CAPITAL UNIVERSITY - KODERMA

BIO-MEDICAL INSTRUMENTATION ASSIGNMENT

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PART – 1

1. What is PCG and Lead in ECG?

Electrocardiogram (ECG) signals and Phonocardiogram (PCG) signals are two events in which ECG is the electrical signal of the cardiac movements and PCG is the visual representation on a chart of a cardiac sound.

2. Summarize electrode and the types of electrodes used in the bipolar measurement?

A bipolar electrode (BPE) is an electronic conductor in contact with an ionically conductive phase. When a sufficiently high electric field is applied across the ionic phase, faradaic reactions occur at the ends of the BPE even though there is no direct electrical connection between it and an external power supply.

Three types of concentric ring electrodes (bipolar, quasi-bipolar and tri-polar) have been used to estimate the Laplacian of different bioelectric signal potentials, including the electrocardiogram (ECG) , electroencephalogram (EEG) and the intestinal electrical activity.

Since EHG signals have similar characteristics as the above physiological signals, the use of Laplacian electrodes could also improve the quality of EHG recordings in comparison with the monopolar recordings. However, the performances of using Laplacian electrodes (including the Laplacian concentric electrodes of bipolar, quasi-bipolar and tri-polar) to record EHG signals have not been quantitatively assessed and compared with the monopolar electrode.

3. Define ECG, absolute & relative refractory period.

Electrocardiography is the process of producing an **electrocardiogram** (**ECG** or **EKG**[]), a recording of the heart's electrical activity. It is an electrogram of the heart which is a graph of voltage versus time of the electrical activity of the heart using electrodes placed on the skin. These electrodes detect the small electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat).

Absolute vs Relative Refractory Period	
The absolute refractory period refers to the time span in which the Sodium channels remain inactive.	The relative refractory period is the phenomenon in which the Sodium gated channels transit from its inactive status to the closed status that prepares the channels to be activated.

Stimulus	
During the absolute refractory period, the stimulus will not produce a second action potential.	During the relative refractory period, the stimulus must be stronger than the usual to produce the action potential.
Involvement of Ion Channels	
The sodium ion channels are completely inactive during the absolute refractory period.	The potassium ion channels are active, and flow of potassium out of the cell takes place during the relative refractory period.

4. Compare resting and action potential.

Resting Potential vs Action Potential	
Resting potential is the voltage difference across the neuron membrane when it is not transmitting the signals.	Action potential is the voltage difference across the neuron membrane when it is transmitting the signals along the axons.
Occurrence	
Resting potential occurs when the neuron does not involve in sending any nerve impulses or signals.	Action potential occurs when signals transmitted along the neurons.
Voltage	
-70mV is the resting potential.	+40mV is the action potential.
Ions	
More Na^+ ions and less K^+ ions outside the neurons when the resting potential occurs.	More Na^+ and less K^+ ions inside the neuron when the action potential occurs.

5. How would you describe the term Conduction velocity?

The time required for the impulse to travel from the stimulation site to location of the muscle contraction (total latency) is recorded in milliseconds. Calculate the conduction velocity.

6.List out the disadvantages of surface electrodes.

ECG measurement technique uses either rectangular or circular shaped plate electrodes made of nickel, silver or German silver materials. It has a smaller contact area and do not seal completely on the patient. Electrodes are pasted on the skin using electrolyte paste. The electrode slippage and plate displacement are the two major disadvantages of this electrode type. They are very sensitive, leading to measurement errors.

Since it is suitable for application on four limbs of the body, they called limb electrodes. During surgical procedure since patient’s legs are immobile, limb electrodes are preferred. Chest electrodes interfere with the surgery, so not used for ECG measurement. At the same time for a long-term patient monitoring limb-electrodes are not used.

To measure ECG from various positions on the chest, Suction cup electrodes are used. It suits well to attach electrodes on flat surface of the body and on soft tissue regions. They have a good contact surface. Physically they are large but the skin contacts only the electrode rim. It has high contact impedance. They have a plastic syringe barrel, suction tube and cables. Recently, due to infection and cleaning procedures, these electrodes are not used.

In the surface electrode, the pressure of surface electrode against the skin squeezes out the electrode paste. To avoid this problem, adhesive electrodes are used. It has a lightweight metallic screen. They have a pad at behind for placing electrode paste. This adhesive backing holds the electrode on place and tight. It also helps to avoid evaporation of electrolyte present in the electrode paste.

7.Can you list the electrodes used for recording EMG and ECG?

Biopotential electrodes are crucial in monitoring ECG, EMG, etc., signals. ... Three types of electrodes (Silver/Silver Chloride (Ag/AgCl) electrodes, Orbital electrodes and Stainless-steel electrodes) were tested to identify the most appropriate one for recording biological signals.

8.Examine the term phonocardiogram.

A phonocardiogram (or PCG) is a plot of high-fidelity recording of the sounds and murmurs made by the heart with the help of the machine called the phonocardiograph; thus, phonocardiography is the recording of all the sounds made by the heart during a cardiac cycle.

Heart sounds result from vibrations created by the closure of the heart valves. There are at least two; the first (S1) is produced when the atrioventricular valves (tricuspid and mitral) close at the beginning of systole and the second (S2) when the aortic valve and pulmonary valve (semilunar valves) close at the end of systole. Phonocardiography allows the detection of subaudible sounds and murmurs and makes a permanent record of these events. In contrast, the stethoscope cannot always detect all such sounds or murmurs and provides no record of their occurrence.

The ability to quantitate the sounds made by the heart provides information not readily available from more sophisticated tests and provides vital information about the effects of certain drugs on the heart. It is also an effective method for tracking the progress of a patient's disease.

9.Elaborate about cell bio potential and action potential.

Biopotentials as a Property of Living Matter. Bioelectrical potentials or bio potentials represent electrical potentials generated in the tissues or individual cells of living organisms. The bio potentials play the most important role in the process of excitation and inhibition of cells.

An action potential is a rapid rise and subsequent fall in voltage or membrane potential across a cellular membrane with a characteristic pattern. ... Depolarization is caused by a rapid rise in membrane potential opening of sodium channels in the cellular membrane, resulting in a large influx of sodium ions.

10. Explain latency related to EMG

Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyograph to produce a record called an electromyogram. An electromyograph detects the electric potential generated by muscle cells when these cells are electrically or neurologically activated.

The signals can be analysed to detect abnormalities, activation level, or recruitment order, or to analyse the biomechanics of human or animal movement. Needle EMG is an electrodiagnostic medicine technique commonly used by neurologists. Surface EMG is a non-medical procedure used to assess muscle activation by several professionals, including physiotherapists, kinesiologists and biomedical engineers. In Computer Science, EMG is also used as middleware in gesture recognition towards allowing the input of physical action to a computer as a form of human-computer interaction.

