SRIRAM'S IAS

GENERAL STUDIES

Biology

Additional supplement

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1 **BIOLOGY**

- Biology is the study of living organisms
- living organisms include plants, animals and human beings.
- Viruses occupy a place between non living and living organisms, may they are connecting links in between.
- Aristotle, a Greek philosopher made BIOLOGY as science, while the word was coined by JEAN LAMARCK.
- Till middle ages it became a descriptive subject.
- With the invention of microscope, the dimensions of biology got completely changed

2 **Organization in living organisms**

Life organization is featured by shape, form, size and composition.
Composition includes organisms made up of only cell- unicellular.
Multi cellular
Tissues (simple)
Tissues (compound)
Organs
Organ systems

3 **Metabolism**

- Metabolism is featured by metabolic activities.
  - ❖Locomotion and movement
  - ❖Nutrition
  - ❖Respiration
  - ❖Excretion
  - ❖Response to stimulus
  - ❖Reproduction

  Life is featured by metabolism-growth-reproduction

4 **Types of Metabolism**

- Metabolic reactions are of 2 types
  - ❖Anabolic reactions
  1. In this process complex organic compounds, cell components and cell products are synthesized.
  2. Anabolic reactions need an input of energy –'"enderginic" in nature.
  3. Anabolism results in growth in terms of body weight and height.

5 **Catabolism**

- Complex organic substances are broken down in to simpler substances
- These reactions usually release energy. As such they are called as "exgergonic" reactions.
- Catabolic end products can not be transformed by the organism.

6 **Types of Metabolism**

- There are 3 types of metabolism , they are
  - –Energy metabolism:
    Organisms need energy for biosynthesis (contraction of muscles, nerve conduction and uptake of materials. A small part of the energy is utilized to maintain body temperature.
  - Intermediate metabolism :
  - Include chemical reactions which change the products of digestion reaching the cells so that cells can utilize the same.

7 **Basal metabolism**

- Even when a person is completely inactive like sleep. Some amount of energy is required to run vital functions such as breathing, heart beat, maintenance of body

fluids and conduction of nerve impulses.

- Therefore the amount of minimum energy for the body to run comes under basal metabolism—BMR
- The BMR is determined by the amount oxygen consumed by the individual and heat generated during the period.

8 **Metabolism**

- The chemical reactions occur more rapidly at high temperatures , therefore BMR increases by 5% for each degree of temperature raise.
- This is one reason why weight is lost during fevers
- So also during nutrition is impaired
- Normal BMR during which 2,500 K.cal is needed for a normal laborer than sedentary person.

1 **Cell division**

- Every cell after maximum growth starts dividing in to daughter cells. (cell division or cell multiplication).
- This division happens in unicellular individuals resulting in reproduction, while in multi cellular individuals, it results in growth.
- The cell division is of two types, The mitosis and meiosis.
- The mitosis is known as equatorial division or somatic cell division occurs only in body cells where the chromosomal number of the cell remains constant. It occurs in the entire life of an individual.
- The meiosis is known as reductional division, during which the chromosomal number is reduced to half.

2 **Cell division cont.....**

- The significance of meiosis is to keep the chromosomal number constant during sexual reproduction of an individual. (the chromosomal number of species is always constant) .
  - Mitotic cell division:
  - Cell– Growth (due to metabolism)—Inter phase--- Cell division.
  - The entire cell division consists of 2 phases
    - Karyokinesis
    - Cytokinesis.
    - Karyokinesis is completed in 4 phases
    - 1.Prophase.2.Metapahse. 3.Anaphase and 4.Telophase

3 **The Cell division –Meiosis..**

- This type of cell division is necessary sexual reproduction.
- In animals it occurs at gonads (testes& ovary).
- Cells of gonads after undergoing meiosis produce gametes or sex cells (eggs and Sperms).
- During meiosis cell chromosomes duplicate the amount of DNA.
- Meiosis consists of 2 phases :
  - Meiosis-I and Meiosis II.
  - The meiosis-I is reductional division (where the chromosomal number is reduced to half)
  - While the Meiosis-II is mitotic

4 **Meiosis –I (the reductional division).**

- It consists of 4 phases, the Prophase-1, Metaphase-1, Anaphase-1 and Telophase-1.
- The Prophase-1 :
- It is along phase containing important events and can be divided in the following stages :
  - I. Leptotene : Individual chromosomes each consisting sister chromatids diffuse and thread like.
  - 2. Zygotene : Pairing of homologous chromosomes takes palace.
  - 3. Pachytene : Crossing over and exchange of chromatin material takes place.
  - Diplotene : Now homologous chromosomes separate.
  - Diakinesis : Nucleoli and nuclear membrane disappears, centrioles duplicate &move to poles, micro tubules are formed

5 **Meiosis-1 Cont.....**

- Metaphase -1 :
- Tetrads are arranges in equatorial plane.
- Anaphase -1 :
- Kinetochore (microtubular kinetochore) shortens, centromeres lie equatorially and

chromatids move towards poles.

- Telophase-1 :
- The chromosomes arrive at poles, nuclear membrane appears and spindles disappears.
- At this stage it undergoes the CYTOKINESIS, resulting in to two cells having haploid chromosomes.
- After the completion of this stage it enters in to Meiosis II , which is nothing but simple mitotic division

6 **Cell cycle**

7 **CELL CYCLE**

- The cell cycle is regulated by two types of proteins
  - A) Cyclins : G1 cyclins, S cyclins and M cyclins
  - B) Kinases :Phosphorylating enzymes..
  - The eukaryotic cell has the following phases.
    - 1. G1 Phase (growth and preparation of chromosomes for replication)
    - Events happen : Cytoplasmic elements like ribosomes, membrane bound organells, subtrates and enzymes for DNA replication are syntheszed.
    - 2. S Phase (synthesis of DNA and duplication)
    - RNA replication and total content of DNA doubles.
    - G2 Phase :(preparatory stage of cell)
    - NM disappears,nucleolus disapperrs, increased nuclear volume, spindle fiber proteins are formed.

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- M-Phase : Is the actual division phase ,by mitosis completed in 4 stages.
- In most of the repeatedly dividing cells the cell cycle is continuous.
- But in cells like nerve cells, muscle cells, RBC the G1 phase permanently enters in to G o phase.
- Also in some lymphocytes re entry of G1 phase takes place from G 0.
- The cell cycle is regulated by genes. Cdc2 gene is responsible for cell division cycle , while P53 is the gene responsible for gene regulation.
- It is found normally that P53 gene mutation leads to cancer.(Paul Nurse, Leland Hartwell and Tin Hunt were awarded Nobel prize for the discovery of P53 gene and its role in cancers)

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- Normal cells usually have a controlled growth.
- In a tissue between cell to cell contact inhibition is maintained and their multiplication is regulated as well. Occasionally when they loose the regulation inhibition the contact is lost, leading to erratic divisions of cell leading to tumor cells, neoplastic cell to malignant cells
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10 **Types of cell division**

1 **The Musculoskeletal system**

- The skeletal system is of 3 types.
  - 1. Exoskeleton : Chitin in Arthropods (featured by moulting and restricting the growth)
  - 2.Endoskeletion : soild and mineralised with cartilage and bone.
  - 3. Hydrostatic skeleton : Fluids acting as support. Body fluids in invertebrates.

  There is a process by which the cartilage is replaced by bone up to some extent while in some vertebrates the entire skeleton is cartilagenous. (Sharks).
  The skeletal system is featured by joints due to which the parts are movable.
  The joints are 3 types : a) Movable b) partly movable and
  c) Immovable. (Skull bones)

2 **The skeleton and joints) ....cont**

- Joints are assisted by Synovial apparatus and tendons and ligaments.
- Neuromuscular junctions : where the motor neurons are innervated to skeletal muscles under the influence of neuro transmitter like Ach, for which the calcium ions are needed. In some fishes muscles are modified in to electrical organs. Ex Electric eel can produce 100 watt current.

3 **The Skeletal system**

- The skeletal system is divided in to 2 parts
- 1. Axial skeletal system and 2. Appendicular skeletal system.
- The Axial Skeletal system :
- It forms the axis of the body without which the can not maintain posture and life.
- It consists of two parts namely the SKULL(skeleton of the head) and VERTEBRAL COLUMN (Back bone)
- Skull parts
- Cranium (brain box)- 8 bones
- Face 14 bones
- Ear ossicles 6 bones

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- Hyoid –Lower jaw
- The vertebral column. (26)
- Cervical 7
- Thorasic 12
- Lumbar 5
- Sacral 5
- Coccyx 5
- Thorax – Sternum 1
- Ribs 24 (12 pairs)
- 1-10 pair ribs are true ribs (attached to sternum)
- 11,12 do not attach to sternum as such they are called as false ribs.

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- Appendicular Skeletal system :
- Consists of two components a) Girdles and
- b) limb bones (fore and hind limbs)
- Fore limb bones
- Humerus-2
- Radius and ulna 2
- Carpals wrist bones 8+8
- Metacarpals 10+10
- Phalanges 14+14.

- * Hind limb bones
- Femur 2
- Tibia and Fibula 2+2
- Patela knee cap 2

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- Tarsals (ankle bones) 7+7
- Metatarsals (foot bones) 5+5
- Phalanges 14+14.

1 **Diet and Nutrition**

*Human food is from various sources

*Human food contains nutrients.

Malnutrition is due to under nutrition, imbalanced nutrition normally leads to deficiencies, syndromes, obesity and toxicity.

•Nutrients are of 2 types

•1.Macronutrients

•2Micronutrients

Macronutrients include carbohydrates, proteins and fats.

Micronutrients include vitamins and minerals.

2 **Types of food**

1. Cereals :

Form the staple food of humanity. They are rich in carbohydrates and contain very small qty of proteins. They many lack minerals and vitamins.

2. Pulses:

Pulses are rich in proteins and small qty of carbohydrates but no minerals.

3 **Diet and Nutrition cont**

3. Leafy vegetables and fruits :
   Contain lots of minerals, vitamins, little amount of protein but no fats.
4. Starchy foods :
   Contain lot of carbohydrates, minerals and no fats.
5. Oilseeds and nuts :
   Contain fats proteins and vitamins.
6. Milk:
   Consists of all nutrients except Vit-C and iron.

4 **Diet and Nutrition --cont**

Carbohydrates

1. They are the energy yielding substances
2. Consumed bulk to bulk
3. Excess of carbohydrates are converted in to glycogen then in to fat.
4. Examples of carbohydrates are starch (plant), glycogen(animal) sugar.
   1. Glucose is seen in blood and grapes
   2. Fructose and galactose are fruit sugars
   3. Normal person may require 250-300gms per day.

