Lesson 7

15.Given below are some human organs. Identify one primary and one secondary lymphoid organ. *Explain its role.* Liver, thymus, stomach, thyroid, tonsils

1. Thymus – is the primary lymphoid organ
   Role: production and maturation of T lymphocytes

2. Tonsils – is the secondary lymphoid organ
   Role: it encounters antigen in the presence of lymphocytes

16.Name and explain the type of barriers which involve macrophages.

• Phagocytic barrier

• This mechanism, specialized cells such as monocytes, neutrophils and tissue macrophages — phagocytose and digest whole microorganisms.

17. What are interferons? Mention their role.

❖ Interferons induce anti-viral state in the uninfected cells. Complementary substances produced from infected cells help the pathogenic microbes or facilitate phagocytosis.

❖ They are included in chemical mediators of innate immunity.

Role: They activate macrophages/lymphocytes/natural killer cells.

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18. Listen/describe innate immunity produced during inflammation.

Inflammatory barriers is the type of innate immunity. Tissue damage and infection induce leakage of vascular fluid, containing lymphatic vessels, signals like serotonin, histamine, prostaglandins. These inflammatory responses protect the infected area. This phenomenon is called diapedesis.

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19. Explain the process of replication of retrovirus where RNA enters into the human body.

❖ After getting into the body of the person, the virus enters into macrophages where RNA genome of the virus replicates to form viral DNA with the help of the enzyme reverse transcriptase.

❖ This viral DNA gets incorporated into the DNA of host cells and directs the infected cells to produce viral particles.

❖ The macrophages continue to produce virus and in this way acts like a HIV factory.

❖ Simultaneously, HIV enters into helper T-lymphocytes, replicates and produces progeny viruses.

❖ The progeny viruses released in the blood attack other helper T-lymphocytes.

❖ This is repeated, leading to a progressive decrease in the number of helper T lymphocytes in the body of infected person.

Symptoms:

❖ The person suffers from bouts of fever, diarrhoea and weight loss.

❖ The person starts suffering from infections and becomes immune deficient and unable to protect against any infection.

❖ Due to decrease in the number of helper T lymphocytes.

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20. Explain the structure of immunoglobulin with suitable diagram. (Aug -2021, May – 22, Mar – 23, Jun – 24)

❖ It is protein molecules synthesized on exposure to antigen - B – lymphocytes produce antibodies.

❖ In the 1950s, experiments by Porter and Edelman revealed the basic structure of the immunoglobulin.

❖ The antibodies are classified into five major categories, based on their physiological and biochemical properties. They are IgG(gamma), IgM(mu), IgA (alpha), IgD(delta) and IgE(epsilon).

❖ An antibody molecule is Y shaped structure that comprises of four polypeptide chains, two identical light chains (L) of molecular weight 25,000 Da (approximately 214 amino acids) and two identical heavy chains (H) of molecular weight 50,000 Da (approximately 450 amino acids).

❖ The polypeptide chains are linked together by di-sulphide (S-S) bonds. One light chain is attached to one heavy chain and two heavy chains are attached to each other to form a Y shaped structure.

❖ Hence, an antibody is represented by H_2L_2. The heavy chains have flexible hinge region at their approximate middles.

[Diagram labels:]

- Antigen binding sites
- Variable Region
- Light Chain
- Disulphide Bond
- Heavy Chain
- Constant Region

❖ Each chain (L and H) has two terminals. They are C - terminal (Carboxyl) and amino or N terminal. Each chain (L and H) has two regions. They have variable (V) region at one end and much larger constant (C) region at the other

end.

❖ Antibodies responding to different antigens have very different (V) regions but their (C) regions are the same in all antibodies. In each arm of the monomer antibody, the (V) regions of the heavy and light chains combines to form an antigen – binding site shaped to „fit" a specific antigenicdeterminant.

❖ Consequently each antibody monomer has two such antigen – binding regions. The (C) regions that forms the stem of the antibody monomer, determine the antibody class and serve common functions in all antibodies.

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21. The functions of immune globulin in humoral/cellular innate immunity system?

What are the cells involved in innate immunity are agglutination, precipitation, opsonisation, neutralization etc., (leucocytes) Monocytes, neutrophils, tissue macrophage and Dendritic cells

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22. What is vaccine? Mention its types? (Aug – 2021, July – 22)

A vaccine is a biological preparation that provides active acquired immunity to a particular disease and resembles a disease-causing microorganism and is often made from weakened or attenuated or killed forms of the microbes, their toxins, or one of its surface proteins.

