

## Biology Class 01

### A broad plan for Science and Technology section

#### Syllabus(1:02:00 PM)

- Prelims: General Science
- Mains: GS3- Biotechnology

#### Weightage(1:05:00 PM)

- Explained through slides
- From 2019 onwards, 4-5 questions on average.

#### Sources and approach(1:07:00 PM)

- **NCERTs:**
- Class 6-8 - Science(Cover to Cover)
- Class 9-10 - Science (Selectively)
- Class 11-12 - Biology(Very selective topics along with the classes)
- Nature of questions explained with the help of a PYQ and the importance of Current Affairs.

#### Food and Nutrition(1:18:00 PM)

- **Nutrients**
- Nutrients are substances in our food which are essential for the life and health of an organism, providing it with energy and acting as building blocks for repair and growth.
- The nutrients can be classified based on the quantity required into- Macronutrients vs Micronutrients.
- **Macronutrient**
- Those nutrients which the body needs in a large amount and form the major part of our diet.
- They include Protein, Carbohydrates and Fats.
- **Micronutrients**
- Those nutrients which the body needs in smaller amounts and form the lesser part of our diet.
- They include vitamins and minerals.

#### Carbohydrates(1:26:00 PM)

- Carbohydrates are naturally occurring organic substances containing hydrogen and oxygen and acting as sources of energy,
- **Types of carbohydrates(based upon their structure)**
- **a. Monosaccharide(single unit)**
- The simplest form of carbohydrate consisting of one single unit.
- Examples: Glucose(source of energy), Fructose(fruit sugar), Galactose(a component of milk)
- **b. Oligosaccharide(2-10 units)**
- It is formed by the joining of 2 to 10 carbohydrate units linked by Glycosidic bonds.
- Examples: Lactose(Milk sugar- made by joining of glucose and galactose), Sucrose(Common Table sugar- made up of glucose and fructose), Maltose(made by joining of multiple glucose)
- \*The bond joining different units is known as the **Glycosidic bond**. This needs to be broken down by the body.
- \* Both mono and oligosaccharides are known as **simple carbohydrates**.
- **c. Polysaccharides (>10 units)**
- It is made up of more than 10 carbohydrate units joined together by glycosidic bonds and forms the structural material in the cell.
- Examples: Cellulose, starch and glycogen(all three are made up of glucose)
- \*Cellulose and starch are found only in plants and Glycogen is found only in animals.
- \*Cellulose forms the cell wall of plants.
- \*Starch is the storage form of glucose in plants and glycogen is the storage form of glucose in animals.

#### Proteins(1:49:00 PM)

- Proteins are **nitrogenous organic compounds** which are made up of **amino acids** joined together by **peptide bonds**.
- **Types of Protein(based on the type of arrangement)**
- **a. Fibrous proteins**
- The amino acids are arranged in a linear pattern and they make up the structure of the different parts of the body.
- Examples: Myosin(makes up muscles), Collagen(found in skin), Alpha-keratin(found in hair and nails)
- **b. Globular proteins**
- The amino acid chains are coiled in a spherical shape and they act as functional proteins in the body.

- Examples: Some hormones like Insulin, proteins in the blood called blood plasma, All enzymes.
- \* Enzymes are **biocatalysts** which help in different reactions taking place in the body. Example: Lactase is an enzyme that will help the break down of lactose into glucose and galactose.

### Lipids/fats(2:06:00 PM)

- Fats are organic compounds of carbon, hydrogen, and oxygen which are insoluble in water.
- The major form in which fats are present in the body is **triglyceride**. It is made up of **3 units of fatty acid** and **1 unit of glycerol** joined by an **ester bond**.
- **Types of fatty acids(Based on composition)**
- **a. Saturated**
- There is no double bond.
- Mostly animal-based fat are saturated and are solid at room temperature.
- Examples: Ghee, cheese, Butter, cream and Coconut oil(Saturated plant-based)
- **b. Unsaturated**
- Presence of double bonds.
- They are mostly plant-based and liquid at room temperature.
- They can be further categorised(based on the number of double bonds):
- **i. Monounsaturated(MUFA)(1 double bond)**
- Examples: Olive oil, sesame oil, avocado
- **ii. Polyunsaturated(PUFA)(> 1 double bonds)**
- Examples: Fish oil, walnuts, flax seeds and chia seeds
- **c. Transfats**
- Transfats are a type of unsaturated fatty acids which are industrially hydrogenated to change to a solid form.
- Examples: Vanaspati ghee, fried and processed food and certain bakery products.
- Transfats are detrimental to the health of the heart and blood vessels as it has the highest tendency to get deposited in the body. It often leads to problems of hypertension.
- **Functions of fats:**
- Cell membrane
- Some hormones like the sex hormones
- Some vitamins like A, D, E, K
- Brain- signals
- Discussion on PYQ

### Micronutrients(3:02:00 PM)

- **Vitamins**
- They are micronutrients needed in small quantities for the proper functioning of the body.
- Most of these can not be synthesised in the body and have to be taken as a part of our diet.
- **Water soluble vitamins**
- **B1(Thiamine)**
- Sources: Milk, yeast, green vegetables
- B1 helps in carbohydrate metabolism in the body.
- Its deficiency can cause indigestion and in severe cases even heart enlargement or heart failure.
- Deficiency disease associated: Beri Beri(retarded growth)
- **B2(Riboflavin)**
- Sources: Yeast, Milk, Peanuts
- It is needed for cellular respiration.
- Deficiency disease: **Cheilosis** which is the development of cracks at the corner of the mouth.
- **B12(Cyanocobalamine)**
- Sources: it can be produced by the bacteria present in our intestine, meat, fish, and eggs.
- B12 is needed for the formation of haemoglobin present in the RBC and its deficiency causes **pernicious anaemia**.
- **Vitamin C(Ascorbic Acid)**
- Sources: lemon, orange, Amla, Green Chilli, etc
- It helps the immune system
- Deficiency disease: **Scurvy**(bleeding gums, pain in muscles and joints)
- **Fat-soluble vitamins**
- **Vitamin A(Retinol)**

