WINTER– 16 EXAMINATION

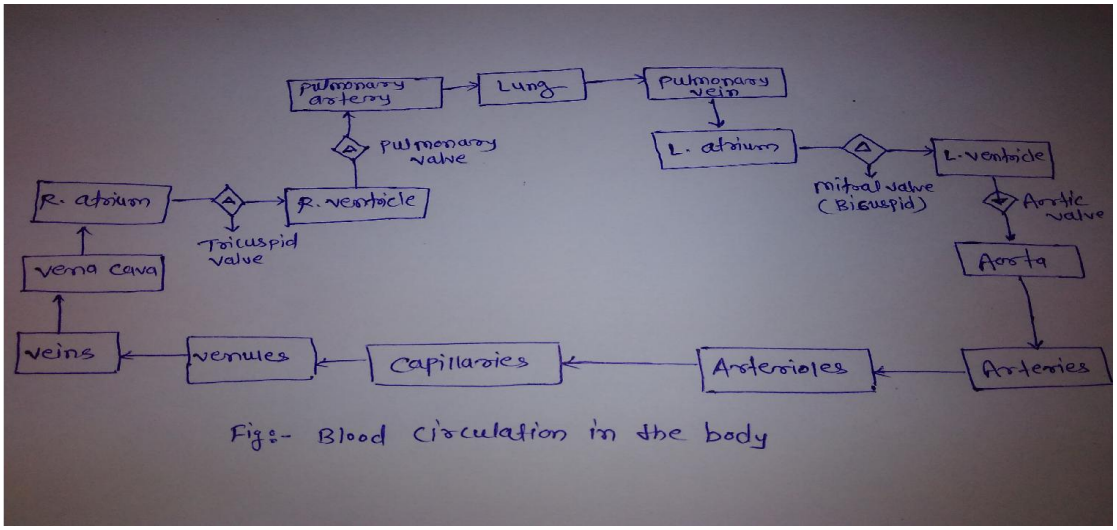
Model Answer

Subject Code: 17543

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical,spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	(A)	**Attempt any THREE.**	12
	a)	**List any four mechanical properties of biomaterial.** **Ans:** **Mechanical properties of biomaterial :** 1. It should be compatible with the tissue mechanically, chemically and pharmacologically. 2. It should have adequate mechanical strength, fatigue and physical properties. 3. It should be chemically inert & stable and should not elicit allergenic , carcinogenic and toxic reactions. 4. Biomaterials may be of natural origin.	**1 mark each**
	b)	**List any four properties of carbon.** **Ans:** **Properties of Carbon :** 1. The carbons are inert ceramic materials. 2. In the quasi-crystalline forms, the degree of perfection of the crystalline structure and the morphological arrangements of the crystallites and pores are important in determining the properties of carbons. 3. All the carbons, currently of interest for use in medical devices have the quasi -crystalline turbostatic structure. 4. Carbon has good biocompatibility with bone and other tissues. 5. It also has high strength and an elastic modulus close to that of bone and so do not suffer from fatigue. **OR** Mechanical properties of carbon: *Property* / *Graphite* / *Glassy* / *Pyrolytic* Density (g/ml) / 1.5-1.9 / 1.5 / 1.5–2.0 Elastic modulus (GPa) / 24 / 24 / 28 Compressive strength (MPa) / 138 / 172 / 517 (575[a]) **Table:** Mechanical properties of carbon	**1 mark each**

	c)	**Draw schematic diagram of blood circulation in the body.** **Ans :**  Fig:- Blood circulation in the body	**04**
	d)	**State mechanical properties of teeth.** **Ans :** Enamel and dentine forms the major part of the teeth. Mechanical properties of enamel and dentin are: *Density (g/cm^3) — Compressive Strength (MPa) — Young's Modulus (GPa) — Thermal conductivity (W/mk)* Enamel: 2.2 — 241 — 48 — 0.82 Dentin: 1.9 — 138 — 13.5 — 0.59 **Fig: Mechanical properties of teeth**	**04**
	(B)	**Attempt any ONE.**	**06**
	a)	**Explain the use of collagen in dentistry.** **Ans :** 1. Collagen is used for prevention of oral bleeding. 2. It is used to support of regeneration of periodontal tissues. 3. It is used for promotion of healing of mucosal lining. 4. It is also used for prevention of migration of epithelial cells. 5. Collagen has also been used as a carrier substance for immobilization of various active substances used in dentistry. 6. Dressing materials containing collagen have been employed effectively to promote of defects in oral mucous membrane.	

OR **06**

Material	*Observation*
Collagen	Collagen sponges decreased seepage of blood during periodontal mucoginvival surgery
Collagen	Collagen membranes have capacity to support regeneration of periodontal tissues
Collagen gel-allogeneic bone	Collagen gel-allogeneic bone implant encouraged ingrowth of regenerative tissue and new bone
Collagen tricalcium phosphate	Collagen-tricalcium phosphate grafts resulted in less soft tissue recession
Collagen coated root implants	Long lasting retention of collagen coated acrylic root implants
Collagen solution	Collagen solution applied to root surface suppressed epithelial migration and new tissue formation
Collagen graft	Collagen graft promoted formation of normal mucous membrane
Collagen allogenic bone	Bone collagen grafts reduced probing depths and gained new attachment
Collagen solution	Application of collagen solution to root surface suppressed epithelial migration and promoted new cementum formation
Collagen film + tetracycline	Topical administration of tetracycline on a collagen film remains active for two to three weeks

Table: Use of collagen in dentistry

b) **Draw and explain structure of typical bone.** **03**

Ans :

