



**SYLLABUS WITH REFERENCES - EXAM 2021**

**PART I**  
**BASIC SCIENCE**

**ANATOMY -**

**I. The cells, tissues and organization of the body**

1. The cell: structure and functions, Plasma membrane, Organelles, Cell division, Mutation, Transport of substances across cell membranes
2. Tissues: Epithelial tissue, Connective tissue, Muscle tissue, Nervous tissue, Tissue regeneration, Membranes, Glands

**II. The Cardiovascular system**

1. Heart
  - Position
  - Coverings
  - Chambers
  - Structure
  - Flow of blood through the heart
  - Blood supply to the heart
  - Conducting system of the heart
  - Innervation – Sympathetic - parasympathetic
2. Circulation of the blood
  - Pulmonary circulation
  - Systemic or general circulation
    - Aorta
    - Portal circulation
3. Summary of the main blood vessels

**III. The respiratory system**

1. Trachea
  - Position
  - Structure
  - Functions
2. Bronchi and small air passages
  - Bronchi and bronchioles
    - Structure
    - Functions of air passages not involved in gaseous exchange
  - Respiratory bronchioles and alveoli
    - Structure
    - Function of respiratory bronchioles and alveoli
3. Lungs
  - Position and associated structures
  - Organization of the lungs
  - Pleura and pleural cavity
  - Interior of the lungs
  - Nerve supply to the respiratory system

4. Respiration
  - Muscles of respiration

#### **IV. The nervous system**

1. Neurons
  - Properties of neurons
  - Cell bodies
  - Axons and dendrites
  - The nerve impulse (action potential)
  - Types of nerves
  - The synapse and neurotransmitters
2. Central nervous system
  - Membranes covering the brain and spinal cord
  - Ventricles of the brain and the cerebrospinal fluid
3. Brain
  - Location – Covering of the Brain
  - Blood supply to the brain
  - Cerebrum
  - Brain stem
  - Cerebellum
4. Spinal cord
  - Coverings
  - Grey matter
  - White matter
  - Blood supply
5. Peripheral nervous system
  - Spinal nerves
  - Thoracic nerves
  - Cranial nerves
6. Autonomic nervous system
  - Sympathetic nervous system
  - Parasympathetic nervous system

#### **VI. The Urinary System**

1. Kidneys
  - Gross structure of the kidney
  - Microscopic structure of the kidney
2. Ureter, urinary bladder, urethra

#### **VII. The Endocrine System**

1. Pituitary gland and hypothalamus
  - Anterior pituitary
  - Posterior pituitary
2. Thyroid gland
3. Adrenal (suprarenal) glands
  - Adrenal cortex
  - Adrenal medulla
  - Response to stress
4. Pancreatic islets

## PHYSIOLOGY

### I. Circulatory body fluids

1. Blood
  - Bone marrow
  - White blood cells
  - Immunity
  - Platelets
  - Red blood cells
  - Blood types and groups
  - Blood transfusion
  - Plasma
  - Coagulation factors & coagulation cascade
  - Hemostasis
  - Oncotic pressure

### II. Cardiovascular system

1. Origin of the heartbeat & the electrical activity of the heart
  - Introduction, cardiac action potential
  - Origin & spread of cardiac excitation
  - The electrocardiogram
  - Nervous control of heart rate
2. The heart as a pump
  - Physical characteristics of atria, Ventricles, valves
  - Introduction, Laplace's law
  - Mechanical events of the cardiac cycle
  - Action Potential of a Cardiac Muscle & Pacemaker Cell

#### CARDIAC ELECTROPHYSIOLOGY

- Transmission of Impulses through the heart
  - ECG Leads
  - Identifying Common Cardiac Arrhythmias
  - Abnormal Sinus Rhythm
  - Abnormal Atrial Rhythms
  - Abnormal Junctional Rhythms
  - Heart Blocks
  - Premature Atrial, Junctional and Ventricular Contractions
  - Supraventricular Arrhythmias
  - Ventricular Arrhythmias
  - Heart rate, pulse rate, stroke volume, peripheral resistance
  - Venous return
  - Cardiac output, arterial pressure and its regulation-Vasodilatation-Vasoconstriction-Vasomotor center-Baro& chemoreceptor
  - Starling's law
  - Cardiac Metabolism
3. Circulation through special regions
    - Introduction
    - Cerebral circulation
      - Anatomic considerations
      - Cerebrospinal fluid
      - The blood brain barrier

- Cerebral blood flow
- Regulation of cerebral circulation
- Brain metabolism & oxygen requirements