- Sources: Carrot, Cod Liver oil,
- Vitamin A is needed for maintaining our skin and eyes.
- Deficiency disease: Night blindness
- **Vitamin D(Calciferol)**
- Source: Exposure of the skin to sunlight
- It helps in the absorption of calcium.
- Deficiency disease: Rickets
- **Vitamin E(Tocopherol)**
- Sources: Vegetable oils
- It is needed for muscle function.
- Deficiency: Muscle weakness and reduced fertility in males.
- **Vitamin K(Phylloquinone)**
- Source: Green leafy vegetables
- It is needed for the clotting of blood.
- Its deficiency will cause increased clotting time.
- PYQ Question discussion

### **Minerals(3:38:00 PM)**

- Minerals are inorganic nutrients needed in small quantities for the proper functioning of the body.
- Classification of minerals(on the basis of quantity needed):
- **a. Macrominerals**
- Examples: Ca, Mg, Na, P, K, Cl, S
- **b. Microminerals**
- Examples: Fe, I, F, Zn, Cu
- **Macrominerals**
- **Calcium**
- Source: Milk and milk products
- Deficiency: Brittle bones and bad muscle movement, Rickets
- **Magnesium**
- Source: Nuts and seeds
- Deficiency: Poor muscle coordination
- **Sodium**
- Source: Common table salt
- It is also needed for muscle movement and maintaining the fluid balance in the body.
- Its deficiency will cause dehydration and body weakness.
- **Phosphorus**
- Source: Pulses, milk
- Deficiency: Weaker teeth and bone
- **Potassium**
- Source: Most fruits and vegetables
- Deficiency causes muscle weakness
- **Chlorine**
- Source: Common table salt
- Deficiency will cause fluid imbalance and dehydration
- **Sulphur**
- Source: Meat, eggs, onions, garlic
- Deficiency may cause protein deficiency.
- **Microminerals**
- **Iron**
- Source: Meat, pulses, spinach
- It is a component of haemoglobin.
- Deficiency will cause iron deficiency anaemia.
- **Iodine**
- Source: Iodised table salt
- It is the component of the thyroid hormone and its deficiency causes Goitre.
- **Fluorine**

- Source: Drinking water and fish
- It prevents tooth decay and deficiency will cause dental caries.
- **Zinc**
- Source: Beans, Chia seeds
- It helps in the working of the immune system and its deficiency can cause hair loss or diarrhoea.
- **Copper**
- Source: Pulses, Nuts and seeds
- Its deficiency can cause a low White Blood Cell count.
- PYQ question
- **Refer to NCERT(Class 6-Chapter 2)**

**Topics for the next class: Cell biology**

**Biology Class 02**

**PYQ discussion**

**Cell Biology(1:07:00PM)**

- The cell is the **basic structural and functional unit** of all known forms of life.
- Based on the number of cells, organisms can be **divided into 2:**
- **a. Unicellular organisms**
- They contain only a single cell which performs all the life processes.
- Examples: Amoeba, Euglena, Paramecium, Bacteria.
- **b. Multicellular organisms**
- They consist of more than one cell.
- These cells can become specialised for different functions all of which coordinate to make life possible in the organism.
- Examples: Plants, Animals, Insects.
- **Prokaryotes**
- They are **unicellular organisms** which **lack a membrane-bound nucleus and cell organelle**.
- The genetic material DNA is **circular** and is present in the **nucleoid region**.
- Examples: **Bacteria and cyanobacteria/blue-green algae**
- **Eukaryotes**
- They can be **unicellular or multicellular organisms** which **have a membrane-bound nucleus and cell organelle**.
- The genetic material is **linear** and is organised in the form of **rod-like structures** called **chromosomes**.
- Examples: **Amoeba, Fungi, Plants, Animals, etc.**

**Structure of the Cell(1:32:00PM)**

- Explained with the help of a diagram.
- **Cell/Plasma membrane**
- It is a biological membrane which separates the interior of all cells from the outside environment.
- It is made up of **phospholipids**.
- **Cell wall**
- It is a structural layer surrounding the cell membrane or plasma membrane in certain types of cells providing them **support and protection**.
- It is present in the following cells/organisms and it is made up of :
- **Plant cells- Cellulose**
- **Bacteria- Peptidoglycan**
- **Fungi- Chitin**
- **Cell nucleus**
- It is the controlling centre of all activities of the cell.
- It is generally spherical in shape and present in the centre of the cell.
- It contains genetic material in the form of chromosomes.
- **Cytoplasm**
- It consists of all the components of the cell enclosed within the cell membrane other than the nucleus.
- **Protoplasm**
- It is the **living part** of the cell which includes the **nucleus and the cytoplasm**.
- **Ribosomes**
- They are sites of **protein synthesis** in the cell.

- They can be present freely in the cytoplasm or attached to the endoplasmic reticulum.
- **Endoplasmic Reticulum**
- It is a **large network of membrane-bound tubes and sheets** which act as **channels of transportation in the cell**.
- **Rough endoplasmic reticulum** contains attached ribosomes and is involved in the **production of proteins**.
- **Smooth endoplasmic reticulum** does not contain attached ribosomes and is involved in the **manufacture of fats**.
- **Golgi bodies**
- They are membrane-bound structures which package and dispatch material to various targets inside and outside the cell.
- **Mitochondria**
- Mitochondria is the site for energy production in the cell and is thus called the **powerhouse of the cell**.
- It contains its **own DNA**.
- **Lysosome**
- They contain **powerful digestive enzymes** which can digest any **foreign material as well as worn-out cell organelle**.
- They can digest the whole damaged cell by releasing their enzymes into the cytoplasm. It can thus be called the **suicide bag of the cell**.
- **Vacuole**
- They are the **storage structures** of the cell.
- They are found in the form of a **single large structure in the plant cell** and **multiple small structures in animal cells**.
- **Plastids**
- They are pigment-containing structures found **only in plants**.
- They contain their **own DNA**.
- They are of **3 types**:
- **a. Chloroplast**- Found in the green parts of the plants, pigment is called **chlorophyll**.
- **b. Chromoplast**- It is for the coloured parts like flowers.
- **c. Leucoplast**- It is white to colourless.
- **Difference between plant and animal cells**
- 

#### **Plant Cells**

Presence of cell wall.

Plastids are present.