5 **Diet & Nutrition-Fats**

- Fats are high energy nutrients
- 1gm of fat provides nearly 9.2 k.cals of energy.
- Essential fatty acids can't be synthesized by body and be obtained from vegetable oils.
- Daily requirement of fats per day is about 50- 70gms
- Fats act as nourishing material during energy crisis, also act as packing material in between tissues.

6 **Cholesterol-cont**

- Urban consumption around 500-600 mg/day may be avoided.
- The raised cholesterol circulates in blood
- Saturated fats from vegetables can increase cholesterol (coconut oil and dalda)
- Excess cholesterol functionally can not be utilized, tends to get deposited in the walls of arteries causing atherosclerosis, arteries loose the property of dilation. It may lead to heart attack.

7 **Cholesterol-cont**

- Types of cholesterol
- HDL s- High density lipoproteins (good cholesterol). These fats transfer LDLs from arteries to liver
- Triglycerides : These are formed by the consumption of heavy starch leading to obesity
- LDLs : Low density lipoproteins (Bad fats) causes plaque formation in arteries

8 **Cholesterol Cont**

- Levels of cholesterol
  *200mg/dl- total cholesterol
  *130mg/dl- LDL
  *200mg/dl Triglycerides
  *35mg/dl HDL

9 **Diet & Nutrition-Proteins**

- Proteins are required for the body building (building blocks of the body)
- They form the structural elements of the body.
- They are made up of amino acids.
- All most all enzymes, hormones and structures are made up of proteins.
- 1 gm of protein can yield an energy of 5.6 k.cals of energy.
- The daily requirement is about 55-70gms.

10 **Diet & Nutrition-Proteins cont**

- Proteins are classified in to
  – 1st class proteins : all amino acids are not synthesized in body and obtained through diet.
  – 2nd class proteins :Proteins are formed by the body through protein synthesis
  – Examples of proteins :
  – Collagen, silk, viruses, microtubules, toxins, hormones, actin &myosin, hemoglobin, antibodies and antigens.
  – Smallest protein is of insulin (made up of 50 amino acids) and enzymes are the largest proteins.

11 **Proteins ---cont**

- Protein deficiencies :
- In infants below one year, it causes MARASMUS (deficiency of proteins and total calorie deficiency.)
- From 1year -5 years it causes KWASIORKOR'S disorder.(only severe protein deficiency)
- An average mammalian cell may contain as many as 30,000 types proteins.
- Malnutrition of proteins leads to deficiency, syndromes, obesity and toxicity

12 **Micronutrients --Minerals**

Minerals form 4% of the body weight.

1. Basing on the requirement they are of two types
2. Major minerals and minor minerals.
3. THE MAJOR MINERALS : Calcium, phosphorous, Potassium, Sodium, chlorine and Magnesium.
4. The minor minerals are Iron, Manganese, copper and Iodine

13 **Major minerals--Cont**

- CALCIUM (Ca)
- It goes in to formation of hard structures like bones and teeth. (90% of calcium is concentrated in these structures)
- A small amount is present in blood and rest of the calcium is in ionic form in body fluids.

- Calcium regulates "ion transport" across cell membranes.
- High concentration of calcium stimulates contraction of heart muscle.(beta blockers block this heart diseases)

14 **Major minerals –Calcium cont**

- Calcium in the serum is maintained by parathyroid hormone.
- Calcium levels drop down when calcium is depleted from bone leading to osteoporosis and this is regulated by hormone calcitonin.
- Calcium is also necessary for blood coagulation.

15 **Major minerals-Phosphorous**

About 85% of phosphorous is present in skeletal tissues-12 gms/kg
The organic phosphorous is involved in biochemical reactions (cellular& ATP formation)
Inorganic phosphorous is widely distributed in food stuffs
The deficiency is unlikely in humans.
If live stock graze phosphorous deficient grasses. Loose appetite and resort to eat bones , wood and clothes

16 **Major minerals- Magnesium**

- It is needed in oxidative reactions
- It is obtained from green vegetables
- It is required at the rate of 0.5gm/kg wt of body or 1-3 mg in serum
- Deficiency causes personality changes and muscular tremors

17 **Mineral nutrition-sodium, potassium and chlorine.**

- These substances are seen in body fluids than in tissues.
- They maintain osmotic pressure, acid base balance, regulation of nutrients in to cells and water metabolism.
- These ions are to be taken regularly as they can not be stored in body.

18 **VITAMINS**

•*The vitamins are purely organic substances.
*They are accessory food factors
*They are required in small quantities (IU).
•Vitamins are classified on the basis of their solubility in water.
•Accordingly, they are two types
•Water soluble and water insoluble (fat soluble)

19 **Water insoluble or fat soluble Vitamins**

- They are :
- Vit-A, Vit-D, Vit-E and Vit-K
- VITAMIN- A
- Chemically it is called as retinol
- It is a carotene derivative and oil soluble
- It an anti infecting vitamin.
- Carrots, tomatoes, milk and yellow of egg are the chief sources.
- Deficiency causes-Xeropthalmia (dryning of eyes), Nyctalopia (Night blindness) and Xerosis (drying of Skin)

20 **VITAMIN-D**

- It is sterol in nature
- It exists as Ergosterol or Ergocalciferol.
- It synthesized by skin through ultraviolet radiation of the Sun (Sun shine Vitamin)
- It is a cholesterol derivative and requirement is 400 IU
- Cod and Shark liver oils are the best sources.
- It is stored in liver.
- It regulates the absorption and utilization of calcium and phosphorous.

Cont....

21 **VITAMIN-D**

- It exists as activated ergosterol or calciferol(chief plant source is Yeast) or D2
- It may exists as activated dehydrocholesterol, found in natural foods. In human beings it is synthesized from ultraviolet radiation.
- It is stable vitamin as it can be processed, caned, stored and cooked.
- Deficiency causes Rickets in children and Osteomalacia in adults

22 **VITAMIN E**

Chemically it is known as Tocopherol
They are unsaturated alcohols
Plant oils like wheat germ, rice germ and cotton seed oils, lipids of green vegetables, fish liver oils , meat and eggs are the chief sources.
It has an anti oxidant property.
Peroxidases are produced by the oxidation of fatty acids, which are toxic to body .Vitamin E prevents this reaction.
They are required for the normal growth of reproductive organs. Its deficiency causes destruction of germinal epithelium of gonads. It is called as anti sterility vitamin.
Its deficiency causes muscular dystrophy.

23 **VITAMIN-K**

- It exists in two forms. The Phylloquinone- K1 and Farnoquinone-K2.
- The chief sources are alfaalfa leaves, dark green vegetables, tomatoes, peas, cabbage, cauliflower, eggs and liver
- Fruits are poor sources of this vitamin.
- It catalyses the synthesis of Prothrombin by liver.
- It is also synthesized by a commensal bacteria present in intestine and colon.

24 **WATER SOLUBLE VITAMINS**

- The water soluble vitamins are B-complex and Vit-C
- B- COMPLEX VITAMINS :
- B 1 vitamin.
- It is known chemically as Thiamine.
- Yeast , milk, vegetables and rice polish are best sources of this vitamin.
- Its deficiency causes Beriberi, featured by lack of appetite, effects the peripheral nervous system, anxiety and mental confusion.
- Its requirement per day will be 1 mg.
- Its deficiency also causes heart enlargement and muscular dystrophy.

25 **VITAMIN B2**

- Chemically it known as Riboflavin, also called as yellow enzyme. Some also call it as Vit-G
- Milk, vegetables, rice polishing, liver and kidney.
- It is required dose per day is 1.5 mg.
- It s deficiency causes sores in the mouth, on tongue and skin. Acute deficiency causes fissures on tongue.

26 **VITAMIN-B3**

- It is called as Niacin or Nicotinic acid.
- The chief source is yeast.
- It is required in 15mg.
- Its deficiency causes Pellegra.
- Pellegra is light sensitive, normally called as symptoms of 4ds like
  - Diarrhea
  - Dermatitis,

– Dementia, and
– Death

27 **VITAMIN-B5**

- This vitamin is also called as "Yeast factor"
- It is also known as "Anti dermatitic factor".
- This vitamin is necessary for the formation of Co-enzyme A (it is concerned with the pigmentation of skin and hair-Anti graying factor)
- Normally milk and milk products due to
- high tryptophan content prevent this deficiency
- Whole grains in milling lose this vitamin.
- Meat and Royal jelly are chief sources

28 **VITAMIN- B6**

- It is chemically known as pyridoxine.
- It is obtained from cereals, grains, yeast (baker's yeast).
- This vitamin converts glutamic acid to Gamma Amino Butryic Acid (GABA) , which is essential for the functioning of nervous system.
- Its deficiency occurs normally in mal absorption and alcoholism.
- The deficiencies are featured by nervous disturbances, convolutions, insomnia, vomiting and diarrhea

29 **VITAMIN- B7**

- It is also known as vitamin H.
- It is called as Biotin.
- It is required in 150-300mg per day.
- Intestinal bacteria can synthesize this vitamin.
- Liver, kidney, egg yellow, milk, molasses, nuts and cereals.
- Its deficiency causes anorexia, muscular pains, loss of hair and cell growth.

30 **VITAMIN B9**

- It is also called as Follic acid.
- Yeast is its chief source.
- It is also available from liver, mushrooms, kidney, green leaves and grasses.
- Since it is obtained from leaves(follium), it called as follic acid.
- Its deficiency causes anemia and stunted growth.
- It is also required in nucleotide biosynthesis.

31 **VITAMIN- B12**

- It is chemically called as cynocoblamin. Coblat containing vitamin.
- This is the only vitamin which is of not in origin of higher plants.
- However it is synthesized by bacteria in animal intestine.
- It is seen heavily in animal products like cheese, eggs, muscles, kidney , liver and mutton.
- HCL is required for its absorption in intestine which is called as Intrensic factor (produced from parietal cells).
- Its deficiency causes perinaceous anaemia (Nutritional) and megaloblastic anaemia (inhibition of DNA synthesis in RBC).alcohol and chemotherapies are responsible for the later.

32 **VITAMIN-F**

- It is known as Linoleiac acid.
- It is obtained from vegetable oils
- Example is linseed oil mostly with unknown function.
- It is mostly used in Soap industry as emulsifier.
- For some reason the diabetic people are known to have this vitamin above normal,

also known to promote cysticfibrisis and dermatitis

33 **VITAMIN -P**

- It is related to Flavanone and hesperdines.
- It is available from fruits.
- Its deficiency causes loosing of resistance power to capillaries.