Onset latency is the time it takes for the stimulus to initiate an evoked potential and reflects the conduction along the fastest fibres. Peak latency is the latency along the majority of axons and is measured at the peak amplitude.

11. Compose the Nernest equation.

The Nernst equation defines the relationship between cell potential to standard potential and to the activities of the electrically active (electroactive) species. It relates the effective concentrations (activities) of the components of a cell reaction to the standard cell potential.

The equation can be used to calculate the cell potential at any moment during a reaction at conditions other than the standard state. In corrosion studies, the equation is used to analyze concentration cells and in the construction of Pourbaix diagrams.

During the reaction, the Nernst equation can be used to determine the cell potential at any instant and conditions different from the standard state.

- Ecell = E0cell - (RT/nF)lnQ

Where:

- Ecell = cell potential under nonstandard conditions (V)
  E0cell = cell potential under standard conditions
  R = gas constant, which is 8.31 (volt-coulomb)/(mol-K)
  T = temperature (kelvin), which is generally 298°K (77°F/25°C)
  n = number of moles of electrons exchanged in the electrochemical reaction (mol)
  F = Faraday's constant, 96500 coulombs/mol
  Q = reaction quotient, which is the equilibrium expression with initial concentrations rather than equilibrium concentrations

The equation can be rearranged to give ln Kc = nFE/RT where Kc is the equilibrium constant at the equilibrium state. The equilibrium potential is dependent on temperature and concentration of reaction partners.

The Nernst equation used in for:

- Accurate determination of equilibrium constants

- Determining voltage and concentration of a component of an electrochemical cell
- Calculating the potential developed by a concentration cell (in corrosion)
- Construction of Pourbaix diagram showing the equilibrium potential between a metal and its various oxidized species as a function of pH

12. Name the various lead systems used in ECG recording.

The six limb leads are called lead I, II, III, aVL, aVR and aVF. The letter “a” stands for “augmented,” as these leads are calculated as a combination of leads I, II and III. The six precordial leads are called leads V1, V2, V3, V4, V5 and V6.

For a routine analysis of the heart's electrical activity an ECG recorded from 12 separate leads is used. A 12-lead ECG consists of three bipolar limb leads (I, II, and III), the unipolar limb leads (AVR, AVL, and AVF), and six unipolar chest leads, also called precordial

ECG measures the electrical activity of the heart from several leads (viewpoints) in order to construct a three-dimensional picture of the patient's cardiac function using vertical and horizontal planes.

13. Talk about Half-cell potential and name the types of leads used for ECG.

Half-cell potential refers to the potential developed at the electrode of each half cell in an electrochemical cell. In an electrochemical cell, the overall potential is the total potential calculated from the potentials of two half cells. ... Potential vulnerability of element surface area to corrosion.

The type of leads is: bipolar and unipolar

14. Identify the importance of biological amplifier.

Generally, biological/bioelectric signals have low amplitude and low frequency. Therefore, to increase the amplitude level of bio signals amplifiers are designed.

The outputs from these amplifiers are used for further analysis and they appear as ECG, EMG, or any bioelectric waveforms. Such amplifiers are defined as Bio Amplifiers or Biomedical Amplifiers.

15. What do you understand by electrophoresis, blood pressure?

Electrophoresis is a laboratory technique used to separate DNA, RNA, or protein molecules based on their size and electrical charge. An electric current is used to move molecules to be separated through a gel.

Haemoglobin electrophoresis is a test that measures the different types of haemoglobin in the blood. It also looks for abnormal types of haemoglobin. Normal types of haemoglobin include: Haemoglobin (Hgb) A, the most common type of haemoglobin in healthy adults.

Blood pressure is the pressure of blood pushing against the walls of your arteries. Arteries carry blood from your heart to other parts of your body. Your blood pressure normally rises and falls throughout the day.

16. Justify the meaning of pH value of blood.

Body must stick to a precise balance of acidity and alkalinity in order to function properly. Even a slight change in this balance can affect many organs.

The acidity and alkalinity of your blood are measured using the pH scale. The pH scale ranges from 0 (very acidic) to 14 (very alkaline). Blood is usually between 7.35 to 7.45.

17. Explain Beer and Lamberts law.

Lambert's law stated that the loss of light intensity when it propagates in a medium is directly proportional to intensity and path length.

Beer's law stated that the transmittance of a solution remains constant if the product of concentration and path length stays constant.

18. Define stroke volume.

The definition of stroke volume is the volume of blood pumped out of the left ventricle of the heart during each systolic cardiac contraction. The average stroke volume of a 70 kg male is 70 mL Not all of the blood that fills the heart by the end of diastole (end-diastolic volume - EDV) can be ejected from the heart during systole.

Thus, the volume left in the heart at the end of systole is the end-systolic volume (ESV). The SV volume may be calculated as the difference between the left ventricular end-diastolic volume and the left ventricular end-systolic volume (ESV).

19. Can you recall the use of calorimeter?

Calorimeters are used to measure the volume and heat produced during a certain time interval. The flow is passed through a tank partly filled with water whose thermal capacity and weight are known before the beginning of the experiment. With the measurement of the increase of temperature and volume of water during known time duration, the heat and flow rates are calculated.

Such calorimeters are particularly suitable for small flow measurements. In the case of large flows, a small (say, 0.01 m) diameter sampling tube can be inserted to collect the fluid to be measured by the calorimeter. The tube is made to traverse the entire radius of the well. The timing for sampling at each radius should be proportional to the area of flow it represents. This method is inexpensive, but the results obtained are not very reliable.

20. Summarize the merits & demerits of electromagnetic blood flow meter.

There are some advantages of electromagnetic flow meter which are given below,

- The electromagnetic flow meter provides rapid response to flow changes.
- It provides linear wide range.
- Measuring range setting can be optimized.
- It has ability to measure reverse flow.
- No additional pressure drops.
- No obstruction is created to flow.
- It is mainly suitable for hydraulic solid transport.
- It is unaffected by changes in temperature, density, viscosity, concentration and electrical conductivity.

There are some disadvantages of electromagnetic flow meter which are given below,

- It is not suitable for low velocity.
- It is more expensive.
- It is suitable for fluids having conductivity greater than 20 micro-ohm/cm.
- Gas inclusion cause errors.

21. Name any 4 physical principles based on which blood flow meters are constructed.

Types of Blood Flowmeters

- Electromagnetic flow meters measure the speed of a fluid passing through a pipe using a magnetic field to measure the volumetric flow. They are based on the principle of Faraday's Law of Electromagnetic Induction, according to which liquid generates voltage when it flows through a magnetic field.
- Ultrasonic Blood Flowmeter, measure the velocity of fluid with ultrasonic to calculate volume flow
- NMR Blood Flowmeter, works on nuclear magnetic resonance principle
- LASER Doppler Blood Flowmeter, works on TIR

22. Show the typical values of blood pressure and pulse rate of an adult.

Blood pressure: 90/60 mm Hg to 120/80 mm Hg
Pulse rate 60 to 100

23. List the components of blood.

The main components of blood are: plasma, red blood cells, white blood cells and platelets.

