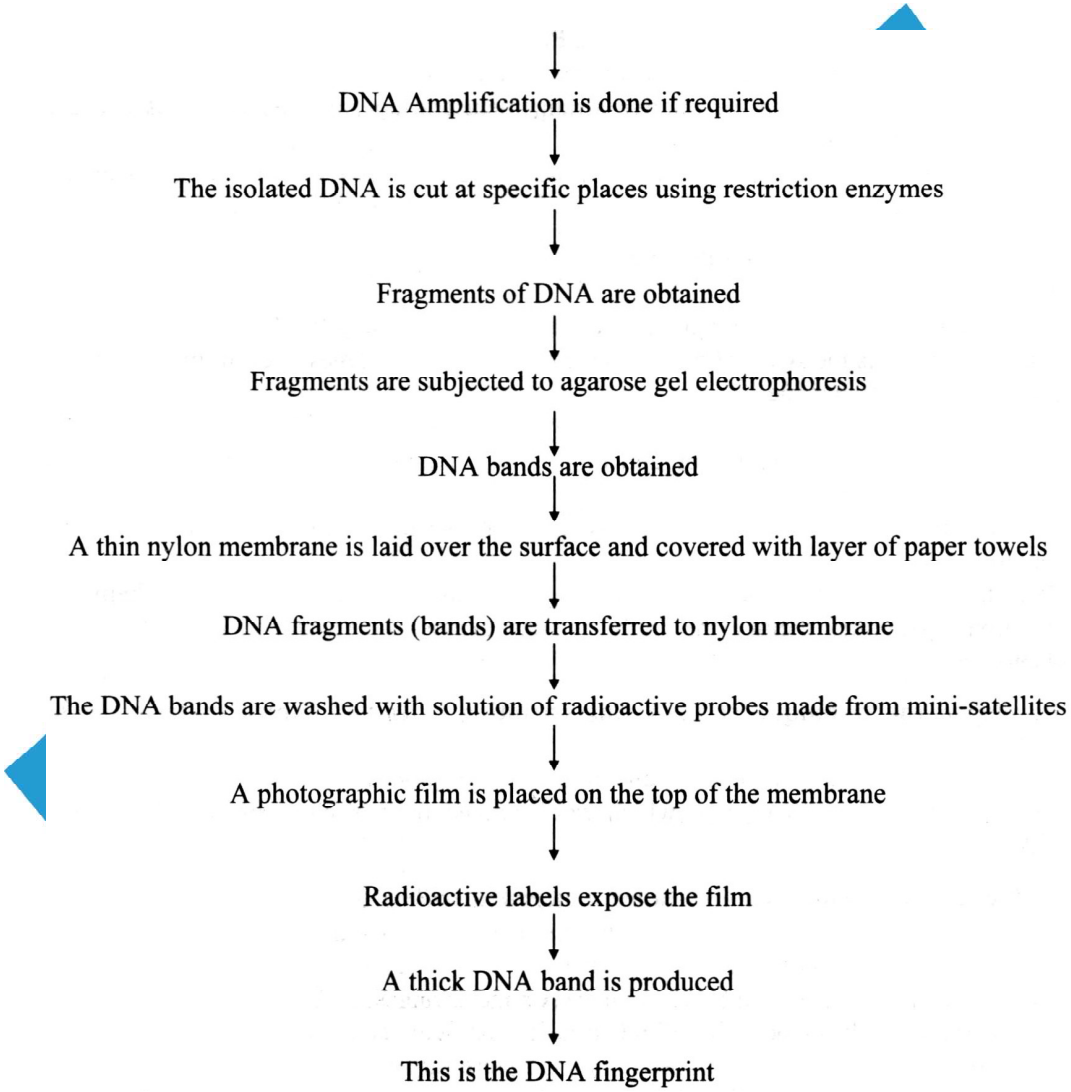
vi) **Southern blotting :** The bands are now blotted on nylon membrane (nitrocellulose paper). The single stranded D A strands get embedded into nylon membrane.

vii) **Hybridization:** The bands are flooded with single stranded radioactive DNA probe. Due to natural affinity, sample DNA and probe DNA form double stranded structure. These double strands remain embedded in the nylon membrane. Remaining single stranded DNA probe fragments are washed off.

viii) **Photography :** This nylon membrane is kept in contact with X ray film. The DNA bands due to radioactive probe give photographic image on X ray film for documentation.