34 **VITAMIN-C**

- Chemically this vitamin is known as ascorbic acid..
- This is a water soluble vitamin.
- The chief sources are lemons, oranges and green chilies.
- Its deficiency causes scurvy. (bleeding through gums).
- It has varied functions like
- It acts as maintainer of intracellular substance, integration of capillaries, collagen synthesis
- It dissolves excessive cholesterol in blood.
- It is actively associated with wound healing.
- Reduces the coagulation of blood.

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It enhances the absorption of iron from intestine.

LINUS CARL PAULING advocated the preventive properties of Vit-C against common cold .

It can also act as preventive agent against cancer.

Storage of Vit-C is impaired due to smoking.

This vitamin can be easily destroyrd by cooking, heating and mincing.

1 **DISEASES AND DISORDERS**

- Both disease and disorder cause lot of harm to human beings, animals and plants.
- There is difference between the disease and disorder.
- Any harm caused by parasite is known as disease while disorder is caused by physiological or genetic disturbance.
- For example Malarial fever is a disease (as it is caused by Plasmodium parasite).
- Diabetes is a disorder (genetic fault)

2 **Diseases and disorders ---cont**

- *The study of parasites is known as parasitology. A parasite always cause undesirable effects on hosts and host parasite relationship is one of the associations of living. Hosts are always at loss. The study of harm caused by parasite in host is known as PATHOLOGY.
- * The science dealing with the CAUSES of diseases is known as ETIOLOGY.
- The forecasting the disease is known as PROGNOSIS.

3 **DISEASE AND DISORDERS cont---**

- Disease and disorders are of 3 types
  - 1. Congenital disorders
    - a) hereditary congenital disease (syndromes)
    - b) Non hereditary congenital disease (teretogenic diseases .Ex.Toxoplasmosis infections, Rubella infections and Herpes)
  - 2. Acquired diseases.
  - 3. Metabolic disorders. : Ex Gout disorder (uric acid levels in blood will be very high, deposited as crystals featured by painful joints)

4 **METABOLIC DISORDERS cont---**

- Arthritis : It known as inflammation of joints, which is of two types
  - a) Degenerative arthritis : Stiffness of movable joints , pain occurring in motion
  - b) Rheumatoid arthritis : Inflammation of joints, swelling and muscular fatigue.

5 **AQUIRED DISEASES**

- They are normally either communicable diseases or non communicable diseases. The communicable diseases are often infectious diseases while the other like allergies and cancers.
- Communicable diseases are due to pathogens or parasites which are different varieties like
  - 1.Viruses.
  - 2 Bacteria.
  - 3 Protozoa.
  - 4 Fungus.
  - 5 helminthes

6 **VIRAL DISEASES**

- Varicella virus (Chickenpox virus. DNA)
- Variola virus (Smallpox virus.DNA)
- Poliomyelitis (polio virus, atrophy of muscles. RNA)
- Hepatitis virus (A,B,C,D. types RNA)
- Orthomyxovirus (Influenza virus.RNA)
- Herpes simplex (herpes virus)
- HTLV 111 (Human T cell Leukemia Virus)
- The Aids virus.

7 **VIRAL DISEASES OF ANIMALS & PLANTS**

- Ranikete disease in poultry, cause avain pneumonia.
- Rinderpest disease causes cattle plauge.

- Vaccinia virus causes cowpox
- Foot and mouth disease in cattle
- TMV (Tobacco Mosaic Virus) causes damage in Tobacco and tomato.

8 **BACTERIAL DISEASES**

- Steptococcus sp (cause throat inflammation, fever and cough)
- Diplococcus pneumoniae (droplet infection, cause pneumonia)
- Mycobacterium tuberculae (Tuberculosis, BCG is given as preventive vaccine.[Bacillus Calmette Gurine])
- Yersinia pestis , the plague bacterium.(rat flees)
- Clostridium tetani : tetanus bacteria, in soil

9 **BACTERIAL DISEASES cont--**

- Salmonella typhi : cause typhoid (food, feces and flies. Confirmative test is VIDOL.
- Vibrio cholera : the cholera causing bacterium.
- Mycobacterium leprae : cause ulcers, nodules and deformation of fingers. Occurs only in immuno deficient persons.
- Haemophillus perturis : cause whooping cough (12-13 explosive cough is whoop)
- Diplococcus ganorrhoeae :Cause venerial disease featured by painless ulcers.

10 **Plant Bacterial diseases**

- Xanthomonas orizae cause paddyblight (leaves develop spots-blight)
- Corney bacterium cause a disease called as ring rot in potato.

11 **Fungal diseases**

- Mycetoma cause disease called Madura foot
- Trychophyton causes Athlete's foot
- Cladosporium and monosporium ring worms cause dermal leisons.

12 **PLANT FUNGAL DISEASES**

Phytopthera late blight in potato.
Pythium –foot rot
Puccinia sp Black, yellow and brown rusts,
Cause rust diseases.
Cercospora – cause Tikka disease in ground nut
Clavis sp.-Ergot disease in millets.
Collictotrichium sp cause red rot in sugar cane.

13 **Protozoan diseases**

- Plasmodium vivax – Benign, tertian malaria(at every 48 hrs fever)
- P.malariae-Quartan malaria- fever every 72 hrs.
- P.falciparum faltal malaria or malignant malaria fever every40-48 hrs)
- P. ovale- rare malaria fever in the nights. Sometimes fever continuous.

14 **Protozoan disease cont--**

- Trypanosoma gambiance. Cause african sleeping sickness
- Leishmania tropica- cause oriental sore. Delhiboil.
- Leishmania donovani- Kalazar fever
- Entamoeba hystolytica cause amoebiasis.

15 **HELMINTH PARASITES TREMATODES & CESTODES**

Fasciola hepatica Liver fluke.
Paragonimus Lung fluke
Schistosoma haematobium blood fluke
Taenis solium Porktape worm
Taenis saginata beef tape worm
Echinococcus granulosus the dog tape worm

16 **HELMINTHS-- Nematodes**

- Ascaris lumbricoides round worm.
- Ancylostoma duodenale hook worm
- Enterobius vermicularis Pin worm.
- Wuchereriabancrofti Filarial worm.
- Loa loa the eye worm.
- Dracunculus medinensis Madina worm

17 **Psychiatric disorders.**

- Depression
- Mania (opposite to depression, abnormal elevated moods)
- Schizophrenia The split brain mentality
- Neurosis
- Phobias
- Hysteria (severe anxiety, lack of control of emotions and out bursts)
- Epilepsy Uncontrollable increased neural activity by some parts of brain).

18 **Degenerative disorders**

- They are usually genetic in origin. Disorder may appear slowly along with age. Ex Muscular atrophy, Myopia and Mysthenia gravis.
- Some genetic disorders are called as Syndromes Ex Parkinson's, Allhzmer"s, Down's, Klinfelter's, Polygladular syndrome, (Endocrine glands depresses).Sickle cell anaemia,Haemophilia, DiGeorge syndrome(deletion of 22 nd chromosome Thymus effected)

19 **Syndromes ---cont**

- Gaucher's syndrome : Due to gene mutation an enzyme glucocerebrosidase, fat gets accumulated in liver , spleen and bone marrow.(enzyme replacement therapy promising).
- Alkaptoneuria Patient's urine is black on exposure to air.

1 **Genetic disorders .....Syndromes**

- Any change in the chromosome number or gene mutations result in disorders, which are heritable.
- The following are few such disorders.-
  - Color blindness. This is disorder in which the effected person will not be able to differentiate the colors like green and red. This condition mostly appears in recessive individuals. And also it is a sex linked trait.

  Down's syndrome : it is also called as Mongolism. It is a congenital abnormality in human beings due to TRISOMY of chromosome 21(occurs as triplicate).As such the affected individuals have 47 chromosomes, individuals showing retarded physical and mental symptoms.

2 **SYNDROMES .....Cont**

- Klinfelter's syndrome : It is an abnormality in males, who are always sterile due to improper development of testis. It is always due to an additional X chromosome (XXY)
- Turner's syndrome : This may effect the females who will be phenotypically female, with rudimentary mammary glands and sex organs. This condition is basically due to lack of an X chromosome (Xo instead of XX).
- Hemophilia : It is popularly called as bleeders disease. This due to a recessive gene, mostly expressed in males. It is an example for sex linked inheritence.

3 **Genetic disorders. Cont....**

- Phenyle ketoneuria : Due to this disorder serious brain damage is caused in infants.
- Such children fail to metabolize phenyle pyruvic acid, whose accumulation causes serious brain damage. Even if they survive they will be idiots.
- Sickle cell anemia : This is mainly due to an abnormality caused in the hemoglobin molecule due to a recessive gene and homozygous condition, resulting the sickling of RBC.
- Thalassemia : This condition is also called as Cooley's anemia , mostly occurring in infants due to synthesis abnormal of hemoglobin, leading to severe anemia.

1 **THE BLOOD**

- The blood is a fluid connective tissue.
- In human beings , it forms about 8% of the body weight./ 5-6 lit in an person averagely weighing 70 kgs.
- It has 2 components the *plasma* and *corpuscles.*
- The plasma is pale yellow transparent fluid of blood maintaining a volume of 45%.
- While the corpuscles are of 55%.
- The blood always maintains a pH of 7.35 (weak alkaline). pH below 7 is fatal.
- The formation of blood from bone marrow is known as haemopoisis.

2 **The Blood cont.....**

- The corpuscles of blood are of 3 types namely
  - *Erythrocytes :* The red blood cells are numerous in number, 5-5.5 million per/cu/ mm in males while in females, it will be 4-5.5 million per/cu/ mm. The RBC are formed from bone marrow, by a process called erythropoisis(require B12 vit, copper, nicotinic acid and riboflavin) by stem cells. The RBC are initially nucleated and soon lose the nucleus and become de nucleated. They are known to contain hemoglobin, due to which the blood's color is red .Every 100 ml of blood should contain 14 gms and 12 gms of hemoglobin in males and females respectively. The RBC are known to have life of 120 days after that they arte being destroyed in spleen by apoptosis. The people living in high altitudes are known to have more RBC than others. The RBC undergoes a condition called Rouleax (piling or stagnation), if they settle at a place for a long time.

3 **The Blood cont.....**

- The blood undergoes a process called agglutination .It occurs on account of un matched blood (clumping of RBC).
- Erythrocyte development depends on feedback mechanism by a hormone called erythropoietin, secreted by kidney.
- After the life span of RBCs, are being destroyed in spleen in to protein (globulin) which is absorbed back in to circulation(in the form of amino acids) and haeme is converted into biliviridin is changed to biliruben in liver and excreted as bile pigment.
- THE SERUM :
- De fibrination of plasma by clotting results in clear yellow fluid called serum.