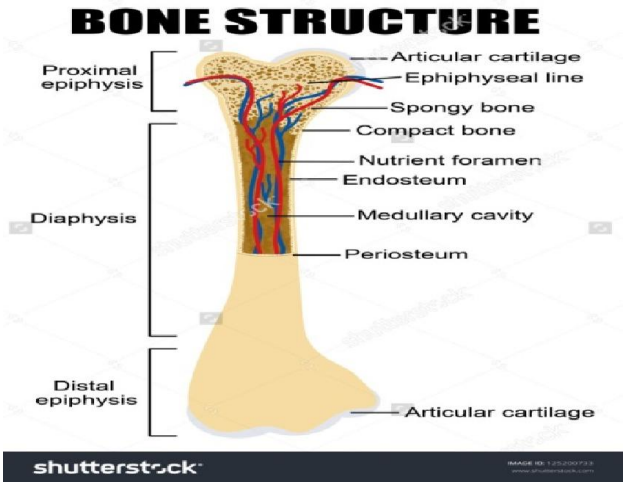
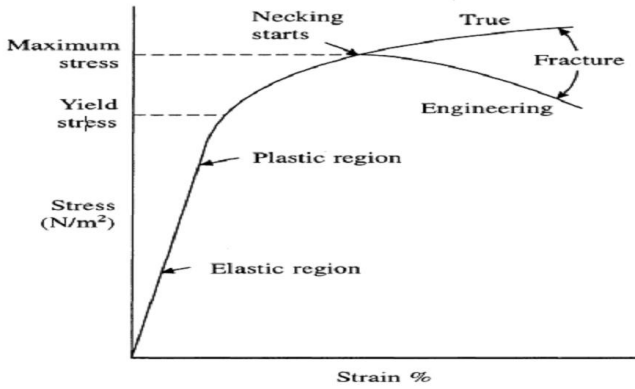
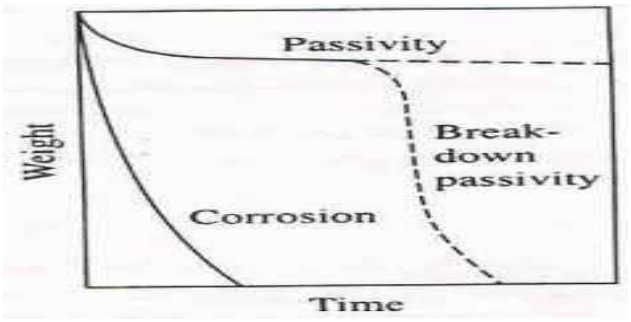
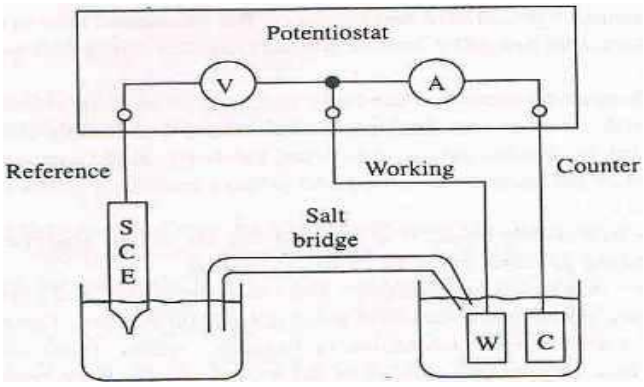


Fig: Structure of typical bone

		Long bone consists of two major regions. Compact or cortical bone and cancellous or trabecular bone. The location of these bone types in a femur shown in above fig. cortical and compact bone is a dense material with a specific gravity of about 2. The external surface of bone generally smooth and is called the periosteum. The interior surface is called endosteal surface, which is roughened. Cancellous bone which exists in epiphysical & metaphysical regions of long bone, is also called spongy or trabecular bone because it is composed of short struts of bone material called trabeculae. The connected trabeculae give cancellous bone a spongy appearance & a vast surface area. From a microscopic view point there are three types of cortical bones, these are woven, laminar, and haversian.	**03**
2.		**Attempt any FOUR.**	**16**
	a)	**List any four features of surface of material.** **Ans:** 1. Crystalline order 2. Surface roughness 3. Surface domain structure 4. Heterogeneties: Lateral and Vertical surfaces. 5. Overlayers.	**1 mark each**
	b)	**Draw neat labelled stress-strain curve for ductile material.** **Ans :**  **Fig: stress-strain curve for ductile material**	**04**

	c)	**Explain corrosion rate measurement in detail.** **Ans :** The rate of corrosion can be assessed using various methods. 1) The traditional test for the corrosion rate is the measurement of weight change of a sample in a solution with time. On passivation weight loss is minimum. However when the passivation breaks down metal corrodes rapidly which is shown in fig below.  **Fig: Weight loss in corrosion** **OR** 2) Another method employs a potentiostat to impose external potential to a specimen,which is made anodic under conditions of slowly increasing polarization.The technique of linear polarization is utilized for measuring the very small corrosion rate of implant materials in vitro and in vivo. A small current is passed from the implant material (working electrode), at a fixed potential (voltage) through an electrolyte solution to an auxiliary electrode and back through an ammeter to the power supply. The potential difference between the implant material and a reference electrode is measured directly with a potentiometer. In a general a linear relation between current and potential is observed to 10 mV. The corrosion rate is determined from the slope of this line, using the appropriate equation. This technique is very sensitive and accurate for small rates with very small applied current(0.001 A/cm^2).  **Fig: A typical three-electrode system for electrochemical testing of corrosion rates.**	**04**