Procedure of DNA finger printing :

Isolation of DNA from the samples collected as tissues of body i.e. blood, hair with root, tissue sample etc.



Q.13.Enlist the steps involved in solving disputed parentage by DNA profiling. **[Mar 2013]**

Ans: *Refer Q.12*

Q.14.Which enzyme is used to cut DNA into pieces?

Ans: Restriction endonuclease is used to cut DNA into pieces.

Q.15.What is restriction fragment length polymorphism ?

Ans: It is technique to measure the length of DNA fragments containing repetitive sequences.

Q.16.Name the radioactive probe used in India for DNA fingerprinting. **[Oct 2013]**

Ans: In India the unique segment obtained from Y chromosome of female banded krait snate i.e. Banded Krait mini satellite is used as radioactive probe for DNA fingerprinting.

12.2 : Genomics and Human Genome Project

Q.17.Define the term 'Genome'.

Ans: Genome is defined as the total number of genes present on the haploid set of chromosomes.

Q.18.Who co-ordinated the human genome project ?

Ans: Human genome project was initiated and co-ordinated by the US Department of Energy and National Institute of Health.

Q.19.Name the two types of maps generated by HGP.

Ans: There are two types of maps: i. Genetic linkage map ii) Physical maps Genetic linkage map determine the relative arrangement and approximate distances between genes and markers on the chromosomes. Physical maps specify the physical location (in base pairs) and distance between genes or DNA fragment with unknown function.

Q.20.Explain Genomics and give its significance.

Ans: Genomics :

i) It is a scientific discipline of mapping, sequencing and analysing the genome.
ii) Thus, Genomics is the study of molecular organisation of genomes, their information contents and the gene products they encode.

Significance of Genomics :

i) The number, size, location and organization of all the genes which are required for formation of an organism can be known.
ii) It is very much helpful for solving many questions arising in biology, by using the information of genome.
iii) Helps in identifying faulty genes for various genetic diseases and seek a cure for them.
iv) Functional genomics include the study of gene expression, regulation and actual production of a phenotype.

Q.21.Who developed the technique of DNA fingerprinting in India? Which material he has used for research ?

Ans:i) Dr. Lalji Singh developed the technique of DNA fingerprinting in India.
ii) He used radioactive DNA probe which was obtained from Y chromosome of female banded krait snake.

Q.22. Why is the Human Genome project called a megaproject ?

Ans:i) Human genome is said to bear 3 x 109 bp. Suppose cost for sequencing one bp is $3 US dollars, the total cost comes out to be 9 billion US dollars.
ii) If such sequences are stored in books, with every page having 1000 letters and each book is of 1000 pages, total number of books formed will be 3300 to store the information present in single human cell.
iii) Thus, for storing this data high speed computers are required. Depending upon high magnitude and requirements of the project, HGP has been called as mega-project.

Q.23. Describe Human Genome Project (HGP).

OR

Write the objectives of Human Genome Project (HGP).

Ans:Human Genome Project :

i) The Human Genome Project (HGP) was initiated in 1990 by U.S. Department of Energy (DOE).
ii) The project was international with a I5-year plan to identify and map an originally estimated 80,000-100,000 human genome and to sequence approximately 3 billion base pairs.
iii) Over 12 countries participated in genome research programme.

Objectives of Human Genome Project :

i) Determine the sequence and number of all the base pairs (three billion) in the human genome - gene mapping
ii) Identify all the genes (25000) present in human DNA .
iii) Determine the function of all the genes and identify the various genes that cause genetic disorders.
iv) Store the information in data base.
v) Improve tools for data analysis.
vi) Find out possibilities of transfer oftechnology developed during HGP to industry.
vii) Address ethical, legal and social issues (ELSI) that may arise from the project.

viii) To have greater understanding of process of human evolution.
ix) To understand more about genetic structure functions, gene mutation, expression and methods to control them.

Q.24.Give the aims of Human Genome Project.
Ans: *Refer Q. 23.*
Q.2S.What are the findings of human genome project?
OR
Mention some of the highlights of human genome project.
Ans: Findings of human genome project:
i) Actual number of human genome is about 30,000 to 40,000.
ii) The complete sequence of human genome present in 23 chromosomes in a diploid cell has been described as "blueprint" of the humanity as it contains scientific keys to understand human biology and behaviour.
iii) Genetic basis of many diseases is. now better understood and therefore innovative methods of detection and cure of diseases can be worked out.
iv) It has shown that the genome of every human being is exactly same. At DNA level all humans are 99% identical. Only 0.001% is different which is the reason for variations in human beings.
v) The studies on HGP have also shown the relevance of huinan genome with other organisms such as mouse, lily plant, *Escherichia coli* etc.