24.Assess the use of flame photometer

Flame photometer is an analytical instrument used in clinical laboratories for determining of sodium, potassium, lithium and calcium ions in body fluids. In the clinical analysis of sodium and potassium, the flame photometer gives, rapidly and accurately numerous differential data for normal and pathological values.

25.Describe the tidal and residual volume.

Tidal volume (TV) measures the amount of air that is inspired or expired during a normal breath.

The residue volume (RV) is the amount of air that is left after expiratory reserve volume is exhaled.

26.Compile the demerits of indirect method of blood pressure measurement.

Indirect methods only measures BP in a very small sample of cardiac cycles. Thus, indirect methods as conventionally used are incapable of assessing the average level of BP throughout the and night over the course of a study.

Second despite the non-invasive nature of indirect methods and well-intended efforts by investigators to train and acclimatize animals to undergo the procedures these methods impose significant stress that disturbs multiple aspects of the cardiovascular system.

27. Organize the importance of Plethysmographs.

Plethysmography is used to measure changes in volume in different parts of the body. The test may be done to check for blood clots in the arms and legs. It is also done to measure how much air you can hold in your lungs.

Penile pulse volume recording is a type of this test. It is done on the penis to check for causes of erectile dysfunction.

Most commonly, this test is performed to check blood flow in the arteries of the legs. This is done in people with conditions like hardening of the arteries (atherosclerosis). Atherosclerosis causes pain during exercise or poor healing of leg wounds. Related tests include:

- Vascular ultrasound
- Ankle brachial indices

28. How is the respiration rate measured?

Your respiratory rate is also known as your breathing rate. This is the number of breaths you take per minute.

You can measure your breathing rate by counting the number of breaths you take over the course of one minute while you're at rest.

To get an accurate measurement:

- Sit down and try to relax.
- It's best to take your respiratory rate while sitting up in a chair or in bed.
- Measure your breathing rate by counting the number of times your chest or abdomen rises over the course of one minute.
- Record this number.

29. Analyse the term “Korotkoff sounds” and total lung capacity.

Korotkoff sounds are generated when a blood pressure cuff changes the flow of blood through the artery. These sounds are heard through either a stethoscope or a doppler that is placed distal to the blood pressure cuff.

There are five distinct phases of Korotkoff sounds:

Phase 1: A sharp tapping.

This is the first sound heard as the cuff pressure is released. This sound provides the systolic pressure reading.

Phase 2: A swishing/whooshing sound.

Swishing sounds as the blood flows through blood vessels as the cuff is deflated.

Phase 3: A thump (softer than phase 1).

Intense thumping sounds that are softer than phase 1 as the blood flows through the artery but the cuff pressure is still inflated to occlude flow during diastole

.

Phase 4: A softer, blowing, muffled sound that fades.

Softer and muffled sounds as the cuff pressure is released. The change from the thump of phase 3 to the muffled sound of phase 4 is known as the first diastolic reading.

Phase 5: Silence.

Silence that occurs when the cuff pressure is released enough to allow normal blood flow. This is known as the second diastolic reading.

30. Why are asynchronous pacemakers no longer used?

Asynchronous pacemaker an implanted pacemaker that delivers stimuli at a fixed rate, independent of any atrial or ventricular activity; this type is now rarely used except to initiate or terminate some tachycardias.

Asynchronous Pacemakers. These are defined as "pulse generators in which. the repetition rate is independent of the electrical. and/or mechanical activity of the heart."26 There. stimulus repetition rate usually is set at 60-70.

31. When do you need heart lung machine.

A heart-lung machine—also called a cardiopulmonary bypass machine—is a device that takes over the function of the body's heart and lungs during open heart or traditional surgery. The machine circulates the essential oxygen-rich blood to the brain and other vital organs during open-heart surgery, allowing the cardiac surgery team to operate on a heart that is blood-free and still. When the surgery is complete, the heart is restarted and the heart-lung machine is disconnected.

The heart-lung machine intercepts the blood at the right atrium (upper heart chamber) before it passes into the heart. Using a pump, the machine delivers the blood to a reservoir, which adds oxygen to the blood. The pump then sends the oxygen-rich blood to the aorta and through the rest of the body.

The machine, which is operated by a trained and certified specialist called a perfusion technologist, also removes carbon dioxide and other waste products from the blood and delivers anaesthesia and medications into the recirculated blood.

Also, in some cases, it cools the blood. Cool blood lowers the body's temperature, which helps to further protect the brain and other vital organs during surgery.

32. Summarize the different types of pacemakers

Pacemaker Types and Systems

Pulse Generators: These are the "battery" component of the pacemaker, which normally produces the electrical activity required to transmit to the heart musculature. Pulse generators are currently placed most commonly in the infraclavicular region of the anterior chest wall.

Trans venous Systems: Most of the cardiac pacing systems use the transvenous electrodes to transmit electrical impulses from the pulse generator to the heart musculature.

Epicardial systems: These work by direct stimulation through the pulse generator by attaching directly to the heart's surface. They are less common use nowadays, and transvenous pacing has completely replaced them.

Leadless systems: There have been some newer innovations to develop leadless systems due to some limitations with transvenous and epicardial pacing systems.

Types of Pacemakers

There are three basic kinds of pacemakers:

- Single chamber. One lead attach to the upper or lower heart chamber.
- Dual-chamber. Uses two leads, one for the upper and one for the lower chamber
- Biventricular pacemakers (used in cardiac resynchronization therapy).

33. Describe dialysate? Mention its Composition

In medicine, **dialysis** is the process of removing excess water, solutes, and toxins from the blood in people whose kidneys can no longer perform these functions naturally. This is referred to as renal replacement therapy. The first successful dialysis was performed in 1943.

Dialysis may need to be initiated when there is a sudden rapid loss of kidney function, known as acute kidney injury (previously called acute renal failure), or when a gradual decline in kidney function chronic kidney disease reaches stage 5. Stage 5 chronic renal failure is reached when the glomerular filtration rate is 10–15% of normal, creatinine clearance is less than 10 mL per minute and uraemia is present.

The present invention relates to an acid concentrate dialysis composition an acid concentrate dialysis composition comprising a mixture of citric acid and citrate, having pH of less than 3.0, wherein the total concentration of citrate is between 35 mM and 450 mM, and wherein the amount of citric acid is more than 50 % of the total concentration of citrate.