4 **The Blood con....**

- LYMPH : Colorless fluid formed of filtration of all colloidal substances, salts and water.
- Lymph flows from blood capillaries in to tissue spaces then in to veins.
- It normally regarded as middle man between blood and tissues.
- It returns all blood proteins from tissue fluids to blood.
- It also maintains the turgor between intercellular spaces.
- The main composition of lymph is plasma with less fibrinogen, without RBC & WBC, more digested food stuffs and metabolic wastes.

5 **The Lymphatic system**

- The system consists of
  - A) Lymphatic vessels
  - B) Lymph nodes (Lymphocytes and macrophages)
  - C) Lymphoid organs (Bone marrow, Spleen & Thymus)

GENRAL DEFENSES IN BODY;

The defenses are associated immune system, which is of 2 types;

I. Innate immunity: General defenses are maintained by barriers, inflammation, compliment system and interferon (antiviral substances), mostly nonspecific.

II. Adoptive immunity or Humoral immunity:

It is of two types 1. T-cell mediated (mostly fungi, bacteria, virus and protozoa are killed and 2. antibody mediated

6 **Plueripotent Stem cells**

- In bone marrow the stem cells, initially for a short time are totipotent and become plueripotent soon.
- Such plueripotent stem cells are differentiated in to two types of blood components.
  - A) Lymphoid progenitors' and
  - B) Myeloid progenitors.

LYMPHOID PROGENITORS :

These are large cells with very large nucleus and scanty cytoplasm involved in scar formation, wound healing and immunity.

They get differentiated in to T lymphoid cells and B lymphoid cells, which are processed in Thymus gland and bone marrow respectively.

The thymus cells are further differentiated in to Th, Ts and Tc cells (depending on the function of them)

7 **The B -lymphocytes**

- The lymphoid cells migrate to bone marrow and become plasma cell on stimulation which I turn produces specific anti bodies or immuno globulins.
- The following are types of Immuno globulins :
  - 1.Immmunoglobulin A Ig A(secretory antibodies,pass through placenta and provide immunity to child up to 1 year)
  - 2. Immunoglobulin G, Ig G
  - 3. Immunoglobulin E, Ig E
  - 4. Immunoglobulin D IgD
  - 5.Immunoglobulin M Ig M
- They are strategically placed in lymph nodes, spleen. Peyers'patches and tonsils.

8

- MYELOID PROGENETORS :
- Soon after they leave bone marrow, they get differentiated in to Erythroblasts, leucoblasts, platelet s and Mega karyocyte.
- The formation of RBC from bone marrow is known as erythropoisis . While the formation of WBC is known as leucopoiesis. (leucopenia-below 6000 /cu/mm, leucocytosis- over 8000-12000 /cu/mm

9 **The Leucocytes -types**

- The leucocytes(about 75% of total granulocytes) are differentiated in to the following.
  - 1. Neutrophils : They form about 70% of the WBC, involved in pus formation and sanitation of the tissues. They are featured by 3 lobed nucleus.
  - 2. Basophiles : Large cells with horse shoe shaped nucleus and normally increase in viral infections, otherwise they are of 1% in normal cases.
  - 3. Eosinophils : They are also called as acidophil. They have the characteristic shape of the nucleus as dumb bell shape. Their increase in their number during parasitic infections than being 4% by normal value.
  - 4. Monocytes : Large cells with round nucleus, can give rise to MAST cells and dendrocytes later become macrophages (increase in tuberculosis and help as scavengers)

1 **Proteins**

- Virtually every process and product in living cells depends on proteins. They do every thing from activation of essential chemical reactions to carrying messages between cells, to fight infections, to make cell membranes, muscles, blood and other structural materials.
- Though proteins are diverse in function, are yet made from only 20 amino acids (simplest protein can contain nearly 50 amino acids while the complex proteins are made up of few hundred to thousand amino acids).
- The enzymes are the biggest single class of proteins.
- On an average mammalian cell about 3000 enzymes.

2 **Proteins structure and classification**

- The proteins are classified in to 2 types
- The 1st class proteins : Proteins that are made up of amino acids which are not synthesized from body. Such proteins should be obtained in to body through diet.
- The 2 nd class of proteins are made of amino acids
- that are synthesized in the body by protein synthesis
- Biological functions of proteins :
- 1. Structural proteins (collagen , silk, virus and microtubules)
  2.Toxins : Diptheria
  3. Regulatory proteins (hormones)
  4. Contractile proteins (actin and myosin)

3 **Types of proteins**

- Transport proteins : (hemoglobin and myoglobin)
- Storage proteins (white of the egg and seeds of plants)
- Protective proteins (Antibodies and compliment)
- Membrane proteins (antigens)
- Enzymes (trypsin, protease and lipase)
- Protein deficiencies :
- Marasmus (infants below one year)
- Kwashiorkor (1 year to 5 years).

4 **PTOTEIN SYNTHESIS**

- All the proteins which are required by the cell are synthesized by the cell itself.
- Chemically, the protein are polymers of amino acids and these are linked together in linear fashion forming the polypeptide chain.
- Only 20 amino acids are biologically important in the formation of proteins, which are innumerable.
- The protein synthesis, includes arrangement of these amino acids in a sequential order, which is determined by the sequence of nucleotides in the polynucleotide chain of DNA.
- A sequence of 3 nitrogenous bases of DNA codes for specific amino acid of polypeptide chain, which is known as triplet code

6 **PROTEIN SYNTHESIS....cont**

- 1.Crick (1958) One way flow of information suggested that DNA transmits the genetic information for protein synthesis by transcribing mRNA(transcription) and other types of RNAs.
- These RNA s translate the nucleotide sequence in to amino acids (translation).
- This is known as one way flow of information or central dogma.
- During the protein synthesis DNA acts as template, due to which a polypeptide is synthesized and released.
- The information transcribed/ copied over m RNA from DNA strand-This process is

called as *transcription* (requires an enzyme-RNA polymerase)

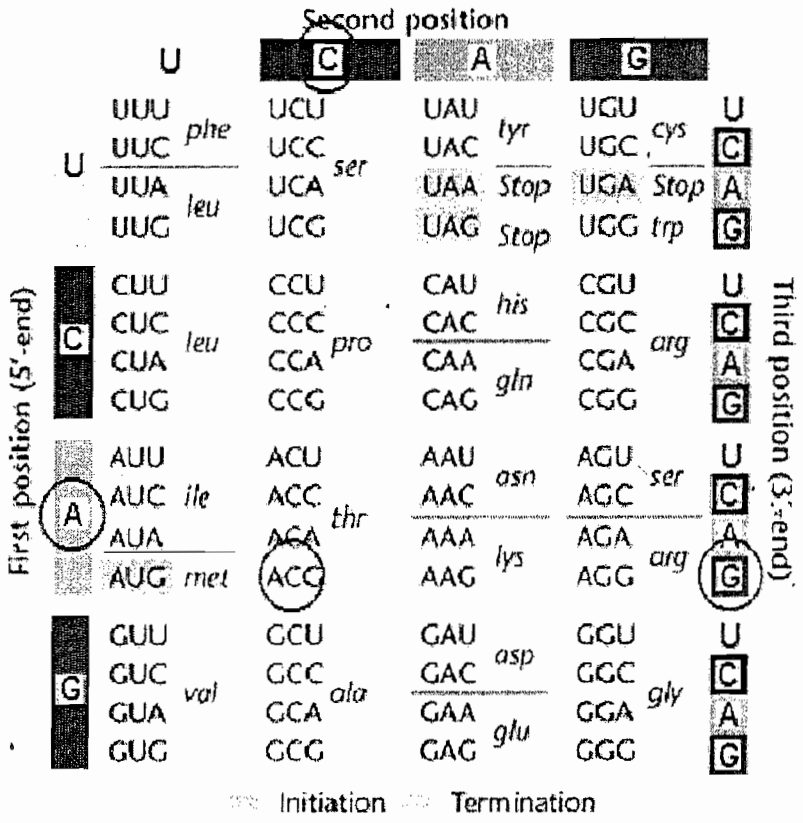
7 **PROTEIN SYNTHESIS Cont.....**

- The gene from which mRNA is transcribed is known as CISTRON (structural part of the gene).
- Now the coded mRNA forms a polypeptide through decoding, which is known as *translation.*
- The process of translation involves 3 types of RNAs
- mRNA(messenger RNA), r RNA (ribosomal RNA),t RNA (transfer RNA), enzymes and protein factors

GENETIC CODE

- The genetic code is a triplet code
- The sequence of bases in mRNA decide the place of amino acid in the protein chain
- Few variations exist between standard and mitochondrial codons (UGA for example is a standard termination codon but in mitochondria it codes for Tryptophan)
- Initiation codon; AUG
- Termination codons: UAA, UGA,UAG
- To read the codon 5'-ACG-3'

  Read A from the left-hand side;. Read C across the top and Read G as the fourth line in that block, on the right-hand side of the table



1 **NUCLEIC ACIDS**

- The nucleic acids are of 2 types.
- They are the DNA and RNA.
  - *The DNA : Deoxyribonucleic acid.*
- It is seen in side the nucleus of all cells except adult mammalian RBC and plant virus.(In bacteriophages and virus the DNA exists as single molecule enclosed in a protein coat) .
- In bacteria, mitochondria and plastids of eukaryotic cells, the DNA is out side the in cytoplasm and circular
- It is the basic constituent of living material
- It exists in double helical structure.
- It is involved in protein synthesis

2 **Deoxyribonucleic acid--- DNA**

- Being a nucleic acid it is made up of large number of nucleotides as such it is a polynucleotide chain.
- Each nucleotide consists of 3 chemical substances namely,
  - I. Phosphorous/ phosphoric acid
  - 2. Sugar (deoxyribose pentose sugar, 3rd carbon attached to base in one strand while in 2nd strand it is attached to 5th carbon atom. This makes strands in DNA antiparallel)
  - 3. Bases (Nitrogen bases)
    - The bases are of 4 types
    - Adenine
    - Thymine
    - Cytosine and
    - Guanine.

3 **The DNA Bases cont....**

- The four nitrogen bases are separated in to 2 categories.
  - *The Purines* : These are two ringed nitrogen compounds
  - Adenine(A) and Guanine(G)
  - *The Pyrimidines* : These are single ringed nitrogen compounds Cytosine(C) and Thymine(T).

MOLAR RATIO OF NITROGEN BASES IN DNA.

It is also called as Chargaff's base ratio. It is featured by

i) regardless of the source, the purine and pyrimidine component occur in equal amounts in a DNA molecule

ii) The amount of adenine (A) is equivalent to the amount of Thymine(T) and Cytosine(C) equivalent to that of Guanine(G).

iii) A=T and C triple bond G.