Q.26.Write a note on relevance of human genome with other organisms.
Ans: Relevance of human genome with other organisms:
i) The studies on HGP have shown that the total number of genes present in man and mouse genome is more or less same.
ii) Approximately 90% of the human genes are similar to that of mouse.
iii) The DNA content of the lily plant is 18 times more than the human genome but produces less number of proteins as compared to man.
iv) *Escherichia coli* has a single chromosome. However, the human genome is only 6 times larger than it.

Q.27.Which organism has the smallest genome?
Ans: *Mycobacterium genitalium* has the smallest genome.

12.3 : Biotechnological Application for Human Health

Human insulin and Vaccine production
Q.28.What is insulin ?
Ans: Insulin is a hormone produced by pancreas to regulate blood sugar levels.
Q.29.Which cells of the body produce insulin ?
Ans: Insulin is produced by the p cells of pancreas of islets of Langerhans.
Q.30. Describe the role of insulin in human body.
i) Insulin is a hormone that regulates the amount of glucose in the blood and is required for the body to function normally.
ii) Insulin is produced by the cells in the pancreas,called the islets of Langerhans.
iii) Raised blood glucose triggers the cells in the islets of Langerhans to release the necessary amount of insulin.
iv) Insulin binds to the receptors on the cell's membrane which activates a set of transport molecules so that glucose and proteins can enter the cell.
v) The cells can then use the glucose as energy to carry out its functions.
vi) Without insulin, the blood glucose build up in the blood and the cells are starved of energy source.
vii) Inadequacy of insulin leads to a disease called Diabetis Mellitus.

Q.31.Name the hormone purified from dog's pancreas by Banting and Best. **[Mar 2013]**
Ans: Insulin is the hormone purified from dog's pancreas by Banting and Best.
Q.32.Who isolated insulin first ?
Ans: Fredrick Banting and Charles Best first purified insulin from a dog's pancreas. Banting won a Nobel Prize for his work.
Q.33.What is diabetes melitus ?

Ans: Diabetes melitus is an endocrine disorder in which there is deficiency of necessary amount of insulin, resulting in higher blood glucose values.

Q.34. Describe the steps in the production of humulin, the human insulin:

OR

How is genetically engineered insulin produced ?

Ans: Humulin is synthetic human insulin prepared by using genetic engineering. Humulin is manufactured from DNA sources in laboratory using recombinant DNA technology. The synthetic insulin (humulin) is as effective as hormone insulin secreted by human pancreas.

Synthesis of humulin :

Eli Lilly, an American company marketed the first human insulin called humulin in 1983.

Cloning refers to the process of making multiple identical copies of one gene.

i) Isolation of desired gene :