The acid concentrate dialysis composition is to be combined to form a dialysis solution having a total concentration of citrate of between 1 and 6 mM.

34. Compare Haemodialysis and Peritoneal dialysis

Ever since peritoneal dialysis (PD) was introduced as a form of renal replacement therapy, its efficacy and complications have been compared with that of haemodialysis (HD). The aim of this study was to determine the efficacy and outcome of PD in comparison to HD in our region.

Methods: We compared 60 patients on PD with 60 matched patients on HD in Tabriz's Sina Hospital during the period 2004-2006. The technique, patients' survival and quality of life were compared by means of a health-related quality-of-life questionnaire (GHQ-28).

Results: There was no significant difference in the mean age and duration of dialysis between patients on PD and HD. Survival of diabetic patients was better with HD than PD, but in non-diabetic patients, there was no difference in the survival rates between the two groups. Among patients on PD, diabetics had a 25 percent higher mortality rate and non-diabetic patients had a three percent higher mortality rate than their corresponding counterparts on HD.

In all four axes of the questionnaire, i.e. psychophysical dysfunction, stress and sleep disorders, social dysfunction and major depression, PD patients had lower scores than HD patients (p-values are less than 0.001, less than 0.001, equal to 0.002 and less than 0.001, respectively), indicating that patients on PD had a better quality of life compared to those on HD.

Conclusion: In this study, technique, patients' survival and their quality of life were better on PD than on HD. However, survival and mortality of diabetic patients on HD were better than those on PD.

35. Analyse the disadvantages of DC defibrillator.

- it cannot be successfully used to correct atrial fibrillation
- Successful attempts to correct ventricular fibrillation are often required
- Attempts to correct atrial fibrillation by this method often results in more serious ventricular fibrillation. Ventricular fibrillation results from coronary occlusion, electrical shock, and abnormalities of body chemistry
- Three shocks using an AC external defibrillator did not interrupt the arrhythmia, whereas one shock delivered from a DC external defibrillator resulted in immediate interruption of the ventricular fibrillation
- Energy stored in a capacitor which is charged at a relatively slow rate from an AC line. A simple arrangement involves the discharge of capacitor energy through the patient own resistance

36. What is meant by fibrillation? And give its type.

Definition of *fibrillation*
1: an act or process of forming fibres or fibrils

2a: a muscular twitching involving individual muscle fibres acting without coordination

b: very rapid irregular contractions of the muscle fibres of the heart resulting in a lack of synchronism between heartbeat and pulse

Atrial fibrillation is the most common sustained arrhythmia, increases with age, and presents with a wide spectrum of symptoms and severity. Paroxysmal, persistent, and permanent forms require very individualized approaches to management.

37. Choose the difference between external and internal defibrillator.

An external defibrillator and an internal defibrillator are essentially the same machine, serving the same purpose, but in two different scenarios. An internal defibrillator is classified as such because it is actually implanted into the patient’s body in order to continuously monitor the heart rate and deliver automated defibrillation if it detects a dangerous drop in the heart rate. An external defibrillator, on the other hand, is meant to be an external device kept on hand for the possibility of an emergency cardiac arrest.

An external defibrillator is generally a portable device that is strategically placed, often in wall cabinets, in locations where large numbers of people gather; churches, office buildings, hotels, casinos, and even hospitals often keep an external defibrillator or multiple external defibrillators on hand. Internal defibrillators, on the other hand, are generally prescribed to an individual who is at risk of suffering a cardiac arrest or heart attack.

38. Compile the procedures for the lungs expansion and contraction while breathing

When you inhale (breathe in), air enters your lungs and oxygen from the air moves from your lungs to your blood. At the same time, carbon dioxide, a waste gas, moves from your blood to the lungs and is exhaled (breathe out). This process is called gas exchange and is essential to life.

In addition to the lungs, your respiratory system includes the trachea (windpipe), muscles of the chest wall and diaphragm, blood vessels, and tissues that make breathing and gas exchange possible.

Your brain controls your breathing rate (how fast or slow you breathe), by sensing your body’s need for oxygen and its need to get rid of carbon dioxide.

The lungs are the primary organs of the respiratory system in humans and most animals including a few fish, and some snails. In mammals and most other vertebrates, two lungs are located near the backbone on either side of the heart. Their function in the respiratory system is to extract oxygen from the air and transfer it into the bloodstream, and to release carbon dioxide from the bloodstream into the atmosphere, in a process of gas exchange.

Respiration is driven by different muscular systems in different species. Mammals, reptiles and birds use their different muscles to support and foster breathing. In earlier tetrapod, air was driven into the lungs by the pharyngeal muscles via buccal pumping, a mechanism still seen in amphibians. In humans, the main muscle of respiration that drives breathing is the diaphragm. The lungs also provide airflow that makes vocal sounds including human speech possible.

39. Organize the different types of dialyzers

I. Classification according to the configuration of the dialyzer

Dialyzers are divided into tube type, flat type, and hollow fiber type. At present, the commonly used dialyzers are hollow fiber type, and the flat-type and tube-type dialyzers used in the early days have been basically eliminated.

The hollow fibre dialyzer is composed of 8000-12000 hollow fibers, the fiber inner diameter is 200-300um, and the wall thickness is 2-30um. The hollow fibers are bundled into bundles and placed in the formed dialyzer casing, and the casing and the dialyzing membrane are sealed with polyurethane. The blood flows through the hollow fibers, and the dialysate flows in the opposite direction outside the fibers.

II. Classification according to the membrane material of the dialyzer

According to the membrane material, dialyzers can be divided into 4 categories:

1. Regenerated cellulose membrane dialyzer, including copper imitation membrane and copper ammonia membrane dialyzer. There are free hydroxyl groups on the surface of cellulose, which can react with blood components and has poor biocompatibility. After the Cupra treatment, the fiber surface is smoother and the biocompatibility is improved.
2. Acetate cellulose membrane dialyzer. The cellulose is acetylated before the film is formed, which improves the biocompatibility and performance of the film.
3. Replace the fiber membrane dialyzer. Blood imitation membrane is an alternative copper imitation membrane because its surface-free hydroxyl groups are covered by tertiary ammonia compounds, which have good biocompatibility.
4. Synthetic fiber membrane dialyzer. Materials for this dialyzer include polyacrylonitrile, polymethylmethacrylate, polysulfone, polycarbonate, polyethylene, and polyamide. They have a higher transport coefficient and ultrafiltration coefficient, better biocompatibility, but a higher price.

III. Classification according to the ultrafiltration coefficient of the dialyzer

According to the ultrafiltration coefficient, there are two different dialyzer types:

1. Low ultrafiltration coefficient dialyzer. Ultrafiltration coefficient <15ml/(mmHg.hm^2), including copper imitation membrane, cuprammonium membrane, blood imitation membrane, and cellulose acetate membrane.