4

5 **DNA Replication**

- Cell division is essential for an organism to grow.
- when a cell divides, it must replicate the DNA in its genome so that the two daughter cells have the same genetic information as their parent.
-
- The double-stranded structure of DNA provides a simple mechanism for DNA replication.

6

- Here, the two strands are separated and then each strand's complementary DNA sequence is recreated by an enzyme called DNA polymerase.

- This enzyme makes the complementary strand by finding the correct base through complementary base pairing, and bonding it onto the original strand.
- As DNA polymerases can only extend a DNA strand in a 5′ to 3′ direction, different mechanisms are used to copy the antiparallel strands of the double helix. In this way, the base on the old strand dictates which base appears on the new strand, and the cell ends up with a perfect copy of its DNA
-

7 **DNA Replication**

8 **PLASMID NOMINICLATURE**

- The bacteria and prokaryotes are known to contain DNA not only in nucleus, but also in cytoplasm.
- Such DNA out side the nucleus is known as extra chromosomal DNA or Plasmids (4-12kbs)
- For example pBR 322 (one plasmid).
- In which p.... stands for plasmid
- BR (Boulevard & Rodrideuz) stands for Scientist who discovered it
- 322 refers to papers of plasmid description.

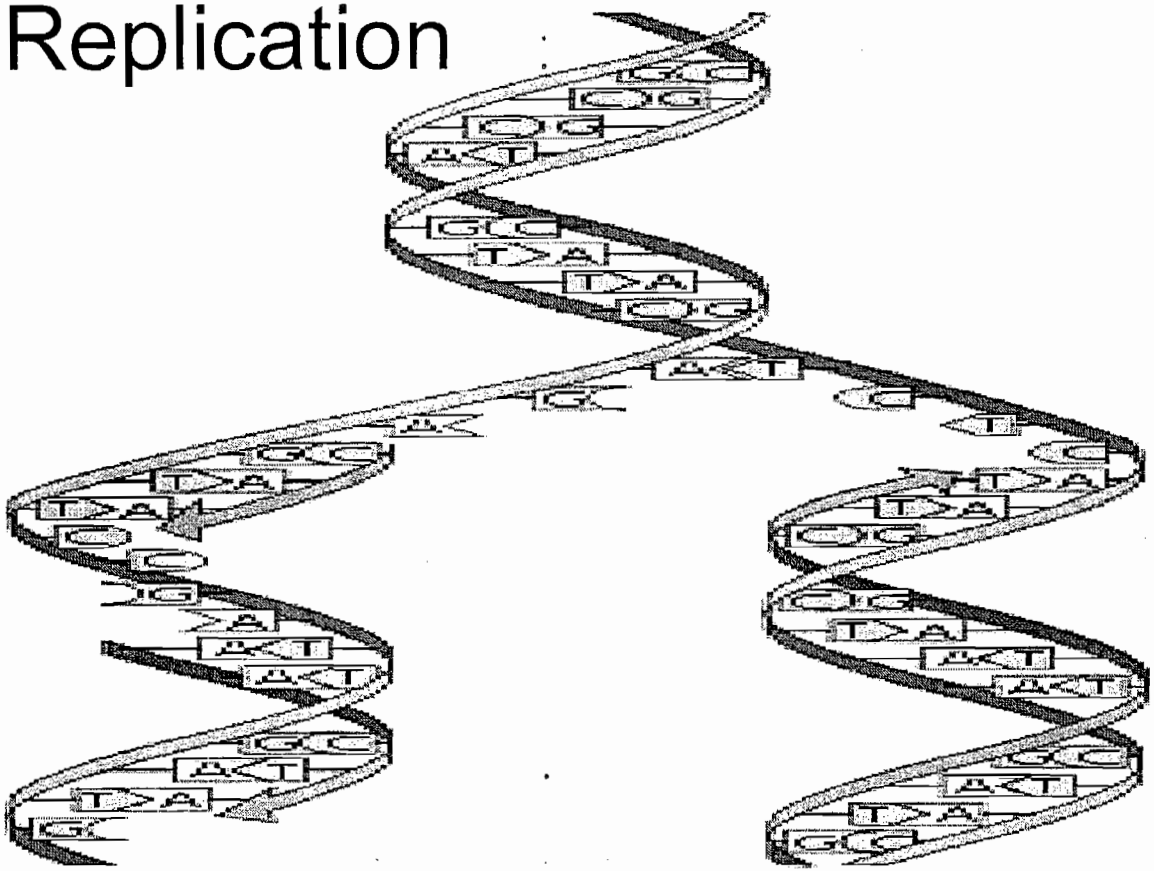
9 **RIBONUCLEIC ACID .....RNA**

- It is one of the nucleic acids, unlike DNA it is single stranded.
- It seen in the cytoplasm and nucleolus. It may occur freely in cytoplasm as well in ribosome.
- In some it can occur as heredity material
- Each strand is made up of nucleotides.
- Each nucleotide consists of sugar , which is of ribose type, phosphorous group and nitrogen bases.
- The bases are similar to DNA bases expect the presence of Uracil instead of thymine.
- The RNA is involved in the protein synthesis.

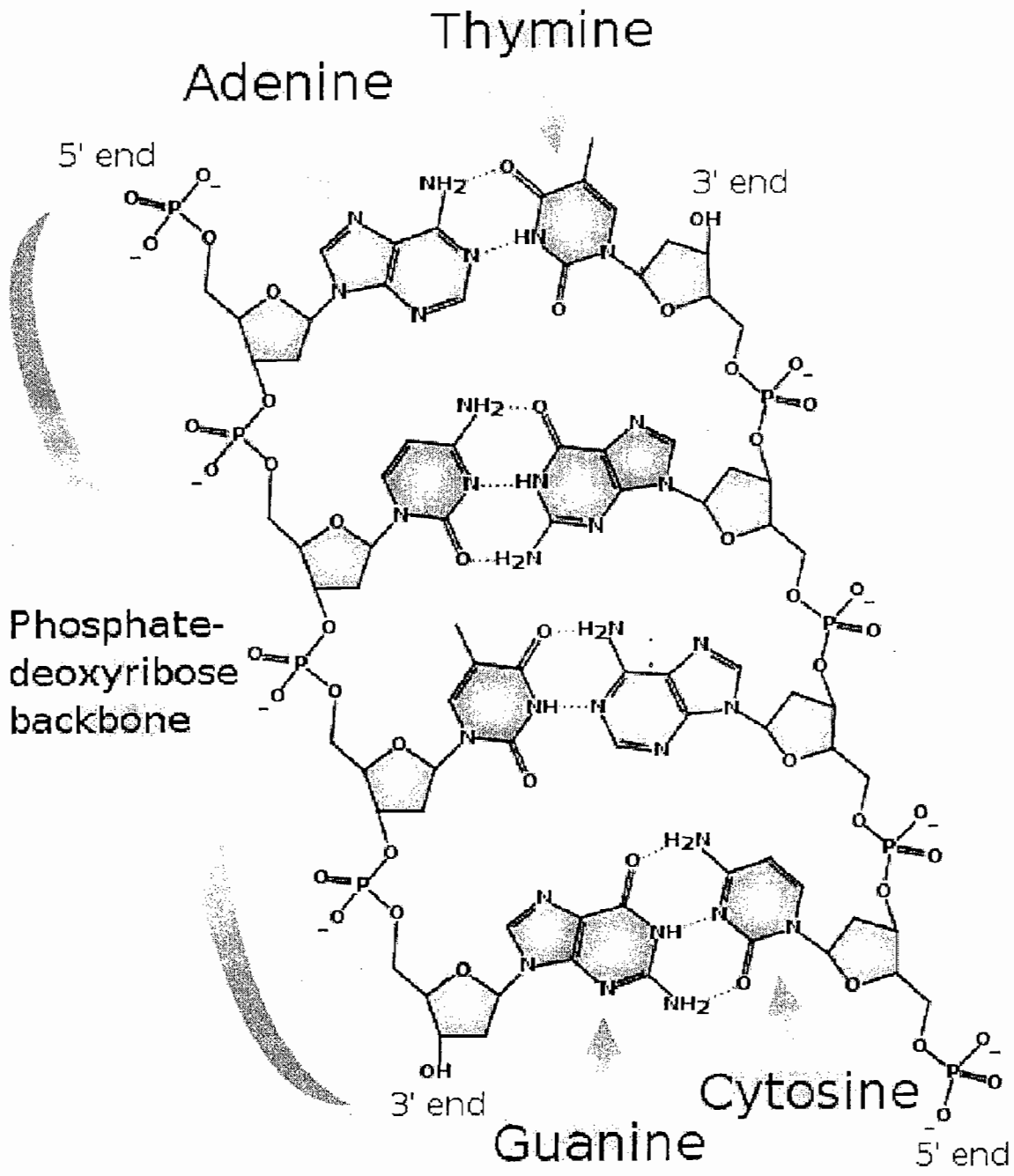
10 **RNA Structure cont.....**

- In all other organisms, where DNA is the hereditary material, the different types of RNA are non genetic.
- The non genetic RNA is usually synthesized from DNA template.
- In general 3 types of RNA have been distinguished.
- They are
  - 1. Messenger RNA or nuclear RNA--- m RNA (synthesized from complementary strand of DNA, carries genetic information to cytoplasm in protein synthesis, Jacob & Monod 1961.It acts as template for protein synthesis)
  - 2. Ribosomal RNA ---r RNA (in eukaryotes they are designated as 28S, 18S and 5S)
  - 3. Transfer RNA ---t RNA (carry amino acids)

DNA Replication



DNA replication. The double helix is unwound and each strand acts as a template for the next strand. Bases are matched to synthesize the new partner strands.


Thymine
Adenine
5' end
3' end
Phosphate-
deoxyribose
backbone
3' end
Cytosine
Guanine
5' end

1 **NEUROTRANSMITTERS**

- * Neurons secrete the neurotransmitters.
- * The following are general neurotransmitters.
- * *Glutamate* neurotransmitter: Excitory in action.
- * *GABA : Gamma Amino Butric acid.* It is inhibitory in action and antagonistic to glutamate.
- * *Dopamines :* Normal neurotransmitters.
- * *Acetylecholine :* Normal neurotransmitters

2 **NEUROTRANSMITTERS- con**

- * *Norepinephrine :* Involved in arousal of an individual.
- *Caffine, nicotine, heroin and Cocanie* also act as neurotransmitters.
- *Serotonins :* They normally act as antidepressants

1 THE GENES

- The term " GENE" was introduced by JOHANNSEN in (1909).
- The gene is a Mendelian factor or called as trait.
- SUTTON proposed the concept of genes
- MORGAN and BRIDGES have elaborated it.
- The concepts of genes are as follows :
- The genes determine physical as well as physiological characters that are transmitted from one generation to another off springs.
- The genes are situated on chromosomes.
- The number of genes of any individual are numerous, yet located on fixed number of chromosomes, characteristic of species.