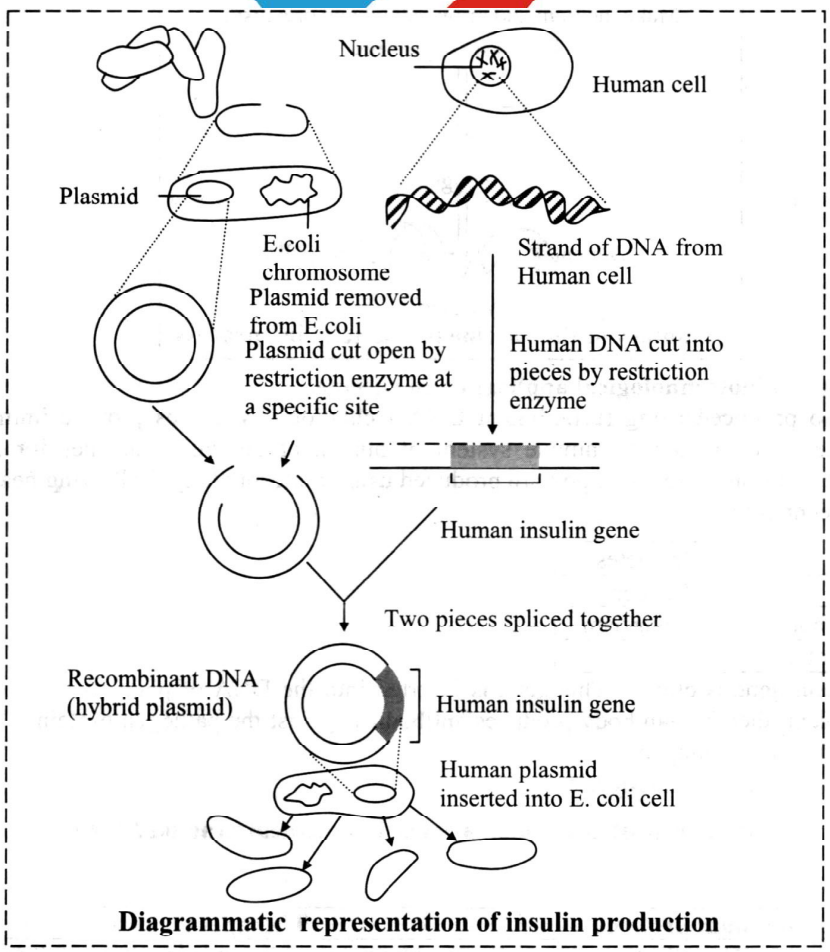
The human insulin gene is isolated from human tissue. The cells are removed and cultured. The cell is broken and DNA is isolated by breaking the nucleus. The desired gene is obtained by cutting the DNA with the help of **restriction endonuclease.** The DNA containing desired gene is called passenger DNA.

ii) Formation of recombinant DNA :

Vector DNA is isolated. Normally the plasmids are used as vectors. The plasmid is cleaved open at a site with the help of restriction endonuclease. Now the desired gene is mixed with plasmid DNA with the help of DNA ligase. The sticky complementary ends of vector DNA and desired DNA fuse. The plasmid DNA containing desired gene (passenger DNA) is called **recombinant DNA.**

iii) Gene transfer to host :

The recombinant DNA is introduced into a host cell e.g. Bacterial Cell (E. coli). The incorporation of recombinant DNA into the host cell is commonly done by electroporation. When bacterial cell divides rapidly, the plasmid along with the desired gene multiplies. Thus several copies of desired gene are produced. The desired gene is allowed to produce a desired product e.g. human insulin. The tons of bacteria make tons of human insulin.



Diagrammatic representation of insulin production

Q.35.Give the diagramatic representation of insulin production.

Ans: *Refer Q. 34 diagram*

Q.36. What are the advantages of genetically engineered insulin?

Ans:i) Genetically engineered insulin is prepared using *E.Coli.*

ii) There is unlimited supply of insulin and it can be obtained at faster rate.

iii) Animals need not be sacrified to yield insulin.

iv) It eliminates chances of a transmission of animal disease through insulin.

Q.37.Name the first vaccine developed against human diseases.

Ans: The first vaccine was produced by Edward Jenner against small pox in 1796.

Q.38.What is adjuvant ?

Ans: It is a substance that improves the effectiveness of a medicine or enhances the ability to produce an immune response.

Q.39.What is vaccine? **[Oct 2013]**

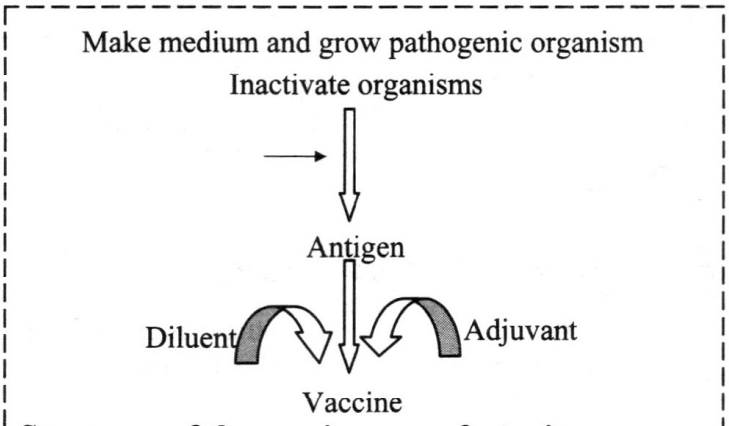
Ans: Vaccine is an antigenic preparation used to stimulate the production of antibodies and induce immunity against several diseases.