2. High-throughput and high-efficiency dialyzer. Ultrafiltration coefficient> 15 ml/(mmHg.h m^2), has a very high removal rate for medium molecular weight substances and can remove large molecular weight β2-microglobulin and other macromolecular substances. Typical high-efficiency hemodialyzers include polysulfone membrane series, PAN membrane, PMMA membrane, and cellulose acetate membrane dialyzer.

40. Show the classification of Pacing modes

The different classification of facing modes include

- atrial pacing
- asynchronous ventricular pacing
- ventricular demand pacing and
- ventricular pacing.

41. Discuss the usage of demand pacemaker.

A demand pacemaker monitors your heart rhythm. It only sends electrical pulses to your heart if your heart is beating too slowly or if it misses a beat. A rate-responsive pacemaker will speed up or slow down your heart rate depending on how active you are.

Atrial demand pacing provides a physiological, simply implemented, and less costly alternative of cardiac stimulation in symptomatic sick sinus syndrome (SSS) patients. Hindrance from widespread use stems mainly from the potential development of high degree AV block and persistent atrial fibrillation.

If it does sense electrical activity, it will hold off stimulating. This sensing and stimulating activity continue on a beat-by-beat basis and is called "demand pacing".

42. Discuss the application of Bio-Telemetry.

The most common usage for biotelemetry is in dedicated cardiac care telemetry units or step-down units in hospitals. Although virtually any physiological signal could be transmitted, application is typically limited to cardiac monitoring and SpO2.

Biotelemetry is increasingly being used to understand animals and wildlife by remotely measuring physiology, behaviour and energetic status. It can be used to understand the way that animals migrate, and also the environment that they are experiencing by measuring the abiotic variables, and how it is affecting their physiological status by measuring biotic variables such as heart rate and temperature.

Telemetry systems can either be attached externally to animals, or placed internally, with the types of transmission for the devices dependent on the environment that the animal moves in. For example, to study the movement of swimming animals signals using radio transmission or ultrasonic transmission are often used but land based or flying animals can be tracked with GPS and satellite transmissions.

43. Recall the different elements in biotelemetry

A typical biotelemetry system comprises:

- Sensors appropriate for the particular signals to be monitored
- Battery-powered, Patient worn transmitters
- A Radio Antenna and Receiver
- A display unit capable of concurrently presenting information from multiple patients

44. Examine desiccation and hemostasis.

Desiccation. Electrosurgical desiccation occurs when the electrode is in direct contact with the tissue. Desiccation is achieved most efficiently with the “cutting” current. By touching the tissue with the electrode, the current concentration is reduced. Less heat is generated and no cutting action occurs.

Hemostasis is your body's natural reaction to an injury that stops bleeding and repairs the damage. This capability is usually for your benefit, conserving blood and preventing infections. In rare cases, the process doesn't work as it should, and this can cause problems with too much or too little clotting.

45. State the meaning of the term radio pill.

Endoscopy capsule or radio pill is a miniature device that wirelessly sends images of the inside of the stomach and digestive tract, thereby assisting in the diagnosis of the gastrointestinal tract. Capsule endoscopy is used to examine those parts of the gastrointestinal tract that cannot be seen with conventional types of endoscopies.

It has proved helpful when disease is suspected in the small intestine, an area that is not easily reachable with traditional endoscopy procedures. Capsule endoscopy is a procedure that employs a tiny wireless camera to take pictures of the gastrointestinal tract, which can be useful for medical diagnosis.

Common applications for performing capsule endoscopy include unexplained bleeding, iron deficiency, abdominal pain, and detection of polyps, ulcers, and tumour of the small intestine.

46. What are the choices of radio carrier frequency for medical telemetry purposes?

Telemetry is also used for the remote monitoring of substations and their equipment. For data transmission, phase line carrier systems operating on frequencies between 30 and 400 kHz are sometimes used.

47. Demonstrate the two methods of shortwave diathermy

A shortwave diathermy overheats tissues by means of the high-frequency electrical or magnetic fields. Respectively, there are two methods of the shortwave diathermy: **Condenser shortwave diathermy (high-frequency electrical field)** Induction shortwave diathermy (high-frequency magnetic field)electromagnetic radio waves.

The heat is produced by oscillation of high frequency electric and magnetic fields, most commonly at 27.2 MHz. Traditionally, there are two types of SWD units which create heat in different ways. Inductive SWD units contain coils which creates a magnetic field. This field projects forward into the body and generates a circular, electric field within the target tissue.

Typically, the coils are confined to flexible cables or within a rigid drum.[39] In comparison, capacitive SWD units use condenser plates to transfer oscillations of electric field between the plates. The target tissue is placed between the condenser plates and acts as a capacitor to store electrical charge, resulting in local heating of the tissue.

Generally, SWD can produce therapeutic heat as deep as 3–5 cm; however, this can vary widely depending on applicator type, setup, and amount of subcutaneous fat. Muscle temperature has been shown to rise 9.5 °C with less than 1 cm of subcutaneous fat, versus only 5.6 °C with greater than 2 cm of subcutaneous fat. In addition, research has shown heat to be better distributed with only air between tissue and applicator, compared to a barrier with a cotton terrycloth.

The indications for use of SWD are similar with those of US and it is typically used to help with extensibility of soft tissue and improve myofascial.[49] SWD treatments typically last between 20 and 30 min, with the intensity being adjusted based on patient tolerance and subjective pain intensity.

Comprehensive precautions for US and SWD are listed in Box 14.10 and 14.11. One important consideration in the use of SWD versus US is that SWD cannot be used near metallic implants, whereas US does not have this limitation. SWD should also not be used in patients with implantable pacemakers or deep brain stimulators, as the electromagnetic waves can cause device malfunction and potential patient harm.

48. Differentiate the types of diathermy

There are three main types of diathermy: shortwave, microwave, and ultrasound.

- Shortwave. Shortwave diathermy uses high-frequency electromagnetic energy to generate heat.
- Microwave. Microwave diathermy uses microwaves to generate heat in the body.
- Ultrasound. Ultrasound diathermy uses sound waves to treat deep tissues.

49. Define micro and macro shock.

There are two distinct types of electrocution which need to be considered in healthcare environments: macro-shock and micro-shock.

Macro-shock occurs when current passes through the body via contact with the skin and this aspect applies to all types of electrical safety. However, external dry skin has high resistance, which limits current flow through the body. Many medical procedures involve moistening the skin, which lowers skin resistance significantly, such as ultrasound gel and surgical applicants.

Furthermore, patients are often in constant physical contact with medical electrical (ME) equipment, both directly and indirectly e.g., electrical monitoring systems and electrically powered beds. The results from macro-shock lead to loss of voluntary muscle control at currents as low as 10mA and ventricular fibrillation at currents of approximately 100mA.