2 THE GENES cont.....

- The place occupied by a gene on a chromosome is called as locus and the genes are arranged in linear manner
- A single gene may occur in several forms with several functional traits, normally the gene carries two alleles. Some genes mutate more than once and have more than two alleles Ex Multiple alleles (Blood groups and corneal color of the eye).
- The genes replicate accurately during reproduction.
- Each gene is capable of synthesizing a particular protein (One gene one enzyme hypothesis: BEADLE and TATUM).
- According to recent information the gene is nothing but a segment of DNA .

3 MOLECULAR STRUCTURE

- BENZER has coined a new term to denote the relationship between DNA mol and genetic phenomenon. According to him the following are units of gene.
  - 1. RECON : It is the smallest unit of DNA, capable of undergoing crossing over and recombination.
  - 2. MUTON: A small unit of DNA capable of undergoing mutation. (a change in the triplet will modify the message carried by codon.)
  - 3. CISTRON :It is the functional unit of the gene and it is a gene in real sense. It capable of synthesizing a polypeptide chain of an enzyme.
  - 4.COMPLON : It is an unit of complementation.
  - 5. OPERON : It is the combination of operator, regulator and inhibitory genes. It has an additive or suprssor effects.

4 Molecular structure cont...

- 6. REPLICON : It is a unit of replication. Several replications constitute a Chromosome.
- GENE REGULATION :
- All structural genes do not function at the same time, some of them function at a later stage and therefore they are under regulation. They are
  - A) Regulator genes.
  - B) Operator genes.
  - C) Promotor genes.
  - D) Suppressor genes.
  - The above genes regulate the function of structural genes coding for a particular enzymes or polypeptides.

1 **STEM CELLS**

- * Found in almost all multicellular organisms.
- * These cells renew themselves by mitotic divisions.
- * They are capable of differentiating in to many other types of cells in the body.
- *The stem-cell research has started in 1960 by Canadian Scientists Ernest A Mc Moulloch & E James.

2 **STEM CELLS Cont...**

- * Mammalian stem cells are of 2 types
  - 1 Embryonic stem cells (found in blastocyst)
  - 2 Adult stem cells (found in all adult tissues).
- The stem cells in developing embryo differentiates in to all of the embryonic tissue (specialized).
- * In adults the stem cells and progenitor cells act as repair system in body. Eg Blood, skin ect.
- * Stem cells can be grown and transformed in to specialized cells through cell cultures.

3 **Properties of stem cells**

- They are self renewable, go through numerous cycles of cell division.
- High plasticity is the characteristic feature of stem cells.
- Great potency (capacity to differentiate in to specialized cell types).
  - Basing on the potency they are classified as
    - TOTIPOTENT
    - PLURIPOTENT
    - MULTIPOTENT
    - UNIPOTENT

4 **Properties of stem cells**

- * TOTIPOTENT
  - Cells in zygote (first few divisions) are tote potent.
  - They are differentiated in to embryonic stem cells and extra embryonic stem cells.
  -
- PLURIPOTENT
  Are the descendents of toti potent cells, further differentiate in to 3 germ layers.
- MULTIPOTENT
  Stem cells producing only closely related family of cells-Haemopoitic tissues.
- UNIPOTENT
  Stem cells can produce only one type of cells, but have the potency of self renewal-Muscle stem cells.
  -
  -
  -
  -

5 **EMBYONIC STEM CELLS (ESC)**

- * From these cells, through ES cell lines, cell cultures are obtained

- * These are derived from epiblast tissue of blastocyst.(Morula stage of embryo)
- * 4-5 days old embryo in human being contains
  50-150 cells which are pluripotent, give rise to 3 germ layres
- * ES cells do not contribute to placenta or extra embryonic membranes

6

- Embryonic stem cells require different environment for the maintenance of undifferentiated condition.
- Mouse ES cells are grown on layers of gelatin and require Leukemia inhibitory factor (LIF)
- Human ES cells grown on gelatin require human fibroblast growth factor (FBGF)
- Human embryonic stem cells are also defined by the presence several transcription factors and cell surface proteins.
- Cell surface antigens are mostly used to identify human embryonic stem cells

7 **ADULT STEM CELLS**

What is an adult stem cell in an individual?

It should have the ability to divide and the ability to create a cell more differentiated than itself

- The adult stem cells are of two types,.the somatic stem cells and germ line stem cells.
- Most adult stem cells are lineage restricted by their tissue origin
- They do not posses any controversy as they are generated by the body continuously

8 **PRESENT STATUS OF STEM CELL TREATMENTS**

- The stem cell treatments in the medical researches are going to revolutionize the fate of human beings in future.
- It exists as a an ultimate hope though it is expensive, with an average success rate
- It is still in the experimental stage.
- Bone marrow transplantation is an exception.

9 

- New technologies are poring in the field of adult and embryonic stem cells research
- It is showing great deal of success in the treatments of disorders like cancer, muscle damage, spinal cord injuries and type-I diabetes
- Adult stem cells have an advantage over embryonic stem cells in avoiding rejection
- They are socially and scientifically accepted.

10 **POTENTIAL TREATMENTS**

- They are used in the following treatments like
  - a) Brain damage
  - b) Heart damage
  - c) Cancer
  - d) Haemopoitic
  - e) Spinal cord injury
  - f) Baldness
  - g) Deafness
  - h) Blindness and vision impairment

11 **STEM CELL TREATMENT... cont**

BRAIN DAMAGE

- Many neurons and oligodendrocytes are lost due to brain stroke.
- The adult healthy human brain contain certain neuronal stem cells, which are needed to replace / renew the neural structures.
- These cells function in different way in adult stage, maintain the function of olfaction.
- Now new drugs are directed on these cells, which differentiate for neural replacement.

•

12 **STEM CELLS IN THE TRATMENT OF CANCER**

- Injecting neural adult stem cells in to the cancerous tumors of brain in rats- tumors started regressing.
- In Harvard Medical school, the stem cells were introduced in to the intracranial tumors of rodents. With in days they have penetrated in to cancer area of tumor and produced *cytosine deaminase an enzyme that converts a non-toxic pro-drug into a chemotheraputic agent* .
- As a result 80-85% of tumor got receded.
- New researches are concentrating on inhibition of cancer than to cure it

13 **STEM CELLS IN THE TREATMENT OF SPINAL CORD.**

- Korean researchers (2004) have transplanted multipotent adult stem cells from umbilical cord to a patient suffering from spinal injury. Today the patient is able to walk.

* Researchers at the University of Wisconsin-Madison differentiated human blastocyst stem cells into neural stem cells, then into the beginnings of motor neurons and finally into spinal motor neuron cells, the cell type that, in the human body, transmits messages from the brain to the spinal cord. The newly generated motor neurons exhibited electrical activity, the signature action of neurons.

14 **STEM CELLS IN HEART TREATMENT**

- The stem cells introduced in to the damaged parts of cardiac muscle, generated new tissue.
-
-
- Several clinical trials have been proved to be highly successful and the process is commercialized.
-

15 **STEM CELL TREATMENT IN HAEMATOPOIESIS (Blood cell formation)**

- Dr. Luc Douay at the University of Paris developed a method to produce large numbers of red blood cells.
- The precursor red blood cells, called hematopoietic stem cells, are grown together with
- stromal cells creating an environment that mimics the conditions of bone marrow, the natural site of red blood cell growth. Erythropoietin, a growth factor, is added, coaxing the stem cells to complete terminal differentiation into red blood cells.

* It has potential benefits in gene therapy and blood transfusion.

16 **STEM CELL THERAPY IN BALDSNESS**

- Hair follicle contain stem cells.
-
- Research on this area will help to control the baldness through hair manipulation or hair cloning
-
- This treatment is expected to work through taking stem cells from existing follicles, multiplying them in cultures, and implanting the new follicles into the scalp. Later treatments may be able to simply signal follicle stem cells to give off chemical signals to nearby follicle cells which have shrunk during the aging process, which in turn respond to these signals by regenerating and once again making healthy hair. *Hair Cloning Nears Reality as Baldness Cure* (WebMD November 2004)

17 **STEM CELLS IN THE TREATMENT OF DEAFNESS**

- There has been success in regrowing cochlea hair cells with the use of stem cells.
-
- Various kinds of deafness can be successfully treated including some inborn errors.

18 **STEM CELL TREATMENT IN BLINDNESS & VISION IMPAIRMENT**

- Researchers have successfully transplanted the retinal stem cells in to the damaged parts of the eyes
-
- Using embryonic stem cells, scientiests are able to grow thin sheet of totipotent stem cells in the laboratory.
-
- When these sheets are transplanted on damaged retina, stem cells have started stimulation of repair renewal.

1 **Biotechnology**

- Multidisciplinary branch of biology (Genetics, Microbiology, Biochemistry and Molecular biology).
- In 1970 it appeared as separate branch of biology. It is featured by demands of skilled persons, supporting the public and sustained growth. It also involves separate disciplines applied to specific problems
- Biotechnology concept was in fact an old concept itself dating back to 6000 BC, ancient history dates back to
- Babylonians making and drinking Beer.
- Egyptians knowing the baking of bread in 4000 BC
- Production of ethanol at the end of 19th century.

2

- The science mainly deals with knowledge featured by observation and experimentation.
- While the technology is the applicatory part science for the benefits in large scale.
- Technology is wide applied in the areas like chemicals, glass, soaps, paper, paints, wax, oils and jute
- The biotechnology is the extension of technology in biological field, mainly included by microbial organisms, plants and animals.
- It is an interdisciplinary subject involving microbiology, genetics, biochemistry and chemical engineering

3 **APPLICATION OF BIOTECNOLOGY**

- 1. Food biotechnology
- 2.Organic acids
- 3. Dairy products
- 4. Enzymes.
- 5. Steroids
- 6. Genetic engineering
- 7. Tissue culture
- 8.Vitamins
- 9. Antibiotics
- 10. Vaccines
- 11. Monoclonal antibodies
- 12. Alcohol beverages and Bio-fertilizers ect.
-

4 **BIOTECNOLOGY .... Cont**

- Biotechnology has 3 cores functions
- Search for Specific biocatalyst (Mostly whole organisms/ microbial processes)
- Creation of conducive environment for biocatalyst
- Separation and purification of essential product

5

- Areas of biotechnology
- Bioprocess/fermentation technology (used to produce food and beverages, now it is a multi enzyme catalytic reaction with in microorganisms which produce desired product in a bioreactor.
- Enzyme technology
- Waste technology
- Environmental technology
- Renewable resource technology
- Plant, animal and agriculture

- Health care.