Single large vacuole.

A peripheral nucleus in the plant cell.

The cells have starch.

#### **Animal Cells**

Only the cell membrane is present and the cell wall is absent.

Plastids are absent.

Multiple, small vacuoles.

The nucleus position is central.

The cells have glycogen.

- PYQ discussion

#### **Classification of living organisms into kingdoms(2:15:00PM)**

- **1. Monera**
- Prokaryotic
- Unicellular
- Examples: Bacteria and Cyanobacteria.
- **2. Protista**
- Eukaryotic
- Unicellular
- Examples: Amoeba, Paramecium, Euglena.
- **3. Fungi**
- Eukaryotic
- Unicellular or multicellular
- Examples: Yeasts, Mushrooms
- **4. Plants**
- Eukaryotic
- Multicellular

- **5. Animals**
- Eukaryotic
- Multicellular

#### **Viruses(2:38:00PM)**

- They are having their own genetic material which can be RNA or DNA and their own set of proteins but lacks the enzymes needed for energy production.
- They can grow and replicate only inside the living cells of another organism.
- They can infect animals, plants and even microorganisms like bacteria.

#### **Animal Kingdom(2:46:00PM)**

- Explained with the help of diagrams
- **1. Porifera**
- Porifera is a non-mobile animal with pores.
- Example: Sponges
- **2. Coelenterata/Cnidaria**
- They are usually found attached to the bottom of the rocks.
- Examples: Jellyfish, Hydra, Corals
- **3. Platyhelminthes or flatworms**
- Their body is flattened from top to bottom and the sexes are not separate. Thus making them hermaphrodites.
- Examples: Tapeworm, Liver fluke, Taenia Solium
- **4. Aschelminthes or roundworm or nematodes**
- Their body is circular in cross-section and the sexes are separate.
- Examples: Ascaris, Hookworm, Filarial worm and Guinea worm
- **5. Annelida**
- They are segmented worms.
- Examples: Earthworm, Leeches.
- **6. Arthropoda**
- They have a **hard external exoskeleton**.
- Examples:
  - **a. Insects**(Bees, wasps, cockroaches)
  - **b. Arachnids**(Spider, Scorpion, Ticks, Mites)
  - **c. Crustaceans**(Prawns, Crabs, Lobsters, Shrimps)
- **7. Mollusca**
- They are aquatic animals.
- Examples: Snails, Octopus, Oysters.
- **8. Echinodermata**
- They have a **calcified endoskeleton**.
- Examples: Starfish and Sea lily
- **9. Chordata**
- Under this, we have **vertebrates**- Animals with a backbone.
- The sequence of evolution of vertebrates:
  - **a. Fish/Pisces**- Examples: Sea Horse, Catfish
  - **b. Amphibians**- Frogs and salamanders
  - **c. Reptiles**- Snakes, Crocodile, Tortoise, Lizard
  - **d. Birds**- Crows, Sparrow, Pelicans, Siberian crane
  - **e. Mammals**- Dolphins, Whales, Dugong/sea cow, Pangolins
- PYQ discussion

#### **Health(3:18:00PM)**

- Doubt resolution
- **Health**
- Complete physical, mental and social well-being of an organism and not merely the absence of disease.
- **Types of diseases:**
- **1. Congenital diseases**
- Any abnormality in the structure or function of a person which is present right from the time of birth.
- Examples: Congenital heart defect, Down's syndrome
- **2. Acquired diseases**

- Any disease which is not present at the time of birth but develops at a later stage of life of an organism.
- They can be further divided into- Communicable and Non-communicable diseases.
- **a. Communicable or infectious diseases**
- They are caused by disease-causing organisms called pathogens.
- Examples: Covid, Malaria, Typhoid, Monkeypox
- They can be further divided into:
- **i. Contagious**
- They can spread by direct contact.
- Example: Covid-19, Chickenpox, Common cold
- **ii. Non- contagious**
- They do not spread by direct contact.
- Example: Malaria
- **b. Non-communicable or non-infectious diseases**
- These are diseases not caused by pathogens but by lifestyle or environmental factors.
- Examples: Asthma, Diabetes

#### **Modes of transmission of communicable diseases(3:40:00PM)**

- Air- Tuberculosis
- Water- Cholera
- Food- Amoebiasis
- Soil- Hookworm infection
- Blood and body fluids- AIDS, Hepatitis B and C
- Direct contact- Covid-19
- Zoonotic- Getting a disease from birds or animals- Bird flu, swine flu, Rabies, Plague
- **Vector**
- Vectors are organisms that do not cause the disease itself but which spreads the infection by taking pathogens from one organism to another.
- **Biological vectors** carry the pathogens within their body and **mechanical vectors** carry the pathogens on the surface of their bodies.
- **Fomite**- Getting a disease from non-living objects from utensils, bedsheets, etc. Examples: Cold or chickenpox.
- Doubt resolution
- **Refer NCERTs- Class 8(Chapter-2,8) and Class 9(Chapter-5,7)**

#### **Topics for next class- Diseases, Immunity**

#### **Biology Class 03**

#### **PYQ discussion**

#### **Bacterial diseases(1:06:00PM)**

- Some of the bacterial diseases are:
- Tuberculosis
- Leprosy
- Typhoid
- Tetanus
- Cholera
- Anthrax
- **Tuberculosis**
- Pathogen- **Mycobacterium Tuberculosis**
- **Pulmonary TB** impacts the lungs.
- **Extra-Pulmonary TB** impacts other organs like the bone, intestine and brain.
- **Symptoms of Pulmonary TB**- Persistent cough for more than 15 days, afternoon fever, weight loss, blood-stained sputum, night sweats.
- **Antibiotics**
- They are the drugs given against bacteria.
- Drug therapy for TB deals with dosage, frequency and duration.
- **Antimicrobial resistance**
- It is the ability of a microorganism like bacteria or virus to stop an antimicrobial like antibiotic or antiviral drugs from working against it.
- It can occur naturally or by misuse of drug therapies.

