BIOMEDICAL TECHNOLOGY

- Biomedical technology involves - Application of engineering and technology principles to the biological systems
- Majorly used in Diagnostic applications like

DIAGNOSTIC IMAGING:
X-ray radiography:

- Most common diagnostic imaging is - X-radiography
  - X-rays are also called - Rontgen rays
- X-rays are a form of Electromagnetic radiation
- The wave length of X-rays in the range of 10-0.01 nm
- X-rays are used for Diagnostic radiography and crystallography
- X-rays were discovered by Wilhelm Conrad Rontgen
- Diagnostic imaging that is considered to be carcinogenic isX-radiography
- In X-rays, the dense bones Absorb more radiation (appear white)
- In X-rays, the soft tissues Absorb less radiation (appear in shades)
- X-ray images are maintained as Hard film copy or as a digital image
- X-ray images coupled with image intensifiers Provide real images
- Observing the flow of blood in blood vessels by real images is Angiography
- To trace the blocks in blood vessels, we are using Digital Subtraction Angiography

CAT or CT (Computerized Axial Tomography) Scan:

- CAT scan is anX-ray procedure that combines with many X-ray images by using a computer
- Three dimensional images can be taken by CAT scan
- The images received by computer areprocessed and developed into Cross-sectional pictures
  - Each picture is seen as anX-ray slice
- The recorded image in CAT scan is called Tomogram
  - CAT scans are useful for Analyzing the internal structures of various parts of the body and their abnormalities

MRI (Magnetic Resonance Imaging):

- Magnetism, radio waves and a computer analysis are used in MRI
- Magnet is surrounded by MRI scanner
- Magnet creates The strong magnetic field and aligns the protons of hydrogen atoms
- Protons are exposed to the beam of radio waves. This Spins the various protons of the body
- Receiver protons of MRI receive the Faint signals of protons
- The receiver information is processed and an image is formed by Computer
- MRI can detect The tiny changes of structures in the body
- Contrast agent used in MRI scanning is Gadolinium
- Theses Contrast agents Increase the accuracy of images
- Extremely accurate method in diagnostic imaging is MRI scanning

MONITORING OF BODY'S VITAL FUNCTIONS:

- **ECG OR EKG (Electrocardiography):**

- ECG/EKG is a Non-invasive test that is used to detect the heart conditions by measuring electrical activity of heart
- The record is called Electrocardiogram
- The instrument used to record the changes is Electrocardiograph
- In an electrocardiogramP-wave indicates **atrial depolarization** QRS complex indicates **ventricular depolarization**
- T-wave represents repolarization of ventricles
- The relationship between P-waves and QRS complexes is 1:1
- The interval from beginning of QRS complex to the apex of the T-wave Absolute refractory period
- The last half of T-wave is Relative refractory period
- PR interval is measured from the beginning of the P-wave to the beginning of the QRS complex
- The PR interval has duration of 0.12-0.20 seconds
- **S**-T segment connects the QRS complex and T-wave
- The duration of**S**-T segment is **0.08-0.12 seconds**
- The Q-T interval is measured from the beginning of the QRS complex to end of the T-wave
- Duration of Q-T interval is 0.40 seconds
- In the heartbeat, both the atria and ventricles relax for about 0.2 seconds
- A prolonged PR interval indicates Coronary artery disease

Ex: Arteriosclerosis and rheumatic fever

- PR interval shortens at high heart rate Ex: Excercise/Fever
- PR interval increases at lower heart rate Ex: Sleep
- First degree heart block is Arteriosclerosis
- Duration, amplitude and morphology of QRS complex helps in diagnosing Cardiac arrhythmia, conduction abnormalities, ventricular hypertrophy, myocardial infarction
- **S**-T segment is elevated above the base line in acute myocardial infarction
- **S**-T segment is depressed in coronary ischemia
- T-wave is inverted**in** coronary ischemia
- T-wave is tall in Hyperkalemia
- T-wave is flat in hypokalemia and coronary ischemia
- Q-T interval lengthens in myocardial damage and coronary ischemia

EEG (Electroencephalography):

- The electrical signals of brain are recorded in**EEG**
- The record is called Electroencephalogram
- EEG diagnoses Epilepsy
- Number of electrodes attached to scalp in recording about 20
- Evaluation of other body functions during sleep by EEG is Polysomnography

TRANSPLANTATION:

- Organ transplants are categorized as life saving technology
- Tissue transplants are categorized as life enhancing technology

Types of transplantation:

- Self tissue transfer is called Autograft

Transfer between genetically identical organisms is called Isograft

Isograft is mainly performed between Monozygotic twins

Isografts are closer to autografts in terms of recipient immune response

Transfer from non-identical members of the same species is called Allograft

Transfer from one species to another species is called Xenograft (xenotransplantation)

Extremely dangerous transplantation among the transfers is Xenograft

An organ of deceased donor may be transplanted to two recipients is called Split transplantation

Complete set of organs may be transplanted through Domino transplantation

Graft rejections and suppressions:

In allograft within 3-7 days the skin becomes revascularized

The vascularization decreases by **7-10 days**

On 10^{th} day **t**he grafted tissue undergoes necrosis

By 12-14 days **t**he tissue is completely rejected

T-cells are **t**he cells which play a key role in allograft rejection

Rejection reactions develop immunological memory in recipient

Immunological memory rejects the second allograft within 5-6 days

Antigenically similar tissues are called histocompatible

Antigenically similar tissues do not allow rejection reactions

MHC of humans is **HLA (Human leucocyte antigen) system**

MHC loci on chromosomes are closely linked

Monoclonal antibodies are used to suppress the rejection reactions.

Certain metabolites are also used as **suppressors.**

ELISA (Enzyme Linked Immunosorbent Assay)

Requirements for ELISA test are **Antibody, antigen, an enzyme, and a substrate**

The commonly measure protein to indicate the pregnancy is **Human chorionic gonadotropin (HCG)**

ELISA is a relatively accurate test

In ELISA, **monoclonal antibodies used**

Types of ELISA

Sandwich test or Competitive test

The substrate coupled with antibodies is used in **Sandwich test**

- The enzyme coupled with antigens is used in**Competitive test**
- The concentration of coloured product in ELISA is measured by spectrophotometer or ELISA Microplate reader
- The intensity of colour is proportional to concentration of antigen
- ELISA is also adapted to measure concentration of antibodies

Ex: Identification of **Human anti HIV antibodies in the blood sample of HIV positive patient**