		The potential of test specimen or working electrode (W) is measured relative to a saturated calomel electrode (SCE). The potential is controlled by the potentiostat, and the current flow between the working electrode and counter electrode (C) associated with thus potential is monitored.	
	d)	**Explain biological tolerance of any four implant metals.** **Ans :** **1. Iron**: The adult human body contains approximately 4 to 5 g of iron. Metabolically active iron is contained in circulating hemoglobin (about 66%), myoglobin (3%) and in heme containing enzymes less than 10% or is attached to transferrin in transit through the plasma. The remainder is held in storage either in ferritin, which is found in greater quantities in the liver, spleen and bone, or it is stored as insoluble intracellular granules of hemosiderin. The balance of iron in the body is maintained by adsorption at approximately lmg/day, with a similar quantity being lost per day. **2. Cobalt**: It is an essential trace element and the function is confined to its role in vitamin B12. A daily intake of 3µm of vitamin B12 is adequate. Free cobalt has no obvious function and there is no apparent mechanism for controlling its uptake into or loss from the body. Eighty percent of dietary intake is unabsorbed and excreted in the faces unabsorbed and urinary excretion of the remainder is relatively fast. In cases of raised dietary cobalt levels it is possible for the cobalt absorbed to be located in the muscles of the heart leading in some cases to cardiomyopathy. It is not a particularly toxic metal and although there are theoretical and experimental grounds for assuming that cobalt based alloys could be quite toxic upon implantation, there is little evidence that they have any adverse effects on implantation in humans. Indeed these alloys offer very good biocompatibility properties, largely on account of the excellent corrosion resistance. **3. Chromium:** Like many of the transition metals, chromium is both an essential dietary element that is required in low concentrations (blood level average 2.8µg/IOO g) and also a toxic substance if present in the raised amounts. Chromium compounds are only poorly absorbed after oral ingestion and storage of chromium (III) is largely confined to the reticuloendothelial systems. The hexavalent chromium ion is able to pass the plasma membrane freely, both in and out of the cell and the reduction takes place mainly in the mitochondria. The mechanism of chromium toxicity is not entirely clear but it has been suggested that the in vivo reduction from hexavalent to trivalent states may be important.	**1 mark each**

4. Molybdenum: It is an essential dietary element and has its highest concentration in the liver at I to 3 ppm. It is necessary for the function of certain enzymes. There are three principal molybdenum containing metallo-enzymes: xanthine oxidase, aldehyde oxidase and sulfite oxidase. In contrast to many metals, molybdenum is quite readily absorbed from the intestinal tract, excretion largely being via the kidneys. Molybdenum is toxic in large doses; the symptoms of toxicity include diarrhea, coma and cardiac failure, and inhibition of activity of ceruloplasmin, cytochrome oxidase, glutaminase, choline esterase and sulfite oxidase. High levels of molybdenum can also interfere with calcium and phosphorus metabolism.

5. Nickel: It is an essential element of limited biological activity with a wide-ranging distribution. In humans, it has a level of approximately 10 mg in adult human tissues. A normal blood level of nickel is around 5mg/l. In human inhalation of nickel may lead to renal effects but observation of toxicity are largely confined to carcinogenesis and hypersensitivity. It is sufficient to note here that nickel carcinogenesis in experimental animal is well established. While these facts are of some concern, their reference to implantation is not yet clear. Contact dermatitis for nickel and nickel alloys has been well established.

6. Manganese: It is at a level of 12 to 20 mg in a 70 kg man, and the normal blood level is 7.0 to 28.0 μg/ml. A higher concentration of manganese occurs in pituitary gland, pancreas, liver, kidney and bones, and accumulation occurs in hair. Within the cell manganese is associated with the mitochondria and it is largely protein bound in plasma. It is a co-factor for a number of enzymes, among them are carboxylases and phosphatases. Manganese is one of the least toxic trace elements. The divalent form is supposed to be more toxic than trivalent form. It has been shown that injected manganese elimination from the human body can be described by a curve with two exponents, the more rapid pathway having a half life of 4 days while 70% of the manganese had an average half-life of 39 days.

7. Titanium: Unlike nickel, titanium has a very good reputation for biocompatibility. Titanium and its compounds are not carcinogenic in experimental animals or in humans.

	e)	**Explain two routes for blood clot formation.** **Ans :** A clot that has formed inside a blood vessel is referred as a thrombus or an embolus depending on whether the clot is fixed or floating, respectively. Two separate routes for activation of the cofactors leading to blood clotting are known as the extrinsic and intrinsic pathways. The extrinsic pathway is so named because it requires a substance not normally present in the blood for activation. Tissue factor is a lipoprotein found in the endothelial cells that line the vascular system and other organs. Damage to tissues or vessels releases tissue factor, which activates factor VII to VIIa in the presence of calcium. Factor VIIa is a protease that converts factor X to Xa. All the factors in the intrinsic pathway are available in circulation. Factor XII undergoes a conformational change when exposed to collagen, basement membrane or a variety of other foreign surfaces. Once activated XIIa initiates a series of reactions. The central event in clotting is the cleavage of fibrinogen in the presence of the proteolytic enzyme thrombin to a fibrin monomer, and its polymerization to form a fibrin polymer. A fibrin clot is cross-linked fibrinogen in a three-dimensional structure in conjunction with platelets and other wound factors. The generation of fibrin from fibrinogen and thrombin from prothrombin are a part of the common pathway of coagulation. Prothrombin is cleaved to thrombin by a complex of factor Xa, factor Va, phospholipid, and calcium. Factor Xa is a serine protease that attacks prothrombin while factor Va is a cofactor that accelerates the reaction.	**04**

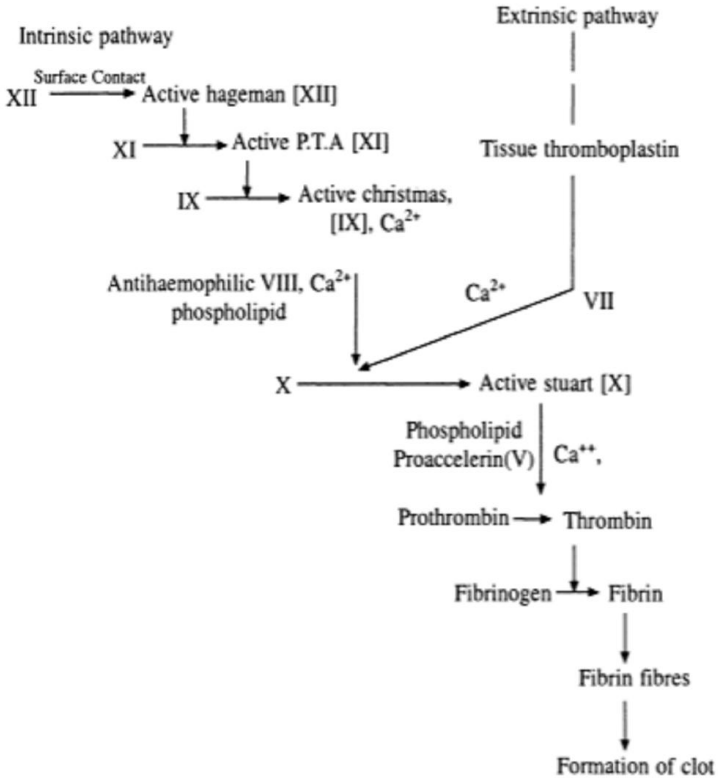


Fig: Two routes for blood clot formation

f) Write note on materials for deep cavities. **04**

Ans :