- Standard treatments become ineffective, and infections persist and may spread to others.
- PYQ discussion

#### **Protozoan(Kingdom Protista) diseases(1:52:00PM)**

- Some protozoan diseases are:
- Amoebiasis
- Giardiasis
- Malaria
- **Malaria**
- Pathogen- **Plasmodium vivax/ Falciparum**
- Vector- **Female Anopheles mosquito**
- **Malaria transmission cycle:**
- Explained through a flow chart
- Infected mosquito(carrying plasmodium)-> bites a person(plasmodium in the blood)-> Infected liver cells(growth of plasmodium)-> Infects Red Blood cells(Multiplication of plasmodium inside the RBCs)-> RBCs burst and plasmodium again enters the blood-> Mosquito can bite an infected person and transmit it to another.
- There is a high intermittent fever.

#### **Fungal diseases(2:06:00PM)**

- Some fungal diseases are:
- Candidiasis- Caused by a fungus called Candida Alba
- Ringworm
- Athlete's foot

#### **Helminthic diseases(2:09:00PM)**

- Some helminthic diseases are:
- Ascariasis
- Taeniasis
- Lymphatic filariasis
- Hookworm infection
- #With respect to diseases, we can focus on the following aspects:
- a. Cause
- b. Mode of transmission
- c. Origin/spread
- d. Diagnosis/symptoms/treatment
- e. National Health Programmes

#### **Viral diseases(2:19:00PM)**

- Some common viral diseases are:
- Hepatitis
- Chickenpox
- Polio
- Dengue
- Zika
- Chikungunya
- AIDS
- **Hepatitis**
- Hepat means liver itis means inflammation(redness, swelling, pain, loss of function or increased temperature). Thus hepatitis is the disease-causing inflammation of the liver.
- The pathogen involved is called **the hepatitis virus.**
- **Jaundice** can be caused by hepatitis infection.
- There are **5 types** of hepatitis virus:
- **Hepatitis A-** Food and water-based contamination
- **Hepatitis B-** Body fluids and blood
- **Hepatitis C-** No vaccine available for this(for all other variants it is available), body fluids and blood(blood is more common)
- **Hepatitis D-** Observed in people who already are infected with Hepatitis B
- **Hepatitis E-** Food and water-based contamination
- PYQ discussion



- The National Health portal website can be referred for diseases.

#### **Non Communicable diseases(2:55:00PM)**

- Some examples:
- Cardiovascular diseases- Hypertension
- Chronic Respiratory diseases- Asthma
- Deficiency diseases- Caused due to deficiency of vitamins and minerals
- Mental disorders- Anxiety and depression
- Environmental diseases- Silicosis(Occupational), Minamata disease
- Cancer

#### **Immunity(3:01:00PM)**

- Immunity is the balanced state of organisms having adequate biological defences to fight infection and any other unwanted attack.
- Immunity can be classified into:
- **a. Innate immunity**
- It is the **non-specific response** which is activated immediately and forms the **first line of defence** of the body.
- There are 3 types:
- **i. Physical barrier**- Skin, mucous membrane
- **ii. Chemical barrier**- Tears, saliva and HCL of the stomach
- **iii. Cellular defences**- Neutrophils and Monocytes (WBCs)
- **b. Acquired/adaptive immunity**
- It is a **specific immune response** which activates on exposure of the immune system to an unwanted agent.
- It is **slower** than innate immunity.
- **Antigen**
- An antigen is any agent which triggers an immune response.
- **Antibody**
- An antibody is a protein produced in response to the antigen.
- **Phagocytosis**
- It is the process by which a cell uses its plasma membrane to engulf a large particle and then digest it.
- **Lymphocytes(WBCs)**
- They are of two types- **B-cells and T-cells**
- All blood cells are formed in bone marrow present in the long bones including lymphocytes
- T- cells have a special feature that after forming in bone marrow these cells move to the thymus gland for maturation, thus called T-cells.
- B-cells or B lymphocytes are the ones that produce antibodies. This response is known as the **Antibody-mediated immune response.**
- T- cells are involved in phagocytosis and thus are also known as killer cells. This response is called a **Cell-mediated immune response.**
- **Vaccination**
- Vaccination is a process whereby a person is made immune or resistant to infectious diseases by stimulating the body's own immune system.
- When a person encounters an antigen for the first time, a slow and low-intensity immune response is produced.
- The B cells however remain sensitised and **immunological memory** is created.
- On subsequent attacks by the same antigen, a fast and high-intensity immune response is produced with the help of the immunological memory. This is the basis of vaccination.
- **Different types of vaccines:**
- **a. Live attenuated**
- The pathogen is weakened so that it does not cause the disease but retains its capacity to grow.
- Examples: Oral Polio Vaccine and BCG vaccine
- **b. Inactivated killed**
- The pathogen is killed but the proteins or certain other components can still create an immune response.
- Examples: Injectible polio vaccine, Covaxin
- **c. Subunit vaccine**
- You give specific parts like proteins or polysaccharides which act as antigens.

- Examples: Whooping cough vaccine.
- **d. Conjugate vaccine**
- When two antigens are given together like a protein and a polysaccharide.
- Example: Pneumococcal Conjugate Vaccine.
- **e. Nucleic acid vaccines**(To be covered later)
- Doubt resolution
- **Refer NCERTs- Class 9(Chapter 13), Class 12(Chapter 8)**

**Topics for the next class- Categories of active and passive immunity, herd immunity, Systems of the human body**  
**Biology Class 04**

#### **PYQ discussion**

##### **Adaptive/acquired immunity(1:03:00 PM)**

- **Active immunity and passive immunity**
- **Active immunity**
- When the immune system is responsible for the production of antibodies in response to an antigen.
- For example, Natural (against infections) and artificial (through vaccination).
- **Passive immunity**
- In this, the antibodies are administered from outside to protect against the antigens.
- For example, Natural(Mother's milk) and artificial(anti-snake venom, plasma therapy).
- Doubt resolution
- **Herd immunity**
- Herd immunity is when enough people in a population have immunity so that the disease can't spread.