These are classified as/types of vaccines are

i) First generation vaccines – Live attenuated, killed, Toxoids

ii) Second generation vaccines – HBV

iii) Third generation vaccines– DNA vaccine

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23. A person is infected by HIV. How will you diagnose for AIDS?

a) ELISA test:

The ELISA test (Enzyme Linked Immunosorbent Assay) detects the presence of HIV antibodies. It is a preliminary test.

b) Western blot test:

It is more reliable and a confirmatory test. It detects the viral core proteins.

If both tests detect the presence of the antibodies, the person is considered to be HIV positive.

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24. Auto immunity is a misdirected immune response. Justify. (Mar – 2020, Jun – 23)

❖ Our body produces antibodies (auto antibodies) and cytotoxic T cells that destroy our own tissues. If a disease-state results, it is referred to as auto-immune disease. Thus, autoimmunity is a misdirected immune response.

❖ Autoimmunity is evidenced by the presence of auto antibodies and T cells that are reactive with host antigens.

❖ When the cells act as antigens in the same body, they are called autoantigens.

Organ specific disease – Hashimoto's, Grave's diseases.

Non – Organ specific disease – Rheumatoid arthritis, Multiple sclerosis.

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25. List the causative agent, mode of transmission and symptoms for Diphtheria and Typhoid.

S.No	Diseases	Causative agent	Mode of transmission	Symptoms
1	Diphtheria	Corynebacterium diphtheria e	Droplet Infection	Fever, sorethroat Hoarseness and difficulty in breathing
2	Typhoid (Entericfever)	Salmonella typhi	Through contaminated food and water	Headache, abdominal discomfort, fever and diarrhoea

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26. A patient was hospitalized with fever and chills. Merozoites were observed in her blood. What is Your diagnosis?

i) Merozoites in the blood (RBC) indicate the presence of Malarial parasite

ii) Occurence of the merozoites in the blood indicates that the person is suffering from malaria

iii) Mononucleated merozoites lyses RBC and releasing merozoites and haemotoxin.

iv) Shivering, chills and high fever are symptoms of diseases.

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27. Write the scientific name of the filarial worm that causes filariasis.

a) Write the symptoms of filariasis.

b) How is this disease transmitted? (May – 2022)

Filariasis is caused by Wuchereria Bancrofti, commonly called filarial worm.

Symptoms:

Inflammation of the lymph node due to accumulation of the worms block the lymphatic system some cases, the obstruction of lymph vessels causes elephantiasis or filariasis of the limbs, scrotum and mammary glands.

Transmission: It is transmitted by Female Culex mosquito.

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28. List the common with drawal symptoms of drugs and alcohol abuse.

The with drawal symptoms may range from

i) Mild tremors to convulsions.

ii) Severe agitation and fits.

iii) Depressed mood, anxiety, nervousness, restlessness, irritability, Insomnia and dryness of throat, etc. depending on the type of drug abuse.

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29. Why do you think it is not possible to produce vaccine against 'common cold'?

It is not possible to produce vaccine against common cold because there are more than 150 different strains of Rhinovirus.

More over the RNA genome keeps changing due to mutation Hence it is very difficult to prepare a common vaccine for the disease.

Lesson 8

9. How is milk converted into curd? Explain the process of curd formation.

The LAB bacteria grows in milk and convert it into curd, there by digesting the milk protein casein. A small Amount of curd added to fresh milk as a starter or inoculum contains millions of *Lactobacilli*, which under suitable temperature (≤40°C) multiply and convert milk into curd.

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10. Give any two bioactive molecules produced by microbes and state their uses.

i. Cyclosporin A, an immunosuppressant used in organ transplantation is produced from the fungus Trichoderma polysporum. It is also used for its anti-inflammatory, anti-fungal and anti-parasitic properties.

2. Statins produced by the yeast Monascus purpureus have been used to lower blood cholesterol levels.
3. Recombinant human insulin has been produced predominantly using E. coli and Saccharomyces cerevisiae for therapeutic use in human.

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10. Define the following terms:

a) Antibiotics:

Antibiotics are chemical substances produced by microorganisms which can kill or retard the growth of other disease causing microbes even in few concentration. Antibiotic means "against life". Antibiotics are used to treat diseases such as plague, meningitis, diphtheria, syphilis, leprosy, tuberculosis etc.,

b) Zymology: (Jun – 2023)

Zymology is an applied science which deals with the biochemical process of fermentation and its practical uses.

c) Superbug: (July – 2022)

"Superbug" is a term used to describe strains of bacteria that are resistant to the majority of antibiotics commonly used today.