Q.40. Describe the process of vaccine production.

Ans:i) Required organisms are grown on cultured medium then inactivation and processing take place

ii) Processed material is then mixed with adjuvant and then fixing and packing of the blended vaccine is done.

iii) They also add a diluent to dilute the material.



Summary of the vaccine manufacturing process

Q.41.Write short notes on biotechnological application in vaccine.

Ans: Vaccines are also produced using recombinant DNA technology. Vaccines provide immunity against a particular disease by evoking the immune system of human or animals. Vaccines for rabies, malaria, hepatitis B, polio virus and also small pox are produced using biotechnology. Following health products are prepared by biotechnology.

Insulin	Diabetes
Interferon	Cancer
Human growth hormone	Dwarfism
Neuro active protein	Pain

A pathogen protein gene is cloned. This gene is inserted into the DNA of plant (potato, banana, tomato). Human eat the plant, then human body produces antibodies against the pathogen protein. Thus, human get 'immunized' against the pathogen.

e.g.: Diarrohea, Hepatitis B and Measles

Q.42.Can you list 10 recombinant proteins, which are used in medical practice? Find where they are used as therapeutics.

Ans:

No.	Recombinant proteins	Therapeutic uses
i)	Human Insulin(Humulin)	For the treatment of diabetes mellitus.
ii)	Factor VIII	For treating haemophilia A.
iii)	Factor IX	For treatment of haemophilia B.
iv)	Interferons	For treatment of viral diseases, cancer and AIDS.
v)	Human growth hormone	To treat pituitary dwarfism
vi)	DNAse-I	For treatment of cystic fibrosis.
vii)	Bovine growth hormone	For increasing milk yield.
viii)	Hepatitis-B surface antigen	Vaccine against hepatitis - B.
ix)	Interleukins	For treatment of various types of cancers.
x)	Anti thrombin-III	To check the clot formation in heart patients.

Q.43. How do vaccines work ? OR
What is the principle behind Vaccination?

Ans :i) Vaccines contain antigens (various body infectious agents).
ii) Each vaccine is specific for a particular infection.
iii) The antigen after entering human body elicits an immune response against that infection.
iv) The memory cells retain the memory and protect against future infections of that disease agent.

Q.44. Give applications of a vaccine. **[Mar 2014]**

Ans:i) Vaccine is an antigenic preparation used to stimulate the production of antibodies.
ii) Vaccines induce immunity against several diseases.
iii) Vaccines stimulate immune system to act against genuine toxins.
iv) Vaccines or vaccination programme is used to eradicate a particular disease. Eg. Now smallpox disease is totally eradicated by vaccination programme.

Gene therapy

Q.45. Enlist the types of gene therapy.

Ans: The two types of gene therapy are
i) Somatic cell therapy : Somatic cells are modified genetically to correct genetic defect.
ii) Germ-line cell therapy: Germ line cells are modified to correct a genetic defect.

Q.46. Define gene therapy. Give its applications.

Ans: Gene therapy is an experimental technique that uses genes to treat or prevent disease by replacing, altering or supplementing a gene that is absent or abnormal and whose absence or abnormality is responsible for the disease.

Applications of Gene therapy :

Gene therapy is used to produce medicinally important recombinant proteins
For example:
i) Bovine growth hormone to increase cattle and dairy yields.
ii) Tissue growth factor promotes new blood vessels and epidermal growth.
iii) Human blood clotting factor VIII to treat haemophilia.
iv) Human insulin to treat insulin dependent diabetes.

Q.47.Enlist the genes used in gene therapy. **[Oct 2013]**

Ans: Examples of genes used in gene therapy:
i) Tissue plasminogen activator (TPA) ii) Dnase
iii) Human growth hormone producer gene iv) Human blood clotting factor - VIII

Q.48. What is the use of tissue plasminogen activator ? **[Mar 2014]**

Ans: Tissue plasminogen activator is used to prevent or reverse blood clots.

Q.49. What are the objectives of gene therapy ?

Ans:i) One of the goals of gene therapy is to supply cells with healthy copies of missing or altered genes.
ii) Instead of giving a patient a drug, doctors attempt to correct the problem by altering the genetic makeup of some of the patient's cells.
iii) Examples of diseases that could be treated this way include cystic fibrosis and hemophilia.

iv) Gene therapy is also being studied as a way to change how a cell functions; for example, by stimulating immune system cells to attack cancer cells or by introducing resistance to human immunodeficiency virus (HIV), the virus that causes acquired immunodeficiency syndrome (AIDS).