##### **Digestive system(1:26:00 PM)**

- Explained with the help of a diagram
- Digestion means the breakdown of food into simpler forms.
- **Mouth**
- It has salivary glands which produce saliva.
- Saliva contains **amylase** which breaks down **carbohydrates**.
- **Oesophagus/food pipe**
- It connects the mouth to the stomach.
- No digestion is taking place, it only acts as a pathway to the stomach
- **Stomach**
- It has gastric juice. Gastric juice has **hydrochloric acid** and **protease enzyme**.
- Protease enzyme: breaks down **proteins**.
- At both ends of the stomach, there are muscles to close down the stomach called **sphincters**.
- **Small intestine**
- It is called small because it is thin, however, it is very long in length.
- It has intestinal juice.
- Intestinal juice contains- **Peptidase for protein; Sucrase, maltase, and lactase(all 3 for carbohydrates)**.
- It also receives secretions from the **liver and pancreas**.
- **Liver**
- It produces bile.
- Bile helps in the digestion of fats but it does not contain the fat-digesting enzymes
- **Gall bladder**
- It stores bile juice and releases it into the small intestine.
- **Pancreas**
- Pancreatic juice contains all three enzymes- **lipase (for fats), protease (for protein), and amylase (for carbohydrates)**.
- \* The **complete breakdown of food takes place in the small intestine** and nutrition is absorbed into the blood from the small intestine.
- **Large intestine**
- The undigested food is passed into the large intestine and it absorbs **all the extra water**.
- Through the **anus**, the undigested food is thrown out of the body called a **stool**.

##### **Respiratory system(1:45:00 PM)**

- The main function of respiration is the production of energy.
- There are two major processes involved- **Gaseous exchange and cellular respiration**.

- **Cellular respiration**
- Every cell will use glucose to produce energy in the presence of oxygen.
- Glucose in the presence of oxygen will give carbon dioxide, water, and energy. This energy is used for different bodily functions.
- This process is known as **aerobic respiration** as oxygen is involved in this process.
- One exception to aerobic respiration present in our body is the **muscle cells** which can produce **Lactic Acid and energy from Glucose** under an **insufficient supply of oxygen**. This process is useful during an intense workout where initially respiration by the muscle cells will be through aerobic respiration but after there is no more supply of oxygen, the muscles produce energy via anaerobic respiration.
- The muscles develop **cramps** due to the deposition of lactic acid produced during anaerobic respiration.
- **Anaerobic respiration**
- Anaerobic respiration takes place without oxygen.
- Glucose is transformed into ethanol and energy in the absence of oxygen.
- The organisms involved are **bacteria and yeast**.
- This process is also known as **fermentation**.
- **Gaseous exchange during respiration**
- Explained with the help of a diagram
- Intake of air through the nasal cavity. From here via Pharynx to Larynx(voice box), it will pass through the trachea.
- The trachea is the windpipe that takes the air from the nasal cavity to the lungs.
- The passageway for air in the lungs: **Trachea-->Bronchi-->Bronchioles-->Alveoli**.
- Alveoli are air sacs that have a very **rich supply of blood**.
- In blood, we have **RBCs** that contain **haemoglobin**.
- Haemoglobin has a very high affinity to oxygen that is, they pull the oxygen out of the air and takes oxygen to every cell of the body.
- \* When there is **less haemoglobin in the blood** the disease is called **anaemia**.
- Doubt resolution

#### **Excretory system(2:19:00 PM)**

- Explained with the help of a diagram.
- The main purpose of the excretory system is waste removal and regulation of water.
- The kidneys are involved in the process of **filtration**.
- For filtration purposes, the basic unit of filtration in the kidney is called a **nephron**.
- Waste is present in the blood.
- Blood supply comes to the kidney.
- The blood-containing wastes come to the kidneys, which remove the waste (including excess water) from the blood.
- The purified blood is sent back to the system and the waste is sent to the urinary bladder
- Ureters are the tubes that connect kidneys to the urinary bladder
- **Urinary bladder**
- The waste collected here is released in the form of urine
- **Urine**
- Urine composition :Urea-2.5%, Other waste- 2.5%, Water- 95%.
- Doubt resolution

#### **Circulatory system(2:47:00 PM)**

- It consists of the **heart, blood and blood vessels**.
- **1. Heart**
- Explained with diagram
- There are **4 chambers/compartments** of the heart.
- The upper chambers are known as **Atrium/Auricles**- Right and Left. They will have **veins**
- The lower chambers are known as **Ventricles**- Right and Left. They will have **arteries**.
- The two main **blood vessels** are the **Artery and the Vein**.
- **Arteries:**
- Artery takes blood away from the heart.
- They are deep-seated, reddish in colour, and thick-walled.
- Arteries carry oxygenated blood with the exception of **Pulmonary Artery**.
- **Veins:**

- Vein takes blood toward the heart.
- They are superficial, located closer to the skin, bluish-green in colour, and thin-walled.
- Veins carry deoxygenated blood with the exception of the **Pulmonary Vein**.
- **Double circulation in the Heart**
- Explained with the help of a diagram
- Oxygenated blood from the lung goes to the heart (**left auricle**) through the **pulmonary vein**.
- Then it goes to the **left ventricle** and from here oxygenated blood goes to the rest of the body through the **aorta (artery)**.
- Vein called **Vena Cava** brings the deoxygenated blood from the rest of the body to the heart in the **right auricle**.
- Then it goes to the **right ventricle** and to the lung through the **pulmonary artery**.
- **Blood**
- It is a red-coloured liquid flowing in the body.
- It has two parts- **Plasma(liquid part) and Cells**.
- **Plasma**
- Plasma is **straw(yellow)-coloured**, and it contains proteins known as **plasma proteins** which are **globular proteins**.
- There are **3 plasma proteins**-
- **1. Globulin:** This is needed for the defence mechanism of the body.
- **2. Albumin:** It helps in maintaining the pressure of the blood.
- **3. Fibrinogen:** It is involved in the clotting of blood.
- **Cells**
- There are **3 types of cells**:
- **1. Platelets**
- Their main role in the body is clotting the blood.
- **2. Red Blood Cells**
- They contain haemoglobin which helps in the transportation of oxygen.
- **3. White Blood Cells**
- They are involved in immunity.
- There are **two categories of WBC**:
- **a. Agranulocyte:**
- They do not contain pigment granules in their cytoplasm.
- They are of **two types**:
- **i. Monocytes-** They provide **innate immunity**.
- **ii. Lymphocytes-** **B Lymphocytes** give us an **antibody-mediated immunity**, and **T-Lymphocytes** provide a **cell-mediated immunity**
- **b. Granulocyte:**
- They contain pigment granules in their cytoplasm.
- They are of **three types**:
- **i. Basophils:** They are involved in inflammation reactions.
- **ii Eosinophils:** They are involved in allergic reactions
- **iii. Neutrophils:** They are involved in innate immunity.