11. Write short notes on the following.

a) Brewer's yeast:

Saccharomyces cerevisiae commonly called brewer's yeast is used for fermenting malted cereals and fruit juices to produce various alcoholic beverages.

b) Ideonella sakaiensis:

Ideonella sakaiensis is currently tried for recycling of PET plastics. These bacteria use PET ase and MHETase enzymes to breakdown PET plastic into terephthalic acid and ethylene glycol.

c) Microbial fuel cells: (AUG – 2021)

[Diagram showing fuel cell structure with Substrate, O_2, H^+, $2H_2O$, CO_2, H_2, and other components]

❖ A microbial fuel cell is a bio-electrochemical system that drives an electric current by using bacteria and mimicking bacterial interaction found in nature.

❖ Microbial fuel cells work by allowing bacteria to oxidize and reduce organic molecules. Bacterial respiration is basically one big redox reaction in which electrons are being moved around.

❖ A MFC consists of an anode and a cathode separated by a proton exchange membrane. Microbes at the anode oxidize the organic fuel generating protons which pass through the membrane to the cathode and the electrons pass through the anode to the external circuit to generate current.

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12. List the advantages of the biogas plants in rural areas. (Jun – 2024)

❖ Biogas can be produced from raw materials such as agricultural wastes, manure, municipal wastes, plant material, sewage, food waste, etc., available naturally in rural areas.

❖ The biogas plant converted the organic materials into gas (63 % Methane) and organic fertilizer through microbial reaction by methanobacterium.

❖ The biogas is devoid of smell and burns with a blue flame without smoke.

❖ The excreta of cattle called dung is commonly called "Gobar". Gobar gas is generated by the anaerobic decomposition of cattle dung.

❖ The slurry is drained through another outlet and is used as fertilizer.

❖ Biogas is used for cooking and lighting.

❖ Biogas plant technology was developed in India due to efforts of TARI and KVIC further the set up does not require a lot of space. There are no side effects and the whole process is eco friendly and easily manageable in rural area.

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13. When does antibiotic resistance develop? (MAY - 2022)

1. Antibiotic resistance occurs when bacteria develop the ability to defeat the drug designed to kill or inhibit their growth. It is one of the most acute threat to public health.
2. Antibiotic resistance is accelerated by the misuse and over use of antibiotics, as well as poor infection prevention control.
3. Antibiotics should be used only when prescribed by a certified health professional.
4. When the bacteria become resistant, antibiotics cannot fight against them and the bacteria multiply.
5. They effectively and accurately target specific pathogenic organisms and are less likely to cause resistance. "Superbug" is a term used to describe strains of bacteria that are resistant to the majority of antibiotics commonly used today.

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14. What is referred to as industrial alcohol? Briefly describe its preparation. (MAR -2022)

Saccharomyces cerevisiae is the major producer of ethanol/C_2H_5OH. It is used for industrial, laboratory and fuel purposes. So ethanol is referred to as industrial alcohol. Bacteria such as Zymomonas mobilis and are also involved in ethanol production.

The principal substrates for the commercial production of industrial alcohol include molasses or corn, potatoes and wood wastes. The process of ethanol production starts by milling a feed stock followed by the addition of dilute or fungal amylase (enzyme) from Aspergillus to break down the starch into fermentable sugars. Yeast is then added to convert the sugars to ethanol which is then distilled off to obtain ethanol which is up to 96 percent in concentration. The two most common type of bio fuels in use today are ethanol and biodiesel, both of them represent the first generation of bio fuel technology. Ethanol is often used as a fuel, mainly as a bio fuel additive for gasoline.

15. What is bioremediation? (Jun – 2023)

$C_6H_{12}O_6$ ------Fermentation-----→ $2C_2H_5OH + 2CO_2$

❖ The use of naturally occurring or genetically engineered microorganisms to reduce or degrade pollutants is called bioremediation.

❖ Bioremediation is less expensive and more sustainable than other remediations available.

16. Differentiate Ex situ and Insitu bioremediation.

1. **In situ bioremediation**
2. **Ex situ bioremediation**

❖ It is grouped into in situ bioremediation (treatment of contaminated soil or water in the site) and

❖ ex situ bioremediation (treatment of contaminated soil or water that is removed from the site and treated).

Lesson 9

10. Mention the number of primers required in each cycle of PCR. Write the role of primers and DNA polymerase in PCR. Name the source organism of the DNA polymerase used in PCR.