- Coronary circulation
- Splanchnic circulation
- Circulation of the skin
- Placental & fetal circulation

### III. Respiratory system

#### 1. Pulmonary function

- Introduction
- Properties of gases, Gas laws
- Diffusion, osmosis
- Mechanics of respiration
- Gas exchanges in the lungs
- Pulmonary circulation
- Other functions of the respiratory system

#### 2. Gas transport between the lungs & the tissues

- Oxygen transport & Oxygen dissociation curve
- Carbon dioxide transport
- Basics of acid-base balance

The pH Scale

The Buffer System

The Henderson-Hasselbach Equation

The role of  $PCO_2$  /  $HCO_3^-$  / pH

Relationships in Acid Base Balance

Respiratory Acid-Base Imbalances

Metabolic Acid Base Imbalances

- Base Excess /Deficit

- Example of Clinical Use of  $P_{CO_2}$  /  $HCO_3^-$  / pH Nomogram

#### 3. Regulation of respiration

- Neural control or breathing
- Regulation of respiratory activity
- Chemical control of breathing
- Non-chemical influences on respiration

### IV. Endocrine system (brief study only)

#### 1. The thyroid gland

- Formation & secretion of thyroid hormones
- Transport & metabolism of thyroid Hormones
- Effects of thyroid hormones
- Regulation of thyroid secretion

#### 2. Endocrine functions of the pancreas & regulation of carbohydrate metabolism

- Islet cell structure
- Structure, biosynthesis & secretion of insulin
- Effects of insulin
- Mechanism of action
- Consequences of insulin deficiency
- Insulin excess
- Regulation of insulin secretion

Glucagons

3. The adrenal medulla & adrenal cortex

Introduction

Adrenal morphology

Adrenal medulla

Structure & function of medullary hormones

Regulation of adrenal medullary secretion

Adrenal cortex

Structure & biosynthesis of adrenocortical hormones

Transport, metabolism & excretion of adrenocortical hormones

4. The pituitary gland

Introduction

Morphology

Intermediate – lobe hormones

Growth hormones

Physiology of growth

Pituitary insufficiency

Pituitary hyper-function in humans

**VII. Temperature: maintenance & regulation**

**VIII. Excretory system**

1. Renal function & maturation

Renal circulation

Glomerular filtration

Tubular function

Water excretion

Acidification of the urine & bicarbonate excretion

Regulation of  $\text{Na}^+$  &  $\text{Cl}^-$  Excretion

Regulation of  $\text{K}^+$  excretion

Diuretics

Renal function Tests

**BIOCHEMISTRY**

1. Introduction to apparatus, chemical balance: different types, principles and practice
2. Concepts of Molecular weight, atomic weight, normality, Molarity, standards, atomic structure, valence, acids, bases, and salts.
3. Concept of Acid Base reaction and hydrogen ion concentration, pH meter, pH buffers.
4. Chemistry and metabolism of Carbohydrates – structure, classification and examples includes aerobic and anaerobic metabolism.
5. Chemistry and metabolism of Lipids – Structure, classification and examples.
6. Chemistry and metabolism of Proteins – Structure, classification and examples.
7. Chemistry and metabolism of Nucleic acids – Structure, classification and examples.
8. Energy metabolism
9. Liver function tests & their assessment
10. Evaluation of important hormones
11. Cardiac profile - Biochemical markers of myocardial infarction.

**MICROBIOLOGY**

**Theory**

Principles of microbiology:

- 1 General introduction and History of Microbiology

- 2 Classification of Microbes
- 3 Bacterial cell
- 4 Antibacterial Agents, and Disinfection
- 5 Sterilization
- 6 Antibiotics, Chemotherapy and Drug Resistance

### **Practical**

Bacteriology:

- 1 Morphology of bacteria
- 2 Hanging drop
- 3 Simple stains

### **Perfusion Technology**

Introduction to the Operating room environment & protocols

General protocols followed in the operating room

Hand washing

Unsterile-sub sterile-sterile methods followed in the O R environment

Handling of Disposables in the OR

Handling & Maintenance of the Equipment in the OR

\* Electricity & electromedical equipment & safe guards

Basics of electricity & functioning of electromedical equipment; Earthing & care of apparatus.