Micro-shocks occur when invasive patient connections are placed across or in close proximity to myocardial tissue and nerves and blood components have relatively low resistance. Therefore, very small levels of electrical current can induce ventricular fibrillation because tissue impedance below the skin surface is low and current is focussed at an invasive location.

Death by micro-shock is known as micro-electrocution and both catheters and pacemakers carry this risk. It has been repeatedly estimated that currents of over 20 microamps can lead to micro-electrocution. Patients in medical environments are uniquely vulnerable to the risks from micro-shock.

50. Give the advantages of cryogenic surgery

Cryotherapy, which literally means “cold therapy,” is a technique where the body is exposed to extremely cold temperatures for several minutes.

Cryotherapy can be delivered to just one area, or you can opt for whole-body cryotherapy. Localized cryotherapy can be administered in a number of ways, including through ice packs, ice massage, coolant sprays, ice baths, and even through probes administered into tissue.

The theory for whole-body cryotherapy (WBC) is that by immersing the body in extremely cold air for several minutes, you could receive a number of health benefits.

The individual will stand in an enclosed chamber or a small enclosure that surrounds their body but has an opening for their head at the top. The enclosure will drop to between negative 200–300°F. They’ll stay in the ultra-low temperature air for between two and four minutes.

You can get benefits from just one session of cryotherapy, but it’s most effective when used regularly. Some athletes use cryotherapy twice a day. Others will go daily for 10 days and then once a month afterwards.

PART 1A

1.Summarize the need for each of the essential components in an endoscope & its applications

Endoscopes play a vital role in investigating, and diagnosing, the cause of many physical problems in patients.

Using an endoscope, doctors may check the digestive system, identify obstructions, and cauterize wounds or perform biopsies. These are complicated systems, designed to play an essential role in medical care – but how are they put together?

By looking at the main components of an endoscope, we can develop an understanding of how they function and operate.

Endoscopes feature multiple primary components, though, depending on the tasks they are designed to perform, the specifics may vary.

A standard endoscope is made up of:

- A flexible or rigid tube
- A lens to transmit the image of the patient's internal system to the operator or viewer (this is generally a relay lens in rigid endoscopes, or multiple fiber-optics for fiberscopes)
- A system to transmit light to enhance the visibility of the area being examined (the source of this light is usually based outside of the body, directed through optical fibers)
- An extra channel to accommodate manipulators of medical instruments for surgical procedures

- An eyepiece (in videoscopes lacking eyepieces, images from inside the patient are sent to a screen for viewing and capture)

Flexible endoscopes feature such external components as:

- a light guide plug, which connects to the source of illumination: for videoscopes, this will typically be heavier than for other types

- an umbilical cable (or universal cord), which links the light guide plug to the scope's control head

- the control head itself, which carries the angulation-control handles to allow the operator to manage the scope's performance, as well as any suction or water functions

- the insertion tube is placed inside the patient's body, and, unsurprisingly, becomes massively contaminated throughout the procedure – the distal end is used to house videoscopes microchips, as well as openings for the air or water functions, as well as for the suction

- the bending section is adjacent to the distal end

Endoscopes continue to evolve, becoming more streamlined and technologically advanced: for example, patients can now swallow microcameras which capture images of their internal system before making their way out of the body. The primary components are likely to remain the same, and any changes will typically be made to enhance performance and the patients' comfort.

At Pro Scope Systems, we specialize in refurbished endoscopes at competitive prices – providing big-company quality with more personalized, small-company service. Our expert team offers insightful information on buying the right scopes for your specific needs, for hospitals and clinics of all sizes.

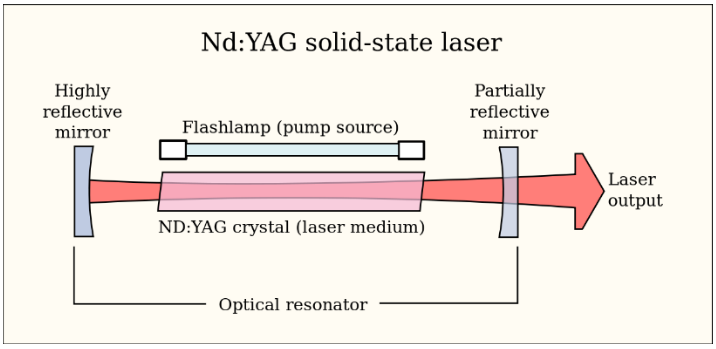
2. Discuss on the process involve in the production of laser with neat diagrams

A laser is constructed from three principal parts:

- An energy source (usually referred to as the pump or pump source),
- A gain medium or laser medium, and
- Two or more mirrors that form an optical resonator.

The pump source is the part that provides energy to the laser system. Examples of pump sources include electrical discharges, flashlamps, arc lamps, light from another laser, chemical reactions and even explosive devices. The type of pump source used principally depends on the gain medium, and this also determines how the energy is transmitted to the medium. A helium–neon (HeNe) laser uses an electrical discharge in the helium-neon gas mixture, a Nd:YAG laser uses either light focused from a xenon flash lamp or diode lasers, and excimer lasers use a chemical reaction.

The gain medium is the major determining factor of the wavelength of operation, and other properties, of the laser. Gain media in different materials have linear spectra or wide spectra. Gain media with wide spectra allow tuning of the laser frequency. There are hundreds if not thousands of different gain media in which laser operation has been achieved (see list of laser types for a list of the most important ones). The gain medium is excited by the pump source to produce a population inversion, and it is in the gain medium where spontaneous and stimulated emission of photons takes place, leading to the phenomenon of optical gain, or amplification.



The optical resonator, or optical cavity, in its simplest form is two parallel mirrors placed around the gain medium, which provide feedback of the light. The mirrors are given optical coatings which determine their reflective properties. Typically, one will be a high reflector, and the other will be a partial reflector. The latter is called the output coupler, because it allows some of the light to leave the cavity to produce the laser's output beam.

3.Explain the working and construction of radio pill with an example?

Radio pill

• Radio pill is an instrument that transmit measurement by radio impulses from within the body.

• A capsule containing miniature radio transmitter that can be swallowed by a patient.

• During its passage through the digestive track a radio pill transmits information about internal condition.

• It is modern wireless type of endoscopic monitoring system.

• The Radio pill is a small capsule shaped electronic pill that can be comfortably swallowed by any normal patient.

• It consists of lens, antenna, transmitters, camera or sensors and battery.

• It can reach regions such as small intestine and provides the video wirelessly to the receiving device connected to the monitoring system outside the human body and kept at distance of 1meter.

• The transmission of data takes place through the radio communication between electronic pill transmitter and external receiver

• This is mainly used for diagnosis of internal part mainly gastrointestinal system which cannot be easily done with the help of normal endoscope.