❖ Number of primers required for each cycle of PCR is 2, they are forward and reverse primers

❖ Primers: A primer is a short strand of RNA or DNA that serves as starting point for DNA synthesis. The primer template is used to synthesize DNA by using Taq – DNA polymerase.

❖ DNA Polymerase: DNA polymerase used in PCR is Taqpolymerase. This enzyme is able to with stand the high temperature and makes the new strands of DNA using existing strands as templates.

❖ Taqpolymerase: Taq polymerase is obtained from thermophilic bacterium called Thermusaquaticus. The

enzyme extends each primer by copying the single stranded template.

❖ Source organism of the DNA polymerase: T aquaticus

11. How is the amplification of a gene sample of interest carried out using PCR? (OR) What is PCR? Explain various steps involved in PCR.

[Diagram showing PCR cycles with Nucleotide, Denaturation, Annealing, Extension, and DNA strands labeled from cycles 1-5]

❖ The polymerase chain reaction (PCR) is an invitro amplification technique used for synthesizing multiple identicalcopies (billions) of DNA of interest.

❖ The technique was developed by Kary Mullis(Nobel laureate, 1993) in the year 1983. Denaturation, renaturation or primer annealing and synthesis or primer extension, are the three steps involved in PCR

1. Denaturation: The double stranded DNA of interest is denatured to separate into two individual strands by high temperature. This is called denaturation.

❖ Each strand is allowed to hybridize with a primer (renaturation or primer annealing). The primer template is used to synthesize DNA by using Taq –DNA polymerase.

❖ During denaturation the reaction mixture is heated to 95° C for a short time to denature the target DNA into single strands that will act as a template for DNA synthesis.

2. Primer Annealing renaturation: Annealing is done by rapid cooling of the mixture, allowing the primers to bind to the sequences on each of the two strands flanking the target DNA.

3. During primer extension or synthesis the temperature of the mixture is increased to 75^0 C for a sufficient period of time to allow Taq DNA polymerase to extend each primer by copying the single stranded template.

❖ At the end of incubation both single template strands will be made partially double stranded. The new strand of each double stranded DNA extends to a variable distance downstream.

❖ These steps are repeated again and again to generate multiple forms of the desired DNA. This process is also called DNA amplification.

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13. What is genetically engineered Insulin?

❖ The insulin which are obtained from recombinant DNA technology are called genetically engineered insulin.

❖ The approval to use recombinant insulin for diabetes mellitus was given in 1982.

❖ This is also called humulin.

14. Explain how "Rosie" is different from a normal cow.

❖ *Rosie* is a transgenic cow.

❖ It was considered different from a normal cow as it produced human protein enriched milk

❖ The milk contained human alpha-lactalbumin / Proteinrich milk (2.4 gm/litre)

❖ It was a nutritionally balanced food for human babies than normal cow

15. How was Insulin obtained before the advent of rDNA technology? What were the problems encountered?

❖ In the early years, insulin isolated and purified from the pancreas of pigs and cows.

❖ It was used to treat diabetic patients.

problems of using animal insulin

It resulted in the occurrence of allergic reaction in some diabetic patients due to minor variation in their structure

16. ELISA is a technique based on the principles of antigen-antibody reactions. Can this technique be used in the molecular diagnosis of a genetic disorder such as Phenylketonuria?

Yes, phenylketonuria can be diagnosed by ELISA

ELISA test used antibodies against phenylalanine which are then bound by another antibody which binds the original antibody as an antigen

17. Gene therapy is an attempt to correct a Genetic defect by providing a normal gene into the individual by this the function can be restored. An alternate method would be to provide gene product known as enzyme replacement therapy, which would also restore the function. Which in your opinion is a better option? Give reasons for your answer. (PS, Mar – 2025)

❖ But are helps in restore the genetic defects.

❖ Gene therapy is better than the enzyme replacement therapy, because gene therapy permanently cure

the genetic diseases caused by single gene mutation

❖ But enzyme replacement therapy manage the diseases and their benefits temporarily.

18. What are transgenic animals? Give examples. (Jun – 2024)

- **Transgenesis is the process of introduction of extra (foreign/exogenous) DNA into the genome of the animals to create and maintain stable heritable characters.**

- **The foreign DNA that is introduced is called the transgene and the animals that are produced by DNA manipulation are called transgentic animals or the genetically engineered or genetically modified organisms**

- **Examples : transgenic mice, cow, Rat, Rabbit, pig, Goat, Sheep, Fish**

19. If a person thinks he is infected with HIV, due to unprotected sex, and goes for a blood test. Do you think a test such as ELISA will help? If so why? If not, why?