#### Blood groups(3:21:00 PM)

- There are two main categorisations called the ABO type and Rh type.
- This is based on the concept of **antigen and antibody**.
- An antigen is located on the **RBC surface** and the antibody is present in **blood plasma**.
- There are certain antigens on the surface of RBCs that determine the ABO type blood group of a person:

Blood Group	Antigen	Antibody
A	A	Anti-B
B	B	Anti-A
AB	A, B	None
O	None	Anti-A, Anti-B

- For a person who has antigen A present in his body, antibody A(anti-A) can not be present. Therefore antibody B is present. Similarly for other cases in the table.
- **Rh type classification**
-

Type	Antigen	Antibody
Positive	Rh	Absent
Negative	Absent	Anti-Rh

- **Transfusion of blood:**
- The donor's antigen is of significance as the recipient's body will recognize the donor's antigen and might initiate an antibody response
- The recipient's antibody is of significance.
- Example: Donor has blood group A (has antigen A) and recipient blood group has AB (can not produce any antibody). This is a case of successful transfusion as no antibody will be present.
- PYQ discussion
- **O negative** is a **universal donor**.
- **AB positive** is a **universal recipient**.
- **Bombay Blood group** is a rare blood group and has no antigen H (a precursor to ABO type blood group).
- **Refer NCERTS (- Class 7(Ch-2,10,11) and Class 10(Ch-6)**

**Topics for next class- Endocrine system, Genetics**  
**Biology Class 05**

**PYQ discussion**

**Nervous system(1:06:00PM)**

- Explained with the help of a diagram.
- The nervous system controls and coordinates the various functions/processes of the body.
- There are two parts:
- **1. Central Nervous system**- Brain and Spinal Cord- Here the complete processing happens.
- **2. Peripheral Nervous System**- two types of nerves- sensory and motor nerves.
- Sensory nerves pick up/take signals to the CNS.
- Motor nerves bring signals from the CNS.

**System of Hormones(1:15:00PM)**

- **Types of glands:**
- **Exocrine glands**- A duct/tube is present which takes the secretions of the gland to the designated place.  
Example: Liver
- **Endocrine glands**- These are ductless glands and their secretions go directly into the blood..
- **Endocrine system**
- It is meant for internal communication and regulation of the human body.
- **Hormones** are secretions of the endocrine gland which don't have ducts and secrete directly into the blood to be transported to the target organs.
- **Various endocrine glands:**
- Explained with the help of a diagram
- **1. Hypothalamus**
- Its function is to monitor the working of the pituitary gland.
- **Releasing Hormone**-it stimulates the pituitary gland to release its secretions.
- **Inhibiting hormone** - it inhibits the pituitary gland to release its secretions.
- **2. Pituitary glands**
- It is of two types- **Anterior Pituitary and Posterior Pituitary**
- It is also called as the master endocrine gland.
- **Anterior Pituitary:**
- **a) Growth Hormone** - for growth and development. Deficiency can lead to **Dwarfism** and excess of this hormone can lead to **Gigantism**.
- **b) Prolactin** - Associated with the formation of **milk**.
- **c) Thyroid-stimulating Hormone(TSH)** - It stimulates the thyroid gland to release its secretion.
- **d) Adrenocorticotrophic hormone(ACTH)** - It stimulates the adrenal gland to release its secretions.
- **e) Follicle Stimulating Hormone(FSH)** - It helps in the growth and development of eggs and sperm.
- **f) Leutinizing Hormone(LH)** - It stimulates the secretion of sex hormones from the gonads(Ovary and testes).
- **Posterior Pituitary:**
- **a) Oxytocin**- It is released during Childbirth.
- **b) Vasopressin or antidiuretic hormone(ADH)**- It helps in the reabsorption of water and electrolytes from the kidneys.

- **Diabetes Insipidus**- this disease is caused by a **lack of ADH**.
- **3. Thyroid Gland**
- Hormone - Thyroid Hormone/Thyroxine
- Thyroxine helps in the metabolism of carbohydrates, proteins and fats.
- **Hyperthyroidism**: Here excess thyroid hormone is produced. It involves feeling hot more often, metabolic rate is high, and can lead to weight loss.
- **Hypothyroidism**- Here not enough thyroid hormone is produced. It involves feeling cold more often, metabolic rate and heart rate will be slower, might lead to weight gain.
- **4. Parathyroid Gland**
- Hormone- Parathyroid hormone
- this Hormone is needed for the metabolism of calcium and phosphate in the body.
- If this hormone increases, then the metabolism of calcium will increase and phosphate will decrease and vice versa.
- **5. Adrenal Gland**
- It is divided into two parts:
- **a. Adrenal Medulla**
- Adrenaline and Noradrenaline hormones
- They are emergency hormones that are secreted during conditions of fear, being frightened, anger or extreme excitement.
- **b. Adrenal cortex**
- i. Mineralocorticoid(Aldosterone)- It regulates the balance of water and electrolytes in the body. It helps to maintain blood pressure.
- ii. Glucocorticoid (Cortisol)- It is involved with carbohydrate metabolism.
- **6. Pancreas**
- It is one gland of the body that has **both exocrine and endocrine** functions and is thus known as a **mixed gland**.
- **i. Insulin**
- It reduces blood glucose levels.
- When less amount of insulin is produced, then blood glucose levels increase in the blood. this disease is known as **Diabetes Mellitus**.
- **ii. Glucagon**
- It increases blood glucose levels.
- PYQ discussion
- The **trophic hormone** is that hormone which controls the secretory activity of other glands.