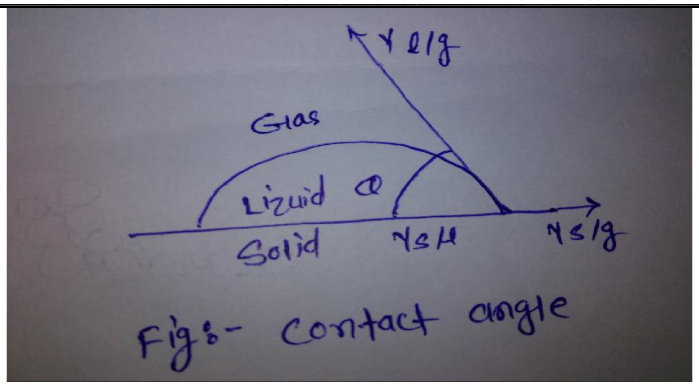
Necrosis of the tissues at the pulp chamber &the root canals of the teeth occur by deep caries or other aggressions treatment of the infection requires the removal of the damaged tissues that cannot be regenerated. Therefore the resulting pulp cavities are previously enlarged, cleaned, disinfected & dried, which are then filled by using different materials and techniques. The nature of materials employed is very important since they contact internal tissues through the root apex. These materials include plastic (cements, pastes etc.) or solid pieces (thin cones). & synthetic polymers such as polyethylene, epoxy, polyacrylate, polycarbonate , silicones. These materials used to give hardness of the final product & also seal the internal part of the canals , in addition Gutta- percha mixed with cement is now widely used as sealing materials. This polymer contains many additives zinc oxide, fillers, plasticizers, radiopaque agents to improve its properties for dental purposes.

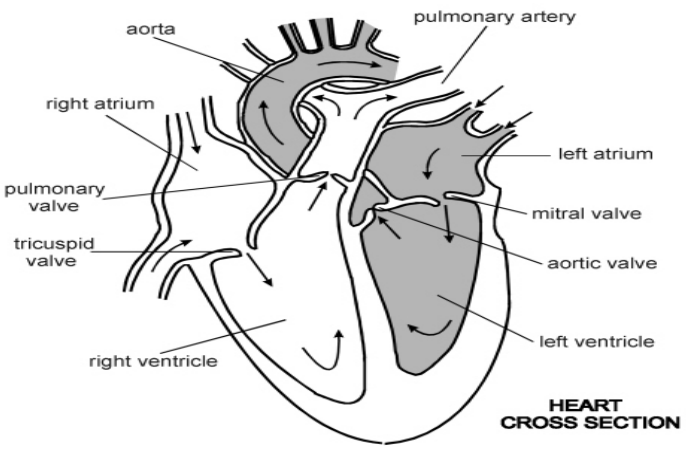
3.		**Attempt any FOUR.**	**16**
	a)	**Explain the concept of corrosion.** **Ans :** **Corrosion:** It is a degradative process often associated with electrochemical and oxidation reaction of metal in electrolytic solution as well as oxidation and degradation of polymeric materials. The primary anodic and cathodic reactions are represented by equations A and B respectively. $$M \rightarrow M^{n+} + ne^-$$ $$1/2\ O_2 + H_2O + 2e^- \rightarrow 2OH^-$$	**04**
	b)	**Write note on testing of biomaterials.** **Ans :**	**04**

Evaluation type/Test methods	*Effect/Indication*
Toxicological	
In vitro: Mutagenicity/ Cell culture toxicity	Inhibition of growth or modification of cellular characteristic
In vivo: Intradermal and Mucus membrane irritation test	Inflammation/irritation
Systemic toxicity	Toxic nature
Carcinogenicity	Tumour formation/DNA mutation
Teratogenicity	Malformation of the fetus
Blood compatibility	
in vitro Hemolytic assay	Red cell rupture
Hemorheological assay	Effect on hemorheological parameters
Clotting time	Blood clotting
Protein absorption	Uptake of plasma proteins
Platelet adhesion	Blood clogging
Long term implantation	Retention of mechanical properties
Pyrogenicity	Microbial contamination
Immunocompatibility	Immunostimulation and rejection

	c)	**Write any four applications of acrylic polymers.** **Ans:** **Applications of Acrylic polymer :** 1. Acrylic polymer is used extensively in medico-surgical application as contact lenses. 2. Implantable ocular lenses. 3. Bone cement for joint fixation. 4. Dentures and maxillofacial prostheses.	**1 mark each**

	d)	**Explain blood compatibility of synthetic vascular implant materials.** **Ans:** The most important requirement for the blood interfacing implants is blood compatibility. The implant should not enhance blood clotting or cause damage to the blood components. Surface roughness is an important factor affecting blood compatibility, since rougher the surface more the area is exposed to the blood. Therefore rough surfaces promote faster blood coagulation than highly polished surfaces. The factors that affect the blood compatibility are: 1. Clot formation. 2. Surface roughness. 3. Negatively charged surface. 4. Inert surfaces. 5. Solution perfused surfaces.	**04**
	e)	**List different biomaterials used in total joint replacement.** **Ans:** **The following biomaterials used in total joint replacement :** 1. Stainless steel 316L 7. Ti-6VAL-4V. 13. Zirconia. 2. Cobalt – based alloys 8. Ti-5AL-2.5Fe 14. Calcium phosphate. 3. Cast Co- Cr-Mo 9.Ti –Al-Nb. 15. Bioglass 4. Wrought Ca.-Ni-Cr-Mo 10. Bioinert. 16. PMMA. 5. Wrought Co-Cr-W-Ni. 11. Carbon. 17. UHMWPE/HDPE 6. Cr-Ti 12. Alumina 18. PTFE	**1 mark each**
4.	**(A)**	**Attempt any THREE.**	**12**
	a)	**Describe contact angle technique used in surface analysis.** **Ans:** When a liquid drop is placed onto a solid surface or another liquid surface two things may happen. The liquid may sit on the surface in the form of a droplet or it may spread out over the entire surface. Which event occurs depend on the interfacial free energies of the two substances. At equilibrium contact angle or Young-Dupree equation describes**:** $\gamma s/g = \gamma s/l + \gamma l/g \cos\theta$ where , γs/g, γs/l and γl/g are the interfacial free energy between the solid and gas; solid and liquid, liquid and gas respectively and θ the contact angle.	**04**