Q.50.What is the significance of gene therapy ?

Ans: Significance of gene therapy :

i) Replace missing or defective genes.
ii) Deliver genes that speed the destruction of cancer cells.
iii) Supply genes that cause cancer cells to revert back to normal cells.
iv) Deliver bacterial or viral genes as a form of vaccination.
v) Provide genes that promote or impede the growth of new tissue.
vi) Deliver genes that stimulate the healing of damaged tissue.
vii) Alter faulty genes.

Transgenic animals

Q.51.Give a brief account of methods of transgenesis.

Ans: Transgenesis involves various methods.

i) Transfer of whole nucleus from a somatic cell of superior donor into enucleated egg of recipient animal.
ii) Transfer of part ofbissected embryo into the enucleated unfertilized egg.
iii) Transfer of a chromosome or chromosomal fragments.
iv) DNA micro injection technique.
v) Gene targeting using embryonic stem cells.

Q.52.Why more than 95% of transgenic animals are mice?

Ans: Mice have a short generation time and a superovulated mouse can yield upto 40 eggs. Reimplantation is relatively easy and mouse can carry upto 20 offsprings.

Q.53.What are transgenic animals? Explain the use of transgenic animals.

Ans: Transgenic animals are those animals which have their DNA manipulated to possess and express foreign gene.

Transgenic animals are useful to the human beings in following ways :

i) To understand the normal physiology and development Specifically designed transgenic animals help us to understand mechanism of gene regulation It is used to study how genes affect the normal functions and development of the body. For e.g. study of biological role of insulin - growth factor in regulating body's growth.

ii) To test vaccine safety

Transgenic animals are used as laboratory animals to test efficiency of newly discovered vaccines before it is used on human beings. Mice are used to test polio vaccines.

iii) To test chemical or toxin safety

For this transgenic animals with foreign genes are produced so that the transgenic animals become more sensitive to toxic chemicals than the non-transgenic animals. These animals are exposed to toxic chemicals and their effects are observed.

iv) To serve as a model for study of diseases

Transgenic animals help us to study how genes contribute to development of disease and for investigation of new treatments for diseases. Transgenic animals are now available to study cancer, rheumatoid arthritis,cystic fibrosis, Alzheimer's disease etc.

v) To obtain biological products

Transgenic animals are created to produce biological compounds or molecules that are useful in various ways. It is accomplished by introducing the gene coding for particular molecule, into the animal. For e.g. Rosie, first transgenic cow was produced which produced milk containing human protein, alpha lactalbumin.

Additional information

1. Paul Berg created the first recombinant DNA by combining the DNA from monkey virus SV40 with that of Lambda virus in 1972.
2. Production of copies of DNA fragments or cells or organisms using genetic engineenng is termed as cloning.

3. Dolly, the sheep, was the first successfully cloned mammal. She was created in 1996 by Ian Wilmut at ScotIant. Thereafter, a dog too has been cloned.

Scientists and discoveries :

No.	Invention / Discovery	Year	Name of Scientist
1	DNA isolation	1869	Friedrich Miescher
2	DNA carries genetic information proved.	1943	Oswald Avery, Colin MacLeod and Maclyn McCarty
3	Double helical structure of DNA discovered.	1953	James Watson & Francis Crick.
4	First recombinant DNA molecules created	1972	Paul Berg
5	First Transgenic organism -E. coli created.	1973	Hertbert Boyer and Stanley Cohen.
6	First transgenic animal-mouse.	1974	Rudolf Jaenisch
7	First synthetic life form from the fIrst synthetic bacterial genome.	2010	J.Craig Venter Institute.
8	First vaccine-Smallpox	1796	Edward Jenner
9	First gene therapy-done in USA for congenital immune deficiency	1990	__
10	Discovery of insulin -	1921	Charles Best and Fredrick Banting

Multiple Choice Question

1. Genetic engineering is the
a) formation of new gene artificially
b) formation of RNA from DNA artificially
c) modification of genes artificially
d) formation of DNA from non DNA material

2. DNA finger printing can resolve
a) identification of a person
b) paternity dispute
c) maternity dispute
d) all of these