#### Genetic material(2:27:00PM)

- **Nucleic acids**
- They form the genetic material of all lifeforms and are responsible for the transmission of characteristics from one generation to the next.
- They are made up of **3 components**:
- a. Pentose sugar
- b. Phosphate group
- c. Nitrogenous base
- DNA has deoxyribose sugar.
- RNA has ribose sugar(Both are pentose sugar)
- The phosphate group is the same for RNA and DNA.
- **Nitrogenous bases**
- They can be classified into -
- **a. Purines** - Adenine(A) and Guanine(G)
- **b. Pyrimidines** - Cytosine(C), Thymine(T), Uracil(C)
- In DNA we have A, G, C and T
- In RNA we have A, G, C and U.
- **DNA structure**
- Explained with the help of a diagram.
- There is a sugar-phosphate backbone.
- There are two strands.

- DNA contains a backbone of sugar and phosphate which are joined together in the 2 strands by the complementary base pairing where Adenine joins to Thymine and Guanine to Cytosine.
- These two strands then twist together into a spiral structure called the **double helix DNA**.
- **Inside the cell**
- Explained with the help of a diagram
- Cell<-Nucleus<-Chromosome<-DNA<-Gene(segment of DNA)
- **Gene expression**
- Segments of DNA tell individual cells how to produce specific proteins.
- These segments are called **genes**.
- It is the presence or absence of specific proteins which gives an organism its trait or characteristic.
- Transcription of DNA to messenger RNA(mRNA) takes place in the nucleus and translation of mRNA into specific proteins takes place at the ribosomes in the cytoplasm.
- **Gene silencing**
- The interruption or suppressing of a gene at the transcriptional or translational level is gene silencing.
- Post-transcriptional gene silencing technology inhibits protein synthesis in target cells using RNA interference(iRNA).
- Example: Flavr Savr Tomato
- Doubt resolution

#### **Vaccine production(3:14:00PM)**

- **DNA vaccine**
- Introduction of a DNA sequence encoding for the antigen against which an immune response is needed.
- The production of the target antigen takes place within the body.
- Example: Zydus Cadila
- **mRNA vaccine**
- It works by introducing an mRNA sequence coding for the disease-specific antigen.
- Example: Pfizer, Moderna

#### **Chromosomes(3:22:00PM)**

- In humans, 46 chromosomes are present in every cell.
- The reproduction will take place by the fusion of egg and sperm by forming a zygote.
- **Haploid cells**
- A haploid cell contains a single set of unpaired chromosomes.
- They are represented as n.
- **Gametes or sex cells or germ cells** are Haploid.
- **Diploid cells**
- Two sets of chromosomes- one coming from each parent.
- It is represented as 2n.
- **Somatic cells**, that is, all the cells of the body other than the gametes are diploid.
- **Homologous chromosomes**
- They are similar in length, structure, and position of genes- one coming from each parent.
- Doubt resolution
- **Refer NCERTs- Class 8(Chapter-9,10), Class 10(Chapter 8), Class 11(Chapter 22)**

#### **Topics for next class- Genetics and Biotechnology**

#### **Biology Class 06**

#### **PYQ discussion**

#### **Inheritance(1:05:00PM)**

- Explained with the help of Mendel's experiment.
- All the characters in an organism are manifested in 2 factors.
- These factors or genes are the units of inheritance.
- The dominant trait is the one which overrides the impact of the recessive trait, for example, in the case of Garden Pea, the green-coloured pod is dominant over the yellow-coloured pod.
- **Homozygous vs Heterozygous**
- Homozygous- When both the genes or factors are the same - G&G, Y&Y.
- Heterozygous- When both the genes or factors are different- G&Y.
- **Phenotype vs Genotype**
- Phenotype- it is the observable characteristic. In our example, the phenotype ratio is 3:1(Green: Yellow)
- Genotype- It is the genetic composition. In our example, the genotype ratio is 1:2:1.

- Blood groups
- 

Phenotype

Genotype

A

AA, AO

B

BB, BO

O

OO

AB

AB(Co-dominance-Both the genes express themselves)

- PYQ discussion

#### Sex determination(1:42:00PM)

- A total of 46 chromosomes are present in 23 pairs.
- Now 1 pair of chromosomes(XX/XY) will determine the sex of a person known as sex chromosomes.
- Male- XY and Female- XX

#### Genetic abnormality(1:54:00PM)

- **a. Abnormality in the number of chromosomes:**
- **Klinefelter's syndrome-** XXY- There is 1 extra chromosome in the male. This male will be developing certain female characteristics.
- **Turner's syndrome-** XO-(2nd X chromosome is absent). This is a sterile female who can not reproduce.
- **Down's syndrome-** There is 1 extra chromosome in the 21st place. It is also called **Trisomy 21**- children with Down's syndrome have a small round head, partially open mouth and mental retardation.
- **b. Gene defects**
- **Autosomal- Sickle cell anaemia(Recessive disease)**
- Genotype of a normal person(Hb, Hb)
- Genotype of a sick person( Hb<sup>s</sup>,Hb<sup>s</sup>)
- A normal person can also have(Hb, Hb<sup>s</sup>), however, he/she can act as a carrier.

#### Sex-linked diseases(recessive)(2:32:00PM)

- **Haemophilia**
- Haemophilia is a rare disorder in which the blood doesn't clot in a typical way because it doesn't have enough blood-clotting proteins.
- It is a defect of the X chromosome.
- X<sup>h</sup>Y (Male)and X<sup>h</sup>X<sup>h</sup> (Female)is the diseased state.
- XX<sup>h</sup> (female) will act as a carrier.
- **Colour blindness**
- Same logic as of haemophilia will apply here.
- PYQ discussion

#### Biotechnology(2:43)

- Biotechnology deals with the techniques of using organisms or their products for the benefit of human beings.
- The main technique used for this technology is **genetic engineering** which deals with the alteration of genetic material
- **Genome**
- An organism's **complete set of DNA**.
- It includes all the chromosomes with all its genes.
- It contains all the data that is needed to describe an organism completely.
- **Genome sequencing**
- It is the process of **describing the exact order of base pairs** in an individual.
- This data can be analysed to understand the functions of various genes and to study how changes impact these genes.

#### Recombinant DNA technology(2:56:00PM)

- Explained with the help of a diagram
- **Steps involved:**
- Isolation of the "desired gene".
- The **nucleases enzyme** will help in cutting the desired gene from the DNA.
- Vector is the DNA which carries the desired gene. Example- **Plasmid** is a small, circular, independent DNA found in bacteria and viruses.
- **Ligase** enzyme is used for joining.