- **Yes ELISA is used to diagnose AIDS**

- **ELISA is a tool for determining serum antibody concentrations**

- **It is also used for detecting the presence of specific antigens and hormones such as human chorionic gonadotropins**

20. Explain how ADA deficiency can be corrected? It can be corrected by

Bone marrow transplantation and Gene therapy

a) Bone marrow transplantation:

- **In some children ADA deficiency could be cured by bone marrow transplantation, where defective immune cells could be replaced with healthy immune cells from a donor**

- **In some patients it can be treated by enzyme replacement therapy, in which functional ADA is injected into the patient.**

b) Gene therapy: (May – 2022)

- **The lymphocytes from the blood of the patient are removed and grown in a nutrient culture medium and**

- **A healthy and functional human gene, ADA cDNA encoding this enzyme is introduced into the lymphocytes using a retrovirus.**

- **These genetically engineered lymphocytes are subsequently returned to the patient.**

- **The disease could be cured permanently if the gene for ADA isolated from bone marrow cells are introduced into the cells of the early embryonic stages.**

21. What are DNA vaccines?

- **DNA vaccines consist of a gene encoding an antigen protein**

- It is inserted into a plasmid and then incorporated into the cells in a target animal.
- DNA instructs the cells to make antigenic molecules which are displayed on its surface
- This would evoke an antibody response to the free floating antigen secreted by the cells.
- This would evoke an antibody response to the germline gene therapy. (July – 2022, Jun – 2024)

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22. Differentiate between Somatic cell gene therapy and germline gene therapy

Somatic cell gene therapy	Germ line gene therapy
Therapeutic genes transferred into the somatic cells.	Therapeutic genes transferred into the germ cells.
Introduction of genes into bone marrow cells, blood cells, skin cells etc.	Genes introduced into eggs and sperms.
Will not be inherited in later generations	Heritable and passed on to later generations.

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23. What are stem cells? Explain its role in the field of medicine. (Mar – 2020, July – 2022)

Stem cells are undifferentiated cells found in most of the multicellular animals. these cells maintain their undifferentiated state even after undergoing numerous mitotic divisions.

Role in the field of medicine:

- Stem cells research has the potential to revolutionize the future of medicine with the ability repair damaged and diseased organs
- The most important and potential applications of human stem cells is the generation of cells and tissues that could be uses for cell based therapies.
- Human stem cells could be used to test new drugs.

24. One of the applications of biotechnology is 'gene therapy" to treat a person born with a hereditary Disease. (MAY – 2022)

i) What does "gene therapy" mean?

It involves the transfer of a normal gene into a person's cells that carries one or more mutant alleles

ii) Name the hereditary disease for which the first clinical gene therapy was used.

The first clinical gene therapy was given in 1990 by French Anderson to four year old girl with Adenosine Deaminase (ADA) Deficiency

iii) Mention the steps involved in gene therapy to treat this disease.

1. **Bone narrow transplantation**
2. **Enzyme replacement therapy**

❖ **During gene therapy the lymphoctyes from the blood of the patient are removed and grown in a nutrient culture medium. a healthy and functional human gene, ADA cDNA encoding this enzyme is introduced into the lymphocytes using a retrovirus.**

❖ **The genetically engineered lymphocytes are subsequently returned to the patient. Since these cells are immortal, the patient requires periodic infusion of such genetically engineered lymphocytes.**

❖ **The disease could be cured permanently if the gene for ADA isolated from bone marrow cells are introduced into the cells of the early embryonic stages.**

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25. PCR is a useful tool for early diagnosis of an Infectious disease. Elaborate.

❖ **The specificity and sensitivity of PCR is useful for the diagnosis of inherited disorders viral and bacterial diseases.**

❖ **The concept behind PCR based diagnosis of infectious disease is simple. If the pathogen is present in clinical specimen, it's DNA will be present.**

❖ **It's DNA has unique sequences that can be detected by PCR. Often using clinical specimens in the PCR mixture.**

❖ **PCR is a valuable tool for diagnosis and monitoring retroviral infections like corona virus (SARS – CO VID)**

❖ **Several virally induced cancers like cervical cancer caused by papilloma virus also can be detected by PCR.**

26. What are recombinant vaccines?. Explain the types.

Recombinant vaccines

Recombinant DNA technology has been used to produce new generation vaccines. The limitations of traditional vaccine production could be overcome by this approach. The recombinant vaccines are generally of superior quality and produce less side effects as compared to the vaccines produced by conventional methods.