3. In vitro replication of DNA is called
a) polymerization reaction
b) polymerase chain reaction
c) DNA fragmentation
d) Southern blotting

4. Restriction endonuclease is used in
a) genetic engineering
b) tissue culture
c) cell fractionation
d) regeneration of tissues

5. Restriction enzymes are used in genetic engineering because they
a) can join DNA fragments
b) cut DNA at specific base sequence
c) cut DNA at variable sites
d) are proteolytic enzymes which degrade harmful proteins

6. Restriction endonuclease performs which of the following ?
a DNA repair
b) DNA replication
c) DNA cleavage
d) all of these

7. Key factor in D A profiling is
a) sequence of nucleotides
b) DNA isolation
c) VNTR
d) RFLP

8. VNTR is employed in
a) protoplasmic culture
b) DNA finger-printing
c) regulation of plant growth hormones
d) enhancing photosynthesis in desert plants

9. DNA fingerprinting refers to
a) molecular analysis of profiles of DNA samples
b) analysis of DNA samples using imprinting device
c) technique used for molecular analysis of different specimens of D A
d) techniques used for identification of fingerprints of individuals

10. Variable number of tendon repeats (VNTRs) are analysed for
a) Recombinant DNA technology
b) Gene therapy
c) Direct gene transfer
d) DNA fingerprinting

11. The scientific key to understand biology and behaviour of human is [Mar 2013)
a) Blue print
b) Genome
c) Genetic linkage
d) DNA probe

12. The Human Genome project was initiated by U.S. Department of
    a) Agriculture
    b) Energy
    c) Science and Technology
    d) Health
13. Genetically engineered insulin can be obtained by
    a) recombinant DNA technique with the help of E. coli
    b) two coded insulin genes separated then incorporated into bacteria
    c) the extraction of cow's and pig's pancreas
    d) technique not developed till now
14. Production of a human protein in bacteria by genetic engineering is possible because .
    a) bacterial cell can carry out the RNA splicing reactions
    b) the human chromosome can replicate in bacterial cell
    c) the mechanism of gene regulation is identical in humans and bacteria
    d) the genetic code is universal
15. In early days, insulin was extracted from
    a) liver of pigs
    b) pancreas of pigs
    c) pancreas of pigs and cattle
    d) liver of horse
16. Humulin is
    a) human insulin b) isoenzyme
    c) hydrolytic enzyme d) powerful antibiotic
17. Genetically-engineered human insulin is obtained by inserting the gene in
    a) pancreatic cells
    b) E. Coli.
    c) Agrobacterium tumafaciens
    d) Drosophilla melanogaster
18. Vaccine is a
    a) collection of antibiotics life saving drugs
    b) life saving drugs
    c) killed bacteria and viruses
    d) collection of lysins
19. Gene therapy is
    a) study of extra nuclear gene
    b) replacement of faulty gene by a normal healthy functional gene
    c) cosmetic surgery
    d) all the above
20. α -I antitrypsin is used in the treatment of **[Oct 2013]**
    a) Phenylketonuria
    b) Cystic fibrosis
    c) Emphysema
    d) Haemophilia
21. An example of gene therapy is
    a) production of injectable Hepatitis B vaccine
    b) production of vaccines in food crops like potatoes which can be eaten
    c) introduction of gene for adenosine deaminase in persons suffering from Severe Combined Immuno-deficiency (SCID)
    d) production of test tube babies by. artificial insemination and implantation of fertilized eggs
22. A transgenic animal has
    a) foreign RNA in all its cells
    b) foreign DNA in all its cells
    c) both a) and b)
    d) none of these
23. Transgenic organisms are formed by
    a) crossing two hybrids
    b) inducing mutations by chemicals
    c) introducing foreign genes
    d) crossing genes of somatic cells of same organisms
24. _____Safety of polio vaccine is tested on transgenic **[Mar 2014]**
    a) pig b) rabbit
    c) fish d) mice

Answer Keys

1.	c)	**2.**	d)	**3.**	b)	**4.**	a)	**5.**	b)	**6.**	c)	**7.**	c)	**8.**	b)	**9.**	a)	**10.**	d)
11.	a)	**12.**	b)	**13.**	a)	**14.**	d)	**15.**	c)	**16.**	a)	**17.**	b)	**18.**	c)	**19.**	b)	**20.**	c)
21.	c)	**22.**	b)	**23.**	c)	**24.**	d)												