• Parameters such as temperature, pH and pressure of gastrointestinal tract can be measured, for the detection of diseases and disturbance in gastro intestinal system which prevents the entry of conventional endoscopic tube, a micro pill with single channel radio telemetric function is preferred.

• The invention of semiconductors provides ease in development of concise electronic pill capable to carry and transmit huge amount of data at a time without affecting the human body.

4.Discuss the various Electrical safety and physiological effects on humans

Electric shock is a physical effect and a violent response to the electrical current, that enters the body.After an encounter with the electric current, there are primary electrical injuries, which indicate tissue damage. Electric current is able to create severe burns in the body. The reason is hidden in the power dissipation across the body´s electrical resistance. Shock can cause: cardiac arrest, burns to tissues and organs, muscle spasms, serious effects to the nervous system and other unexpected consequenses. Other disorders can appear in the weeks or months following the shock, depending on which organs the current passed through.

Another note to pay attention to, is defends effects of alternating current and direct one. As to the alternating current, it depends mainly on the frequency, in fact the low frequency alternating current is more dangerous than the high-frequency alternating and direct current of the same voltage.

The low frequency alternating current produces extended muscle contraction-tetanus. *Tetanus* is the condition where muscles involuntarily contract due to the passage of external electric current through the body. When involuntary contraction of muscles controlling the fingers causes a victim to be unable to let go of an energized conductor, the victim is said to be frozen on the circuit.

Direct current is most likely to cause a single convulsive contraction, which often forces the victim away from the current's source.

Direct current (DC) is more likely to cause muscle tetanus than alternating current (AC), making DC more likely to "freeze" a victim in a shock scenario. However, AC is more likely to cause a victim's heart to fibrillate, which is a more dangerous condition for the victim after the shocking current has been halted.

Internal organs are mainly affected by electrical burns. The burns of this kind may appear slightly or they doesn´t show on the skin at all. They are caused by the heat generated from the body's resistance to the current passing through it. These cases are more dangerous than external injuries.

5.Elaborate the different methods of applying electrodes in shortwave diathermy treatment.

Shortwave diathermy (SWD) or microwave diathermy (MWD) are frequently used by physical therapists for the treatment of musculoskeletal conditions. The mechanisms of action of these devices are related to the increase in tissue temperature. Among their therapeutic effects, SWD and MWD decrease tendinous inflammation and chronic and acute pain and improve function. These effects stand as evidence to justify the use of these methods.[1]

According to Rabini et al.,[2] deep heating promoted by MWD may reduce the intensity of pain and physical function in patients with knee osteoarthritis, and these benefits are maintained up to 12 months after the end of the treatment. As a preventive action, MWD treatment one day before eccentric exercise has a prophylactic effect on muscle damage.[3]

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Infrared thermography is a non-invasive and highly sensitive method of measuring skin temperature. It provides a safe, painless, non-ionizing examination that determines the degree of distribution of local cutaneous blood perfusion.[7] According to Sikdar et al.,[8] thermography has become an important tool for measuring temperature in specific areas. Thermography detects alterations in skin temperature affected by the activation of autonomic nervous system pathways and by heat itself, which is conducted from one tissue to another at different depths.[9] Studies have shown that the increase in tissue temperature is directly related to the increase in local blood flow.

Blood flow analysis can be based on ultrasound Doppler flowmetry (UDF), which can estimate blood velocity. UDF probe emits the ultrasonic wave to a moving red blood cell and the cell reflects the incident wave. Therefore, the frequency of the reflected wave is altered according to the Doppler principle. This frequency shift is detected and analyzed by the UDF.

The UDF monitor shows real-time wave patterns within given time periods, and the UDF unit calculates the blood flow rate, pulsation index, and circulation index. Furthermore, the examiner can listen to pulsation sounds in real time.

Therefore, we believe the use of SWD and MWD increases the skin temperature and arterial blood flow of the lower limb. This clinical trial is unique and can contribute to a better understanding of the use of SWD and MWD as this has never been investigated in a high-quality trial. Therefore, the aim of this study is to evaluate the behavior of skin temperature before, during, and after the application of SWD and MWD in healthy women and to evaluate the effect of heat on local arterial blood flow using infrared thermography and ultrasound Doppler.

The application of SWD was performed in four steps: SWD with the power off and knee in extension; SWD with the power on and knee in extension; SWD with power off and 90° of knee flexion; and SWD with power on and 90° of knee flexion. The application of MWD was performed with power off, knee extension; and MWD with the power on and knee in extension. In both cases, randomization guaranteed a minimum 7-day interval between each of the steps.

6.Examine the principle of following: (i) Filter Photometer, (ii) Auto analyzer

A filter photometer is a colorimeter in which the length of light is selected by the use of appropriate glass filters. In all cases spectrometry readings of absorbance units go from 0 to 1 based on a relative absorbance by a standard filter at a given wavelength.

In filter photometers, optical filters are used to give the monochromatic light. Spectrophotometers can thus easily be set to measure the absorbance at different wavelengths, and they can also be used to scan the spectrum of the absorbing substance.

There are two types of photometry - differential and absolute. In differential photometry, the object under study is observed along with one or more nearby comparison stars. The ADU count for both objects are then compared to find the difference, which is then used to derive the difference in brightness.

The AutoAnalyzer is an automated analyzer using a flow technique called continuous flow analysis (CFA), or more correctly Segmented Flow Analysis (SFA) first made by the Technicon Corporation. The instrument was invented in 1957 by Leonard Skeggs, PhD and commercialized by Jack Whitehead's Technicon Corporation. The first applications were for clinical analysis, but methods for industrial and environmental analysis soon followed. The design is based on segmenting a continuously flowing stream with air bubbles.

Continuous flow analysis (CFA) is a general term that encompasses both Segmented Flow Analysis (SFA) and Flow Injection Analysis (FIA). In Segmented flow analysis, a continuous stream of material is divided by air bubbles into discrete segments in which chemical reactions occur.

The continuous stream of liquid samples and reagents are combined and transported in tubing and mixing coils. The tubing passes the samples from one apparatus to the other with each apparatus performing different functions, such as distillation, dialysis, extraction, ion exchange, heating, incubation, and subsequent recording of a signal. An essential principle of SFA is the introduction of air bubbles.

The air bubbles segment each sample into discrete packets and act as a barrier between packets to prevent cross contamination as they travel down the length of the glass tubing.

7.How would you use the ultrasonic waves in measuring, (i) Blood Flow, (ii) Blood pressure.

A Doppler ultrasound is a non-invasive test that can be used to estimate the blood flow through your blood vessels by bouncing high-frequency sound waves (ultrasound) off circulating red blood cells. A regular ultrasound uses sound waves to produce images, but can't show blood flow.