		 **Fig: Contact angle**	
	b)	**Enlist properties of alumina and zirconia.** **Ans:** **Properties of alumina:** **(1 mark each)** 1. Chemically stable and corrosion resistant. 2. It is insoluble in water. And slightly soluble in strong alkali and acid. 3. High melting point. 4. Highest hardness. 5. Highest mechanical strength. **Properties of zirconia:** **(1 mark each)** 1. excellent biocompatibility and wear properties 2.Use temperatures up to 2400°C 3. High density. 4. Low thermal conductivity (20% that of alumina). 5. Chemical inertness. 6. Resistance to molten metal's. 7. Ionic electrical conduction. 8. Wear resistance. 9. High fracture toughness. 10. High hardness. 11. High refractive index.	**02** **02**

	c)	**Draw and explain structure of heart.** **Ans:**  **Fig: Structure of heart** The heart is a specialized muscle that contracts regularly and continuously, pumping blood to the body and the lungs. The pumping action is caused by a flow of electricity through the heart that repeats itself in a cycle. If this electrical activity is disrupted - for example by a disturbance in the heart's rhythm known as an **'arrhythmia'**- it can affect the heart's ability to pump properly. The heart has four chambers - two at the top (the atria) and two at the bottom (the ventricles). The normal trigger for the heart to contract arises from the heart's natural pacemaker, the SA node, which is in the top chamber (see diagram). The SA node sends out regular electrical impulses causing the atrium to contract and to pump blood into the bottom chamber (the ventricle). The electrical impulse then passes to the ventricles through a form of 'junction box' called the AV node (atrio-ventricular node). This electrical impulse spreads into the ventricles, causing the muscle to contract and to pump blood to the lungs and the body.	**02** **02**
	d)	**Write note on knee joint repair.** **Ans:** Total Knee Replacement (TKR) The femoral component consists of a fairly thin, rigid shell with an attached fixation system to bone. The geometry of the femoral shell requires a stiff, high strength, low wear rate material such as metal. The femoral component is fixed to the cortical bone of the femoral shaft. The fixation system may be either PMMA cement or a biological in growth type.	

		The tibial portion consists of a broad plateau covering the tibia, consisting of a stiff metal tray supporting a polymeric or fiber reinforced polymer. Repeated tensile loading may cause failure of PMMA-bone interface TKR utilizes a limited number of metallic alloys including cobalt-chromium and titanium alloy. Cobalt-chromium alloy combined with ultra high molecular weight polyethylene (UHMWPE) remains the contact surfaces of choice, despite some adverse effects on biocompatibility and mechanical problems. These include creep and fatigue of UHMWPE component due to high stresses and repeated loading and wear of polymeric contact surface due to adhesion of the polymeric surface to the metallic.	**04**
	(B)	**Attempt any ONE.**	**06**
	a)	**Write the procedure for testing the reliability of dental implant and list the materials used in porous dental implant.** **Ans:** The testing the reliability of dental implants involves several stages. 1. First, materials are tested for toxicity by implantation subcutaneously in rats for periods of time up to 30 days and through tissue culture tests. 2. The second step is to test the devices in an animal model. Of all animals, the baboon is considered the most preferred experimental animal in dental-implant studies, since its physiology and immunological responses are very similar to those of humans. 3. In general, the clinical condition of dental implants is evaluated by using radiographs, gingival tone, pocket depth and mobility. A stereo-photogrammetric method of measuring the extent of tissue changes and mobility of subperiosteal implants technique utilizes stereophotographs to measure quantitatively, the extent of tissue swelling or resorption, as well as, migration of dental implants to an accuracy of 16 µm. **The materials used in porous dental implant:** 1. Titanium & Titanium –6 2. Aluminum-4Vanadium (Ti-6AI- 4V) 3. Ti, Cobalt-Chromium-Molybdenum-Based Alloy 4. Iron-Chromium-Nickel-Based Alloys), 5. Ceramics (Aluminum, Titanium and Zirconium oxide, Bioactive and biodegradable ceramics) 6. Carbon Carbon & carbon silicon, 7. Polymers and Composites (Polymethylmethacrylate (PMMA), Polyethylene (UHMW-PE), Polytetrafluoroethylene (PTFE), Silicone rubber, Polysulfide etc.	**03** **03**

b) **Enlist different mechanical properties of bone. Also explain cellular events in bone healing.** **03**

Ans:

	Direction of test	*Modulus of elasticity (Gpa)*	*Tensile strength (Mpa)*	*Compressive strength (Mpa)*
Leg bones	Longitudinal			
Femur		17.2	121	167
Tibia		18.1	140	159
Fibula		18.6	146	123
Arm bones	Longitudinal			
Humerus		17.2	130	132
Radius		18.6	149	114
Ulna		18.0	148	117
Vertebrae	Longitudinal			
Cervical		0.23	3.1	10
Lumbar		0.16	3.7	5
Spongy bone		0.09	1.2	1.9
Skull	Tangential	–	–	–
	Radial			97