6

- Enzyme technology : Concentrated around biocatalysts.
- Most enzymes are proteins (Summer,1920)
- Enzyme are 2 types : Extra cellular enzymes (Secreted out side the cell, Ex
- Carboxyl methylcellulose and Poly galcturonase), intra cellular proteins (secreted in side the cell, Ex. Invertase and Uricoxidase)
- Microbial enzymes are non toxic and biodegradable

7

- Enzyme technology has 3 phases, production,
- isolation and purification. In protein engineering
- recombinant technology has revolutionized the
- synthesis of various hormones like Insulin (Humulin), somatotropin(growth hormone), Somato statin, Bendorphion(30 amino acid Neuro peptide of opiate activity) and Interferon.

8

- Single cell proteins (SCP) :
- Dried cells of microorganisms are used as food or feed(Microbial proteins).
- Microorganisms contain more amount of DNA and RNA than plants and animals as such they produce more proteins than plants and animals
- Ex. *Methylophillus*, a bacterium produces methanol,
- *Methylotrophus* produces an animal feed called-
- Pruteen and Spirulina an algae. Some waste products also yield single cell proteins by *Candida utilis*

9

- Hybridoma Technology :
- Used to produce monoclonal antibodies which are exceptionally pure and highly specific. They are mostly powerful and antiviral.
- Cesar Milstein and Gorge Kohler were the fist to produce the monoclonal antibodies. The coupled antibody/ B-lymphocyte with multiple myeloma cells(tumor originating cells in the haemopoitic portion of marrow). It is normally found that a mammal can generate up to 100 million different antibodies.

Applications of Monoclonal antibodies :

- Diagnostic (Blood groups, cancer, pregnancy and allergies), Organ transplantation, treating tumors and immuno purification of interferon

10 **POLYMERASE CHAIN REACTION**

- It is a technique used in molecular biology.
- It is developed by KARY MULLIS in 1983 for which he won Nobel prize in 1993
- DNA polymerase is an enzyme is used in this technique to amplify a piece of DNA in vitro, as such it is called as vitro enzymatic reaction
- With this technique, it is possible to amplify single or few copies of DNA.
- It is mostly employed to wide array of genetic manipulations.
- Enzyme used in this reaction is obtained from a bacterium called *Thermus aquaticus, as such it is also called as Taq polymerase*

11 **PCR Cont.....**

- Most PCR s are based on thermal lighting (heating and cooling alternatively)
- The selected DNA is heated to high temperatures and this process is called as DNA melting, during which the two strands of DNA separate and are used as templates.
- STEPS IN PCR.

- 1, Initialization : heating reaction to 94-96 0C for 1-9 minutes. (HOT START PCR)
- 2. Denaturation : 1st regular cycling event. Heating to 94-98 0C for 20-30 sec. This cause the separation of two strands of DNA by breaking the hydrogen bond between bases.

12 **PCR Cont.....**

- 3. Annealing : Suddenly the temperature is lowered to 50-56 0C.
- Annealing primers are added to strands of DNA template, Polymerase is then added which binds to strands.
- Soon the template strand can synthesize DNA.
- 4. Extension : It is also called as elongation phase, depends on the polymerase applied. The Taq polymerase has its optimal activity at 72 oC.
- 5. Final elongation : The temperature is reduced to 4-15 o C.

13 **Applications of PCR**

- Somebody needs only one cell, a drop of blood, sperm of an individual to make multiple copies for matching.
- It is also applied in the detection of some viral diseases, much before the symptoms could appear in patient.
- Involved in parentage disputes.
- The forensic application is ultimate.(Ex of saliva cells from the back of stamp traced the culprit)
- Historians use it as an evidence in the process of evolution. (Mummies are subjected to DNA test).
- In discovering a drop of wine exactly from which grapes went out side the bottle.

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- *DNA Finger Printing :*
- All living organisms show differences from each other mainly due to their base pair sequence of DNA. The comparison of DNA sequence of two individuals will reveal the relation or not.
- Stages in the Finger printing :
  - I. Isolation of DNA(from cells or organs of body ,usually from tissue or blood, hair or skin
  - 2.Washing : Isolated DNA or the targeted DNA is washed with an enzyme proteinase (physical purification).
  - 3.Purification : With carbon tetrachloride and phenol.
  - 4.Cutting ,Sizing and sorting(Special enzymes called endo nucleases cut the fragments at desired places, Biological scissors

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  - 5.Staining : A stain called Ethidium bromide is added to color the fragment
  - 6.Viewing : Under UV light
  - 7.Transfer : To a nylon sheet on gel and soaking for over night
  - 8.Probing and printing : Each probe Typically sticks in only at one or two places in the nylon sheet and the bar code is printed

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DOT Blot Techniques :

- It is a technique in molecular biology used to detect the Bio molecules.
- Traditionally the molecules are separated by chromatographic methods.
- A mixture containing bio molecule to be detected is applied on membrane as a dot.
- Northern blotting : Procedure where RNA fragments are transferred from an Agarose

gel to nitrocellulose filter where RNA is hybridized to a radio active probe.

17 **Dot blot.....cont**

- Southern dot blot :
- In this technique the DNA fragments are transferred from Agarose gel to nitrocellulose filter, where the DNA is hybridized with radio active probes.
- The Northern and Southern blots are usually applied to detect nucleotide probes.
- Western dot blot technique :
- This technique is applied to detect only molecules like antibodies or antigens.
- The above techniques are very accurate in detecting the corresponding molecules.
-

18 **ENZYME LINKED IMMUNO SORBENT ASSAY- ELISA**

- It is a biochemical and immunological technique.
- It is useful only for the detection of antibodies or antigens from the given samples.
- It is a main diagnostic tool in medicine, pathology and quality control.
- In this technique either antibodies or antigens are needed for the detection.

19 **ELISA .....Cont**

- In this technique an unknown amount of antigen is fixed on a surface, where specific antibodies are added.
- The antibodies are normally linked to an enzyme, which can produce some detectable signal.
- Through this method the amount of antigen/ antibody is measured.
- It is mostly used to detect the antibodies in the serum.
- Earlier in this technique radio active labeling was used, which can cause health hazards. (Health threat than diagnostic value) . Stratis Avrameas & G.P.Pierce have developed the modified method in which the container containing immuno sorbent--- Porath,1966

20 **Genetic engineering**

- * It is also called as protein engineering, Recombinant DNA technology or genetic manipulation / modification(GM) or Gene splicing.
- It should not confused with traditional breeding .In this the genes are manipulated indirectly.
- The gens are biological soft wares and their mere presence is not enough. They should be regulated by promoter, regulator and operator systems.
- The genetic engineering deals with two aspects namely the molecular cloning and transformation

21 **STAGES IN GENETIC ENGINEERING**

- Isolation of interested gene from others.
  - * DNA information can be obtained from c-DNA or DNA libraries
  - * The obtained DNA is amplified through PCR technique.
  - * insertion of the eukaryotic genome DNA in to prokaryote.

  Insertion :

  * Insertion of the desired gene in vectors such as plasmids.(usually viral vectors or liposome or by directly by gene gun). Restriction enzyme (restriction endonucleases enzyme) and ligases are useful for splitting and attaching respectively. These enzymes are isolated by Will Porter &John Darms 1978 (won Nobel Prize)

22 **Genetic engineering cot...**

- Transformation :
  - * Once vector is obtained, it can be used to transform the targeted organism.
  - * After the transformation the genetically modified organism (GMO) is isolated.

  Applications of genetic engineering :

1. It is successful in crop technology.
2. Production of substances like Insulin (Humulin), erythropoietin in Chinese Hamster's ovarian cell.
3. Hormones like somatotropin, Beta endorphins (opiate activity), Interferon, somato statins and vaccines like hepatitis vaccine.

GMO may cause threat to environment (through consumption)

23 **STEM CELLS**

- They are found in all multi cellular organisms.
- These cells renew themselves by mitotic cell divisions.
- They are capable of differentiating in to many types of cells in the body.
- The stem cell research has started in early 1960 by Canadian Scientists ERNEST. A .MC COULLOCH and E JAMES.
- The mammalian stem cells are of two types :
  - Embryonic stem cells.(found in blastocyst)
  - Adult Stem cells (found in the adult tissues)

  The stem cells developing in the contributes to the development of embryonic tissues (Specialized).

24 **STEM CELLS Cont...**

- In many adult individuals the stem cells and progenitor cells act as repair system in body. Ex. Blood, development of tissues and skin.
- The stem cells can be grown and transformed in two specialized cells through cell cultures, which are used in medical therapies and therapeutic cloning through embryonic cell lines, autologous embryonic stem cells.
- The stem cells are highly plastic, found in the umbilical cord and bone marrow.
- Self renewability and potency are the features of properties of stem cells.

25 **Stem cells potency**

- 1. Tote potency :
  - Such stem cells are called as multi potent which will be for a short time. The cells of zygote mostly the first few are toti potent. These are differentiated in to embryonic stem cells and extra embryonic stem cells.
  - 2. Pluerepotency :
    - Are the descended cells of tote potent cells. They can differentiate in to cells derived from any 3 germ layers.

    3. Mutipotency :

    The stem cells of this type can produce only closely related family of cells, ex haemopoitic tissue (RBC, WBC,PLATELETS and IMMUNE CELLS)

    4.Unipotency ;Stem cells producing only one type of ce cells, ex .muscle stem cells

26 **Embryonic stem cells (ESC)**

- These are the cell lines of embryonic stem cells, usually derived from EPIBLAST tissue of blastocyst or morula (a stage of the embryo).
- Early blastocyst (human embryo) , 4-5 days old contains 50-150 cells are pleurepotent stem cells, can give rise to all 3 germ layers in human beings.
- Most research is on ES cells of mouse or human being.(m ES cells and h ES cells respectively)
- The embryonic stem cells require different environment to maintain them as undifferentiated condition in gelatin
- They require leukemia inhibitory factor (LIF) and human fibroblast growth factor(HBGF) respectively.

- Human embryonic stem cells are featured by surface antigens, on the basis of which they are identified.

27 **Adult stem cells :**

- The adult stem cells have the property of dividing and the ability to create a cell more differentiated than itself.
- The adult stem cells are of two types. The somatic stem cells and germ line stem cells, the later are involved in giving rise to gametes.
- The pleurepotent adult stem cells are small in number
- Most adult stem cells are lineage restricted, mostly by their tissue origin (mesenchymal or endothelial stem cells).
- The adult stem cells do not pose any controversy, as they are generated in the body continuously (advantage over the embrynic stem cells.)