A Doppler ultrasound may help diagnose many conditions, including:

- Blood clots
- Poorly functioning valves in your leg veins, which can cause blood or other fluids to pool in your legs (venous insufficiency)
- Heart valve defects and congenital heart disease
- A blocked artery (arterial occlusion)
- Decreased blood circulation into your legs (peripheral artery disease)
- Bulging arteries (aneurysms)
- Narrowing of an artery, such as in your neck (carotid artery stenosis)

A Doppler ultrasound can estimate how fast blood flows by measuring the rate of change in its pitch (frequency). During a Doppler ultrasound, a technician trained in ultrasound imaging (sonographer) presses a small hand-held device (transducer), about the size of a bar of soap, against your skin over the area of your body being examined, moving from one area to another as necessary.

This test may be done as an alternative to more-invasive procedures, such as angiography, which involves injecting dye into the blood vessels so that they show up clearly on X-ray images.

A Doppler ultrasound test may also help your doctor check for injuries to your arteries or to monitor certain treatments to your veins and arteries.

An ultrasonic blood pressure measuring device measures the blood pressure of a blood vessel by performing transmission of an ultrasonic wave and reception of a reflected wave with respect to the blood vessel using an ultrasonic probe.

A blood vessel position determination unit determines the position of the blood vessel with respect to the ultrasonic probe based on the reception signal of the ultrasonic probe. A blood pressure measurement execution unit executes blood pressure measurement based on the relative position of the blood vessel determined by the blood vessel position determination unit.

8.(i) What should be the characteristics of bio potential amplifier?
(ii) Show the origin of bio potential.

The basic requirements that a biopotential amplifier has to satisfy are:

- the physiological process to be monitored should not be influenced in any way by the amplifier
- the measured signal should not be distorted
- the amplifier should provide the best possible separation of signal and interferences
- the amplifier has to offer protection of the patient from any hazard of electrical shock
- the amplifier itself has to be protected against damages that might result from high input voltages as they occur during the application of defibrillators or electrosurgical instrumentation.

Biopotentials originate within biological tissue as potential differences that occur between compartments. Generally the compartments are separated by a (bio)membrane that maintains concentration gradients of certain ions via an active mechanism (e.g., the Na^+/K^+ pump).

Hodgkin and Huxley (1952) were the first to model a biopotential (the action potential in the squid giant axon) with an electronic equivalent.

A combination of ordinary differential equations (ODEs) and a model describing the nonlinear behaviour of ionic conductance in the axonal membrane generated an almost perfect description of their measurements.

Cells transport ions across their membrane leading to ion concentration differences and therefore charge differences - hence generating a voltage.

- Most cell groups in the tissues of the human body do not produce electric voltages synchronously, but more or less randomly. Thus, most tissues have a resultant voltage of zero as the various random voltages cancel out.

• When many cells produce voltages synchronously the resultant voltage is high enough to be measurable e.g., EMG - muscle fibre contraction, most cells of the fibre perform the same electric activity synchronously and a measurable electric voltage appears.

9. Identify and describe the different types of bio potential electrodes used in measurement of bio signals

Biopotential electrodes act as an interface between the biological tissue and the electronic measuring circuit, performing the transduction of ion current into electronic current.

They are generally made of noble metal (silver, steel, gold) in different shapes (circular, rectangular, needle-shaped, etc.) and are coated with a salt, such as silver chloride, or polymers, such as Nafion® (fluoropolymer–copolymer based on the sulfonated tetrafluoroethylene discovered in the late 1960s by Walther Grot de Du Pont).

The surface of a metal electrode is coupled to the skin through electrolyte gel. The salt and the electrolyte gel help transducing the flow of ionic charges into an electronic current.

This chapter presents the main concepts for understanding how biopotentials are registered, the functioning of the electrode/electrolyte and electrolyte/skin interfaces, the electrical characteristics of biopotential electrodes and the different types of electrodes used to register biopotential.

At the end of chapter, it will be possible to understand how the transduction of a biopotential occurs, that is, how the events which begin with the exchange of ions across the cell membrane can be represented by an electrical signal captured with a metal electrode placed over the body surface or inserted into the biological tissue.

Bioelectric events have to be picked up from the surface of the body before they can be put to the amplifier for subsequent record or display. This is done by use of electrodes. The potentials produced at different points are measured by placing electrodes at various points on the body. They carry the currents produced due to potential differences to instrumentation amplifiers, where the signals are amplified and further processed by signal processing systems.

Bioelectrodes can be classified as:

- Surface electrodes: These electrodes pick up potentials from the surface of the tissue.
- Deep seated electrodes: These electrodes are inserted inside a live tissue or cell.

When a measurement is made outside the body by placing surface electrodes it is called in vitro measurement. When measurement is made by inserting a needle electrode inside the tissue, it is called in vivo measurement.

Due to the movement of electrodes, noise signals are generated. They are referred to as artifacts. To avoid artifacts and establish a low impedance path, an electrolyte or a jelly is applied to the area where the electrodes make contact. The skin is first cleaned by rubbing alcohol; all hair at that portion is removed. A jelly is then applied and the electrode is placed.

10.Estimate the various types of Oxygenators and State its advantages and disadvantages

An oxygenator is a medical device that is capable of exchanging oxygen and carbon dioxide in the blood of human patient during surgical procedures that may necessitate the interruption or cessation of blood flow in the body, a critical organ or great blood vessel. These organs can be the heart, lungs or liver, while the great vessels can be the aorta, pulmonary artery, pulmonary veins or vena cava.

An oxygenator is typically utilized by a perfusionist in cardiac surgery in conjunction with the heart-lung machine. However, oxygenators can also be utilized in extracorporeal membrane oxygenation in neonatal intensive care units by nurses.

For most cardiac operations such as coronary artery bypass grafting, the cardiopulmonary bypass is performed using a heart-lung machine (or cardiopulmonary bypass machine). The heart-lung machine serves to replace the work of the heart during the open bypass surgery.

The machine replaces both the heart's pumping action and the lungs' gas exchange function. Since the heart is stopped during the operation, this permits the surgeon to operate on a bloodless, stationary heart.

One component of the heart-lung machine is the oxygenator. The oxygenator component serves as the lung, and is designed to expose the blood to oxygen and remove carbon dioxide. It is disposable and contains about 2–4 m^2 of a membrane permeable to gas but impermeable to blood, in the form of hollow fibers.

Blood flows on the outside of the hollow fibers, while oxygen flows in the opposite direction on the inside of the fibers. As the blood passes through the oxygenator, the blood comes into intimate contact with the fine surfaces of the device itself. Gas containing oxygen and medical air is delivered to the interface between the blood and the device, permitting the blood cells to absorb oxygen molecules directly.