Table: Mechanical properties of bone

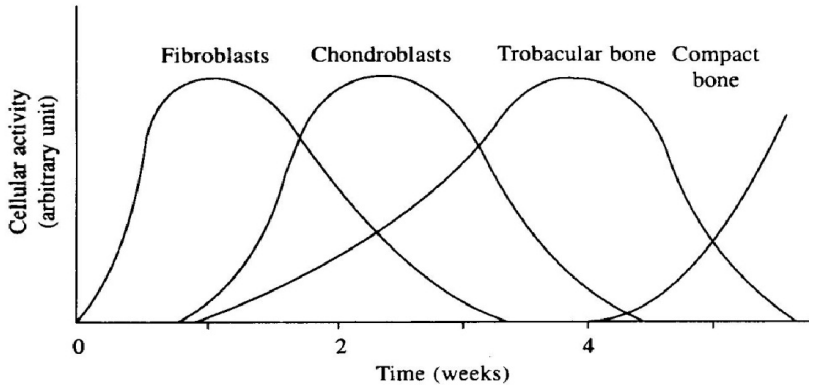
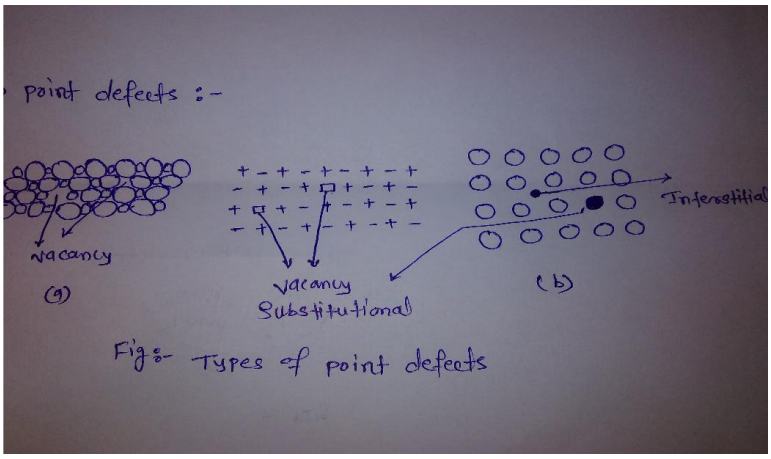
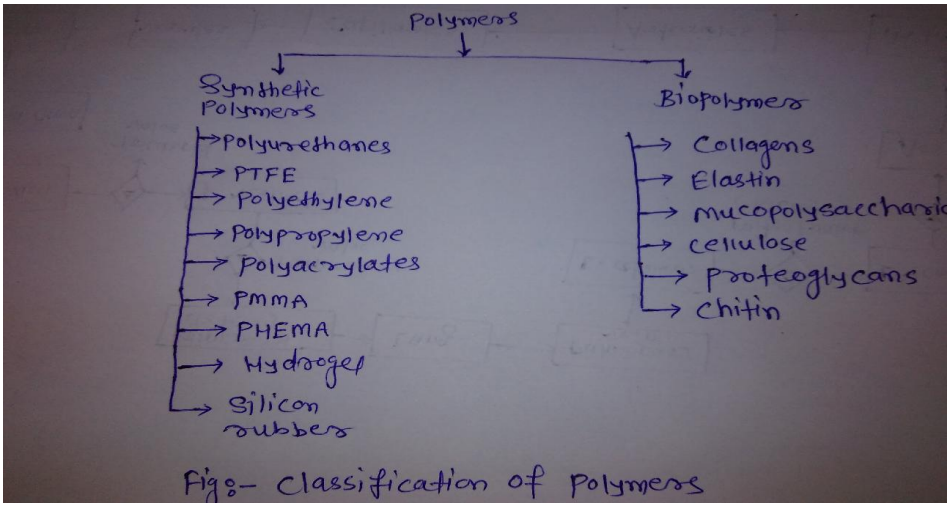


Fig: Cellular events in bone healing

1. Upon bone fracture a certain sequence of cellular events is observed for healing bones. There are basically three types of cellular activities : fibroblastic, chondroblastic and osteoblastic.
2. Fibroblast from the periosteum and surrounding tissues proliferate vigorously into the region of fracture within 1 or 2 days. During the same period capillaries being proliferating into the wound invading the fibrous callus prior to actual new bone formation. Within the first week osteogenic cells begin to migrate from the peripheral regions towards the bone fracture
3. After about a week, the level of mucopolysaccharides begins to decrease while collagen production by fibroblasts, chondroblasts and osteoblasts becomes significant. **03**
4. In a little more than 1 week collagen fibers bridge the entire gaps of the fracture and the pH returns to normal. Osteoblasts begin to form new trabecular bone in the marrow.
5. After 2 weeks a collagen matrix replaces the entire clot and chondroblasts are seen in the region between the matrix and the advancing bone growth.

		6. After a week or two the uptake of calcium and phosphorous into the wound area increases which is attributed to the increased rate of bone mineral deposition. 7. By the third and fourth weeks the major activity is the replacement of chondroblasts by trabecular bone and after 5-6 weeks the major activity is the remodeling of the bone trabeaculae with the deposition of compact bone.	
5.		**Attempt any FOUR.**	**16**
	a)	**Enlist three imperfections in crystal and sketch any one.** **Ans:** 1. Point defect 2. Line defects 3. Plane defects  **Fig: Imperfections in crystal**	**02** **02**
	b)	**Classify polymers. List uses of any one type of polymer.** **Ans:**  **Fig: Classification of polymers**	**02**

Uses of polymer:

Polymer	*Specific properties*	*Biomedical uses*
Polyethylene	Low cost, easy processibility, excellent electrical insulation properties, excellent chemical resistance, toughness and flexibility even at low temperatures	Tubes for various catheters, hip joint, knee joint prostheses
Polypropylene	Excellent chemical resistance, weak permeability to water vapors, good transparency and surface reflection	Yarn for surgery, sutures
Tetrafluoro-ethylene	Chemical inertness, exceptional weathering and heat resistance, nonadhesive, very low coefficient of friction	Vascular and auditory prostheses, catheters, tubes
Polyvinyl-chloride	Excellent resistance to abrasion, good dimensional stability, high chemical resistance to acids, alkalis, oils, fats, alcohols, and aliphatic hydrocarbons	Flexible or semi-flexible medical tubes, catheter, inner tubes, components of dialysis installation and temporary blood storage devices.
Polyacetals	Stiffness, fatigue endurance, resistance to creep, excellent resistance to action of humidity, gas and solvents	Hard tissue replacement
Polymethyl methacrylate	Optical properties, exceptional transparency, easy thermo-formation and welding	Bone cement, intraocular lenses, contact lenses, fixation of articular prostheses, dentures
Polycarbonate	Rigidity and toughness upto 140°C, transparency, good electrical insulator, physiological inertness	Syringes, arterial tubules, hard tissue replacement
Polyethylene terephthalate	Transparency, good resistance to traction and tearing, resistance to oils, fats, organic solvents	Vascular, laryngeal, esophageal prostheses, surgical sutures, knitted vascular prostheses
Polyamide	Very good mechanical properties, resistance to abrasion and breaking, stability to shock and fatigue, low friction coefficient, good thermal properties, good chemical resistance, permeable to gases	PA 6 tubes for intracardiac catheters, urethral sound; surgical suture, films for packages, dialysis devices components, PA66 heart mirtal valves, three way valve for perfusion, hypodermic syringes, sutures
Polyurethane	Exceptional resistance to abrasion, high resistance to breaking, very high elasticity	Adhesives, dental materials, blood pumps, artificial heart and skin

Table: Uses of polymers

02

c) Enlist applications of silicon rubber and elastin.

Ans :

Applications of Silicon Rubber:

1. Used to make catheters.
2. The replacement of destroyed or diseased finger joints with silicone prostheses is carried routinely.
3. Silicone rubber are the replacement of carpal bones, toe prostheses and capping temporomandibular joints.
4. Breast augmentation with silicone rubber mammary prothesis is carried out routinely. Silicone rubber has been extensively used in maxillofacial surgery.Such uses include nasal supports, jaw augmentation, orbital floor repair, and chin augmentation.

02

		5. Silicone rubber such as artificial bladder, sphincters and testicles are being investigated. **Applications of Elastin:** 1. Drug delivery system. 2. scaffolds 3. derma substitutes. 4. Tissue repair or tissue engineering. 5. protein purification. 6. biosensing.	**02**
	d)	**What are different total hip replacement ? Explain any one.** **Ans:** **Hip replacement devices :** 1. Thompson, 316L 2. Austin moore,316L 3. Bipolar 316L. 4. Modular bipolar, Ti alloy stem , Co-Cr head 5. & 6. Charnley, Co-Cr . 7. Modular, Ti alloy stem, Co-Cr head. **Explanation :** A hip replacement consists of femoral component that is a ball mounted on a shaft & an acetabular component having a socket into which ball is placed. Cobalt - Chromium & Titanium-Aluminum-Vanadium alloys or alpha alumina are used by different manufacturer for the femoral component & high molecular weight polyethylene to cover the socket. Several design types with different stem lengths are available. Boutin (1974) had reported several hundred successful clinical cases using a ceramic ball on a metallic stem femoral component & a matching alumina acetabular component. Boutins devices were all fixed in the bony tissues with standard PMMA cement. Subsequently the HDHMW polyethylene cups were introduced along with ceramic balls attached to metallic stem.The number of alternative combinations of materials use in total hip replacement include Metal- Metal, Metal- HDHMW polyethylene, Ceramic- HDHMW polyethylene, Ceramic- Ceramic.	**02** **02**

e) List properties of stainless steel and Nitinol. — **02**

Ans:

Properties of stainless steel :

Material	Condition	Ultimate tensile strength(Mpa)	Yield strength (Mpa)	Elongation in 2 in, min. %
316	Annealed	515	205	40
	Cold finished	620	310	35
	Cold worked	860	690	12
316L	Annealed	505	195	40
	Cold finished	605	295	35
	Cold worked	860	690	12

Properties of Nitinol:

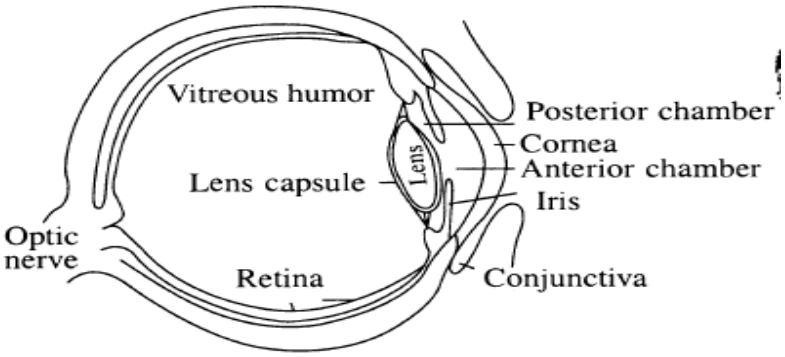
1. After the material is deformed it can shape back to its previous shape following heating the material. (Shape memory effect).
2. High acoustic damping.
3. Direct conversion of heat energy into mechanical energy.
4. Good fatigue properties.
5. Low temperature ductility.
6. Low modulus of elasticity and tougher material.
7. Good biocompatibility and corrosion resistance.