Different types of recombinant vaccines includes

- **Subunit recombinant vaccines**
- **Attenuated recombinant vaccines and**
- **DNA vaccines**

Subunit recombinant vaccines

- **Vaccines that use components of a pathogenic organism rather than the whole organism are called subunit vaccines; recombinant DNA technology is very suited for developing new subunit vaccines.**
- **It includes components like proteins, peptides and DNAs of pathogenic organisms.**
- **The advantages of these vaccines include their purity in preparation, stability and safe use.**

Attenuated recombinant vaccines

- **This includes genetically modified pathogenic organisms (bacteria or viruses) that are made nonpathogenic and are used as vaccines.**
- **It is now possible to genetically engineer the organisms (bacteria or viruses) and use them as live vaccines and such vaccines are referred to as attenuated recombinant vaccines.**

DNA vaccines

- **Genetic immunisation by using DNA vaccines is a novel approach that came into being in 1990. The immune response of the body is stimulated by a DNA molecule.**
- **A DNA vaccine consists of a gene encoding an antigenic protein, inserted ionto a plasmid, and then incorporated into the cells in a target animal.**
- **DNA instructs the cells to make antigenic molecules which are displayed on its surfaces. This would evoke an antibody response to the free floating antigen secreted by the cells.**
- **The DNA vaccine cannot cause the disease as it contains only copies of a few of its genes.**

❖ DNA vaccines are relatively easy and inexpensive to design and produce.

❖ Vaccines produced by these new techniques have definite advantages like producing target proteins, long lasting immunity and trigger immune response only against specific pathogens with less toxic effects.

27. Explain why cloning of Dolly, the sheep was such a major scientific breakthrough?

❖ Dolly the transgenic clone was developed by the nuclear transfer technique.

❖ This was a major breakthrough since it showed that genetics manipulations are possible in adult cells.

❖ Transagenic animals serve as good models for understanding human diseases which help in investigation of new treatments for disease. Eg. Transgenic models exits for many human disease such as cancer rheumatoid arthritis est.

❖ Further dolly was the first animal to be cloned from a differentiated somatic cell taken from an adult Animal without the process of fertilization.

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28. Mention the advantages and disadvantages of cloning.

Advantages:

❖ Offers benefits for clinical trials and medical research. It can help in the production of proteins and drugs in the field of medicine.

❖ Aids stem cell research.

❖ Animal cloning could help to save endangered species.

Disadvantages:

❖ Animal and human activists see it as a threat to biodiversity saying that this alters evolution which will have an impact on populations and the ecosystem.

❖ The process is tedious and very expensive.

❖ It can cause animals to suffer.

❖ Reports show that animal surrogates were manifesting adverse outcomes and cloned animals were affected with disease and have high mortality rate.

❖ It might compromise human health through consumption of cloned animal meat.

❖ Cloned animals age faster than normal animals and are less healthy than the parent organism as discovered in Dolly.

❖ Cloning can lead to occurrence of genetic disorders in animals.

❖ More than 90% of cloning attempts fail to produce a viable offspring

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29. Explain how recombinant Insulin can be produced.

[Diagram showing the process of recombinant insulin production with following labeled components:

- DNA
- Human pancreas cell
- Human insulin gene
- Bacterial plasmid
- Plasmid DNA cut with restriction enzymes
- Plasmid + human DNA
- Bacterium
- Introduction of recombinant plasmid into bacterial cell
- Recombinant Bacterium
- Fermentation Tank
- Recombinant bacterial and producing human insulin in large quantities
- Extraction & purification of Human insulin
- Human insulin (final product in bottle)]

❖ In the early years, insulin isolated and purified from the pancreas of pigs and cows was used to treat diabetic patients.

❖ Due to minor differences in the structure of the animal insulin as compared to human insulin, it resulted in the occurrence of allergic reactions in some diabetic patients.

❖ Production of insulin by recombinant DNA technology started in the late 1970s.

❖ This technique involved the insertion of human insulin gene on the plasmids of E.coli.

❖ The polypeptide chains are synthesized as a precursor called pre-pro insulin, which contains A and B segments linked by a third chain (C) and preceded by a leader sequence.

❖ The leader sequence is removed after translation and the C chain is excised, leaving the A and B polypeptide chains.

❖ The approval to use of recombinant insulin – 1982.

❖ Human insulin was marketed as Humulin – 1986.