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- Bio remediation
  - Biotechnology is committed to environmental management. It aimed to use microbial degradation, for example pollutants are removed from effluents.(Alternate technology to remove the pollutants).Its applications are as follows
  - Biogas : Methane and CO2 mixture is used in dry composting. Archaebacteria are used for this purpose.
  - Preservation of eutrophication (Bio remediation helps in removing nitrogen from soil and helps in preventing eutrophication.)

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  - Bio films:
  - Multiple communities of micro organisms growing on soil surfaces form thin coat called as bio film.(Gas streams coming out of water treatment plants degrade the pollutants.
  - Remove all toxic chemicals Ex. *Pseudomonas cepasia* is useful to remove chlorinated compounds.

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- Transgensis
- Inserting a foreign gene(Transgensis) in to a genetic make up of any organism by genetic engineering is known as Transgensis.
  - In Transgensis the promoter (Gene)sequence is substituted
  - The most commonly used promoter gene is Ca MV35S(from Cauliflower mosaic virus)
  - A marker gene is also added to the promoter for easy identification. (Marker gene encodes proteins that provide resistance to agents that are toxic to plants).

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  - A marker gene is also added to the promoter for easy identification. (Marker gene encodes proteins that provide resistance to agents that are toxic to plants).
  - Plants can be transformed by two methods : a) Gene gun method(Microinjection of genes in to an organism). b) *Agrobacterium* method(Single site insertion)
- Stages in transgenic animals :
- 1) Identification and construction of foreign gene.
- 2) Microinjection of DNA to the nucleus of fertilized egg
- 3) Transplantation or implantation of these cells to the mother

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  - 4) Developing embryos
  - 5) demonstrating that the gene is regulated well.
  - 6)Transgenic technology is the extension of ancient agricultural practice only.

- 7)The first record transgenic examples are from animals- on mouse called *Super mouse*
- 8)Transgenic Ape is ANDi (Transgenic *Rhesus monkey*), BT Cotton contains gene from *Bacillus thirungensis.*
- 9) Super mouse
- 10). Thaumatin (low calory sweetner)

33 **Pros and cons of Transgensis**

- The following are risks involved in Transgensis.
  - 1.Unpredictability of nature
  - 2. Bio safety (decided by ICAR)
  - 3. Genetic contamination.
  - 4. Green revolution leading to gene revolution.

The following are the advantages of Transgensis :

1. Under the guidance of INSA, the technology is applied to edible crops.
2. Useful in developing drought resistant verities with reference to whether, disease and pest.
3. Marginal land utility

1 **ANIMAL HUSBANDARY**

*It is the science dealing with study of breeding, care , feeding and treating diseases of animals like Cattle, poultry, pigs, camels, horses, dogs and other domestic animals.

Cattle :

*There are more than 26 breeds of cattle available in India.

*Cattle now are exclusively called as Bovines featured by cud chewing habit, having 4 chambered stomach, hallow horns and even toes, with a life span of 20 yrs.

*Matured cattle will have 32 teeth. Zoologically it is called as Bos indicus (cow, humped cattle and the male is called as bull).

* Gir (Rajasthani and Gujarath cow) Sahiwal (UP cow) Malvi (Rajasthani drought resistant variety),Ongole (Andhra pradesh) and Jersy is an imported breed.

2 **Buffalos**

* About 97% of buffalos are seen in Asia.
- It is zoologically called as Bubalus bubalis weighing about 400-800 kg wt, with a life span of 25 yrs.
- They are mostly nocturnal and poor heat resistant animals.
- They are known to provide 300 day lactation per year.
- The dairy industry is more buffalo oriented than cows.
- They are featured by more calf mortality and are easily susceptible for Rinderpest infections (cattle plague).
- The buffaloes yields milk with 7% of fat
- Murrah (Punjab & Haryana), Surthi (Gujarat) Bhadwari and Mehsana (Gujarat)

3 **ANIMALHUSBANDARY ---CONT**

- The cattle genome or Bovine genome is worked out completely by National Institute of health and US Dept of Agriculture, known to contain about 22,000 genes and almost resembling the humans by 80%.
- The breeds are designed for meat and milking.
- Cattle ruminant can convert cellulose in to glucose and volatile fatty acids. The microbes of ruminant can synthesize amino acids for protein formation.
- Cattle emit large amounts of methane released out burping have greater role global warming effect.
- Due to heavy grazing of the grasses, the biodiversity is disturbed. (environmental effect)

4 **GOATS AND SHEEP**

- Goats:
- It is regarded as poor man's cow.
- It is called as Capra species, weighing about 75-80 kg, with a life span of 10 yrs.
- Goats are highly economical because their meat is low in fat content while its milk has high fat content. Therefore it advisable foe consumption by adults and nutritive for children
- Goat's milk can be digested easily in spite of heavy fat content (it exists in lyophilized form.)
- Goat's droppings provide rich form of manure containing nitrogen and phosphorous.
- CIRG (Central institute of Research on Goat) in UUPUPMakhdoom UP

5 **SHEEP**

- It known as Ovis aries.
- Featured by10 -15 yrs of life span
- Unlike goats, sheep provides meat, milk and wool.)
- Sheep are more temperature resistant than goats and subjected to more mountain areas.

- To improve sheep breeds the govt has set up a research institute in Haryana , The CSBF (Central Sheep Breeding Farm).
- separe
- To improve sheep

6 **ANIMAL HUSBANDARY---- PIGS**

- The pigs are called as non ruminant animals.
- Biologically it named as Sus. The male and female pigs are respectively called as Boar and Sow respectively.
- The life span of pig is about 16 yrs.
- China ranks first in the world for pig production.
- Pigs are known for prolific breeding and feeding.
- They are the fast growing animals and they are known for converting the vegetable matter in to animal matter.
- Pigs do not have functional sweat glands as such to keep themselves cool by water and mud as sun cream. Severe stress in them lead to cannibalism.

7 **Animal husbandary : Camels**

- They are mainly used for travel in deserts than food animals
- India possesses 1.2 million camels.
- Each animal weighs450-500 kg, camels are slow breeders (lays a calf every 3years) , with a life span up to 40 years.
- They are less intelligent animals.
- On availability they drink water and store in the vesicles of stomach.
- Lot of water is stored in the form of fat, which is stored in hump.
- The camel produces milk, hair and meat

8 **ANIMALHUSBADARY -----HORSES**

- The horses are hoofed ungulate mammals.
- They are the earliest domesticated animals.
- Due to their good built and strong sense of balance, they can escape from predators.
- They have great fight and flight instinct.
- They are featured by night vision.
- They are employed in police, sport and transport.
- Hearing and touch senses are exceptionally well.
- Being cognitive, having spatial distribution and quick learning they are intelligent animals.

9 **Animal Husbandary ----Horses**

• Breeds	Distribution
• Kathiawari	Gujarat , Rajasthan
• Marwari	Rajasthan
• Bhutia	Bhutan & Punjab
• Manipuri	North- eastern mountains.
• Spiti	Himachal Pradesh.
• Zanskari	Ladakh

10 **Animal Husbandary--Edible Fishes**

- Fresh water fishes
- Labeo rohita: Rohu All over India
- Labeo calbasu: Calbsu North & South India
- Catla catla All over India.
- Mystus singhala all over India.
- Clarius batrchus, All over India
- Wallgo attu all over India

- Marine fishes :
- Harpodon, the Bombay duck coastal Maharastha
- Anguilla eel Coastal indai
- Pomphret Indo-Pacefic.
- Salmon East & West coast

1 **PLANT HISTOLOGY**

- Study of tissues is known as Histology
- Plant tissues are basically of two types
  - 1. MERISTEMATIC TISSUES
  - 2. PERMANENT TISSUES
  - The meristematic tissue is composed of actively dividing cells, with dense cytoplasm, without vacuoles.
  - They are mostly involved in increasing the length and thickness of plant.
  - According to their position they are of 3 types.
    - A) Apical meristems :Ex in the tips of stems and roots leading to primary growth.

2 **Meristematic tissues cont...**

- B) Lateral meristems : Cells divide only in one plane cause increase in diameter. Due to this tissue's activity secondary thickening of plant is possible. Ex. Cork cambium.
- C) Intercalary meristem : located at the base of node, internodes or leaf base.

3 **Permanent tissues**

- The cells in this tissue are specialized.
- They are all thick walled with lot of intercellular spaces and the wall is made up of cellulose.
- These tissues are distributed all over the plant like in root, stem and leaves.
- Their basic function is assimilation or storage of waste products like gum, resin ect, or store food stuffs.
- The permanent tissues are of 3 types

4 **Permanent tissues ... cont**

- i. Simple permanent tissue.
- Ii. Complex permanent tissues.
- iii. Epidermis.
- Simple permanent tissue is 4 types.
  - 1. Collenchyma : Cells prominent in between cell spaces are filled by cellulose and pectin material. This tissue provides strength to plant.
- 2.Parenchyma : These tissues are distributed all over the plant like in root, stem and leaves. The basic function is storage of stuffs.

5 **Simple permanent tissues ...cont**

- 3. Arenchyma: In aquatic plants cells do have huge inter cellular spaces for floating .
- 4. Sclrenchyma : Cell walls are thick (lignin impermeable to water), cells are dead.

6 **Complex permanent tissues.**

- They are of two types; the XYLUM and PHLOEM
- XYLEM: It is the chief conducting tissue(water and organic solutions)
- Formed of bundles of pipes-plumbing like.
- PHLOEM : It carries dissolved substances, it is formed in the form of conducting tube, but assisted by companion cell and sieve plates. These tube transport organic food up and down.

7 **Permanent tissues**

Epidermis.

It is usually the covering layer in which the cells are compactly placed without any intercellular spaces.

8 **HISTOLOGY ----- ANIMAL TISSUES.**

- Basing on the structure and function 4 major tissues are identified. They are as follows

- 1. Epithelium
- 2. Connective tissue.
- 3. Muscular tissue and
- 4. Nervous tissue.
- The above combinations of basic tissues form different types of compound tissues, which in turn are involved the formation of various organs.

9 **Histology – Epithelium.**

- It is in the form of sheath of cells.
- It usually forms the covering layers, internal as well external and always one cell thick layer, then it is called as simple otherwise stratified.
- Types of epithelium :
  - 1. Squamous epithelium. Thin and flat seen in alveoli, epidermis and skin.
  - 2. Cuboidal epithelium. Cells are cube like seen I thyroid and ovaries
  - 3. Columnar epithelium. Cells column shaped, seen in intestine, stomach and pharynx

10 **Connective tissue**

- This tissue supports the body organs
- It also connects various parts of the body.
- It is featured by ground substance the MATRIX containing the following cells.
  - Fibroblasts produce fibers the yellow and white.
  - Macrophages
  - Adipose cells

  The blood is also the connective tissue, whose matrix is plasma in which cells like RBC WBC and platelets freely move.