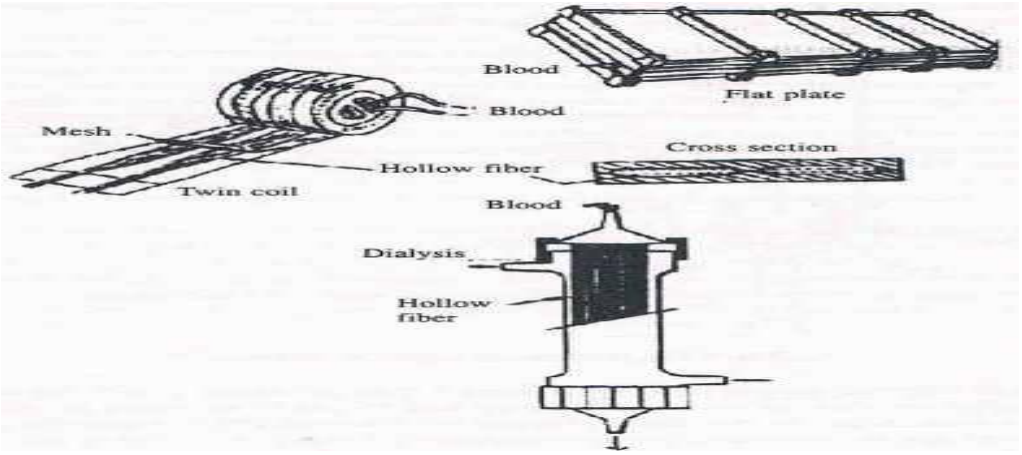
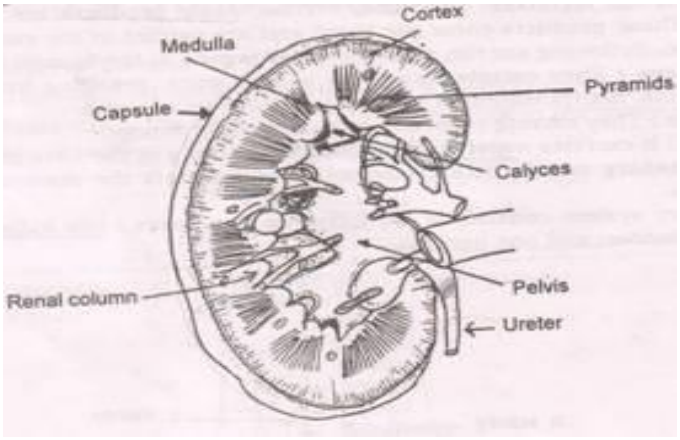
02

f) List factors affecting bone formation and resorption. — **04**

Ans:

		1. Vascular in growth: Fibronectin, endothelial cell growth factor (ECGF). 2. Bone formation: Insulin-like growth factor (IGF-1) somatomedin c, platelet-derived growth factor. (PDGF), Fibroblast growth factor (FGF) IL-1, ECGF, insulin, bone-derived growth factors (BDGF II and I) bone morphogenetic protein (BMP). 3. Bone resorption, IL-1, Osteoclast-activating factor: (OAF), parathyroid hormone, PDGF, transforming growth factor B (TGF-B), tumor necrosis factor (TNF), prostaglandin E_2.	
6.		**Attempt any FOUR.**	**16**
	a)	**Write note on bone regeneration with resorbable material.** **Ans:** A cancellous autograft is considered as the most suitable means for the reconstruction of bone defects. Allogenic and xenogenic grafts are option for bone rgeneration but have short comings. The costs of bone allografts, which require careful handling, are exceptionally high. Along with that, autogenous bone transplantation include prolongation of operation time, increased loss of blood, the risk of infection, nerve and vascular injury, thrombosis, fracture risk, additional scar, postoperative pain and cost of additional operation. Therefore bone replacement materials assume greater significance. From experiments using more or less compact calcium phosphate or apatite ceramics, many researchers have showed that incorporation of these implants takes place without foreign body reactions and bone regeneration occurs on the surface and margins of the implant in contact with bone. However, when implanted in soft tissue without bone contact this material does not favor bone formation. Collapat® is represents a very good bone substitute material. Collapat® is regarded as a strong bone regeneration-promoting medium in contact with bone. In general, Collapat® yields good vascularity and favorable bone replacement capability in bone beds and at bone surfaces. A similar material, Pyrost®, is obtained from natural bone by using careful pyrolysis and sintering procedure. This material with natural bone structure and mineral content shows favorable osteoinductive activation.	**04**
	b)	**List different types of biomaterials used for optical implants.** **Ans:** 1) Hydrogels 6) PHEMA 2) Polyvinyl Alcohol 7) Cellulose acetate/ butyrate	**1 mark**

		3) Silicon rubber 8) Siloxanyl alkyl methacrylate 4) Collagen 9) Silicon resin 5) Acrylic rubber 10) Alkyl styrene & fluorocarbon polymers.	**each**
	c)	**Explain structure of eye.** **Ans:**  **Fig: Structure of Eye** **Explanation :** The eyeball is approximately spherical & has a diameter of about 2.5 cm. It contains three layers including the fibrous outer coat, vascular middle coat, and light sensitive inner coat. The outer fibrous coat consists of the sclera (white portion) which is continuous with cornea (transparent portion). In the back of the eye is a vascularized thin pigmented membrane, The choroid that supports the retina. The retina is a light sensitive membrane lining the internal surface that transfer light intensity and color into electrical signals. Light passes through the cornea , the anterior & posterior chambers , aqueous humor, the lens , & the vitreous body & then pigmented cells of the retina & thereby stimulates photoreceptor cells, the rods & cones. Rods are sensitive to dull light & give vision of movement & shape. Cones are sensitive to bright light &are receptors of color & shape outline. Photo stimulation of these cells results in the production of nerve impulses that are conducted to brain via optic nerve. Lens is a transparent structure between the anterior chamber & vitreous humor that is stretched into an oval shape by suspensory ligaments.	**04**
	d)	**Enlist different types of dialyzers. Draw neat sketch of any one type.** **Ans:** Dialyzer is most important part of the artificial kidney. Various designs of dialyzers are available. These include, 1.Flat plate	

		2.Coil-type 3. Hollow fiber  **Fig: Different types of dialyzers**	**02** **02**
	e)	**Draw structure of kidney and give functions of it.** **Ans:**  **Fig: Structure of kidney** **Functions of kidney:** 1) Formation of urine. 2) Glomerular filtration. (Mechanical filtration). 3) Maintain water balance. 4) Maintain electrolyte balance. 5) Remove waste products. 6) Assist/ Help in regulation of blood pressure. 7) Assist / Help in red blood cell production.	**02** **02**