- The desired gene is joined to a vector forming **recombinant DNA**.
- Examples:
- **Covishield/Sputnik production**- Here adenovirus is used as a vector.
- Recombinant Hepatitis B vaccine using Yeast.
- PYQ discussion and doubt resolution

#### **In Vitro Fertilisation(IVF) or Test Tube Baby Process(3:30:00PM)**

- Explained with the help of a diagram
- Normal process: Egg and sperm cells fuse together to form a zygote(single cell) which then changes into an embryo(multiple cells).
- When the above process takes place in the lab, then it is called as IVF process.
- The viable embryo is transplanted into the uterus.
- If the embryo is transplanted to some other woman(instead of the biological mother), then the process is known as surrogacy.
- Doubt resolution
- **Refer NCERTs(Class 10- Chapter 9).**

**The topic for the next class: Biotechnology continued**

**Biology Class 07**

#### **PYQ discussion**

##### **DNA editing/Gene editing(1:04:00PM)**

- It is a process by which genes can be **added, deleted, or replaced** by the use of **genetic engineering**.
- The name of technology used is known as **CRISPR(Clustered Regularly Interspaced Short Palindromic Repeats)**. It is also called as **gene editing tool** or **molecular scissors**.
- **CRISPR has two parts**\_-
- **Guidance molecule - Single-guided RNA(sgRNA).**
- **Nuclease- Cas9 protein/enzyme**
- Single-guided RNA guides the Cas9 enzyme to specific parts of the DNA and Cas9 cuts the DNA at that specific site.
- The scientists associated with this technology received the Nobel prize in Chemistry.

##### **Animal Cloning(1:20:00PM)**

- Explained with the help of a diagram
- Cloning deals with creating a total copy/replica of an organism.
- The organism whose replica is to be created, a somatic cell is taken from it.
- Now one donor egg cell is required.
- With the process of **enucleation**, the nucleus of both somatic cells and egg cells is taken out.
- The nucleus of a somatic cell is put into an empty egg cell through **somatic cell nucleus transfer**.
- Now, this is stimulated to form an **embryo**.
- This embryo is transplanted into the **uterus**.
- Example: **Dolly-the Sheep**

##### **Three-parent baby(1:47:00PM)**

- Mitochondrial DNA(mtDNA) is **very small** as compared to the DNA in the nucleus of the cell.
- However, if there is some defect in mtDNA, then this can be transferred to the next generation.
- Example of mitochondrial DNA- **Leigh disease**
- mtDNA is inherited from only the mother.
- **Mitochondrial Replacement Technology**
- Explained with the help of a diagram
- The mother's egg has defective mtDNA.
- The donor has normal mtDNA.
- The nucleus from the mother's egg cell is removed and it is put in the donor's egg cell(nucleus removed earlier), thus creating an egg with the mother's nucleus and normal mtDNA of the donor.
- This process is also known as **Pronuclear transfer**.
- This whole process can be done at the zygote stage as well.

##### **Stem Cells(2:02:00PM)**

- Stem cells are unspecialized cells that can divide and grow into different types of cells.
- **Different types of stem cells**
- **1. Embryonic stem cells**
- They exist at the early stages of life and can change into any type of cell of the body.

- **2. Adult stem cells/tissue-specific stem cells**
- They are present in different tissues like bone marrow, skin, and brain and form cells specific to that tissue.
- **3. Induced pluripotent stem cells**
- They are differentiated cells that can be induced to divide and become undifferentiated.
- **Potential stem cell therapy applications**
- Blood- leukemia, sickle cell anemia
- Spinal Cord- Spinal injury
- Skin- Burns
- Liver- Cirrhosis hepatitis
- Brain- Parkinson's, Alzheimer's
- Heart- Heart diseases
- Muscle- Muscular dystrophy
- Pancreas- Diabetes
- Bone/cartilage- Arthritis
- PYQ discussion

#### **Biotechnology(2:51:00PM)**

- Blue Biotechnology(Marine)
- Green Biotechnology(Agriculture)
- Red Biotechnology(Medical)
- White Biotechnology(Industrial)
- Grey Biotechnology(Environment)
- **Green Biotechnology**
- Genetically Modified Organisms (GMOs) refer to any organism where the genes/DNA have been altered using genetic engineering techniques. In the case of crops, we call them **Genetically Modified Crops(GM Crops)**.
- **Benefits of GM Crops**
- Increased shelf life- **FLAVR SAVR tomato**
- Increased production- **GM Mustard**
- Pest-resistance- **Bt Cotton**
- Climate change- **Aloe Vera**
- Additional nutrients to the crops- **Golden rice(Vitamin A)**
- **Concerns regarding GM Crops**
- Environmental impact- can impact the soil, air, and water. There can be a loss of biodiversity.
- Impact on health- More information on the long-term impact of using GM crops on health is required.
- Economic challenges through the creation of monopolies by big MNCs. For example, the case of **Monsanto** where they created **Terminator seed technology**. The seeds can be utilized only once.
- **White Biotechnology**
- The application can be in chemicals, dyeing-based industries, etc. Examples: Dishwashing bars
- **Grey Biotechnology**
- **Bioremediation**- Use of living systems/living organisms to remove pollution from the environment. For example, **Oil Zapper** (a group of GM bacteria that can break down and clear the oil spills).
- **Challenges**
- Financial constraints
- Less research and development
- Regulatory issues
- Lack of adequate awareness
- Gaps in university-industry linkage

#### **Ethical concerns/issues(3:19:00PM)**

- Against natural order
- Equity challenges
- Designer babies
- Biopiracy
- Refer: Website of Department of Biotechnology, Mains 365(Biotechnology and Health), Yojana and Kurukshetra magazines
- PYQ discussion

- Refer NCERTS- Class 6(Ch-2,7), Class 7(Ch-1,2,10,11,12); Class 8(2,8,9,10); Class 9(Ch-5,13); Class 10(6,8,9); Class 11(Ch-22); Class 12(Ch- 5,6,7,8,11,12)
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**The syllabus is complete.**