Static electricity

\* Biomedical waste & its management

\* Cardiopulmonary resuscitation – Basic cardiac life support

-Advanced cardiac life support

Intensive coronary unit & recovery room concepts

\* Sterilization – Material & methods

Introduction to the various components of Cardiopulmonary bypass system

Introduction to the Basics of CPB procedures & System

## **APPLIED PATHOLOGY**

### **I. CARDIOVASCULAR SYSTEM.**

- Atherosclerosis- Definition, risk factors, briefly pathogenesis & morphology, clinical significance and prevention
- Hypertension-definition, types and briefly pathogenesis and effects of hypertension
- Aneurysms- definition, classification pathology and complication.
- Pathophysiology of heart failure
- Cardiac hypertrophy causes, pathophysiology & progression to heart failure.
- Ischemic heart diseases-definition, types. Briefly pathophysiology, pathology & complications of various types of IHD
- Valvular heart diseases-causes pathology & complications. Complications of artificial valves

Describe the definition, etiology, pathophysiology, clinical presentation, and diagnostic features associated with a variety of acquired pathologies including but not limited to:

- a. cardiac and vascular aneurysms
- b. cardiac tumors
- c. cardiac valvular disease
- d. cardiomyopathies
- e. endocarditis

- f. heart failure
- g. ischemic heart disease
- h. pericarditis

2. Describe the definition, etiology, pathophysiology, clinical presentation, and diagnostic features associated with a variety of congenital pathologies including but not limited to:

- a. Aortopulmonary window
- b. atrial septal defect
- c. coarctation of the aorta
- d. cor triatriatum
- e. corrected transposition of the great arteries
- f. Dextrocardia
- g. Ebstein's anomaly
- h. endocardial cushion defect
- i. fistulas
- j. hypoplastic left heart syndrome
- k. left ventricular outflow obstructions
- l. patent Ductus arteriosus
- m. persistent left superior vena cava
- n. pulmonary atresia
- o. Right ventricular outflow obstructions
- p. single ventricle
- q. tetralogy of Fallot
- r. total anomalous pulmonary venous return
- s. transposition of the great arteries
- t. tricuspid atresia
- u. truncus arteriosus
- v. vascular ring anomalies
- w. ventricular septal defect

3. Categorize congenital pathologies as being primarily obstructive, cyanotic, and/or acyanotic in character.

4. Describe the surgical objectives, indications, contraindications, techniques, and CPB requirements associated with the variety of acquired pathologies listed in objective #1. Procedures to be described include but are not limited to the aneurysmectomy, mammary graft, partial left ventriculectomy, pericardiectomy, Ross, Saphenous vein graft, and valve replacement.

5. Discuss the characteristics of the ideal prosthetic valve, categories and types of prosthetic valves available, criteria for selection, and details of use.

6. Describe the palliative surgical objectives, indications, contraindications, techniques, and CPB requirements associated with the variety of congenital pathologies listed in objective #2. Procedures to be described include but are not limited to the Blalock-Hanlon, Blalock-Tausig, Brock, central shunt, Glenn, PA banding, Rashkind, and Waterston.

7. Describe the corrective surgical objectives, indications, contraindications, techniques, and CPB requirements associated with the variety of congenital pathologies listed in objective

Cardiomyopathy-definition, types, causes and significance

- Pericardial effusion-causes, effects and diagnosis.
- Congenital heart diseases-basic defect and effects of important types of congenital heart diseases.

## II. HEAMATOLOGY

- Anemia-definition, morphological types and diagnosis of anemia.
- Brief concept about hemolytic anemia and polycythemia.

- Leukocyte disorders-briefly leukemia, leukocytosis, agranulocytosis etc.
- Bleeding disorders-definition, classification, causes & effects of important types of bleeding disorders. Briefly various laboratory tests used to diagnose bleeding disorders.

### III. RESPIRATORY SYSTEM

- Chronic obstructive airway diseases- definition and types briefly causes, pathology and complications of each type of COPD
- Briefly concept about obstructive versus restrictive pulmonary disease pneumoconiosis-definition, types, pathology and effects in brief.
- Pulmonary congestion and edema
- Pleural effusion – causes, effects and diagnosis.

### IV. RENAL SYSTEM

- Clinical manifestations of renal diseases.
- Briefly causes, mechanism effects and laboratory diagnosis of ARF & CRF.

### APPLIED PHARMACOLOGY

General concepts about pharmacodynamics and pharmacokinetic principles involved during activity.

#### I. Autonomic nerves system.

- Anatomy & functional organization.
- list of drugs acting on ANS including dose, route of administration, indications, contra indications and adverse effects

#### II. Cardiovascular drugs – enumerate the mode of action, side effects and therapeutic uses of the following drugs.

##### i. Antihypertensive

- Beta adrenergic antagonists
- Alpha adrenergic antagonists
- Peripheral vasodilator
- Calcium channel blockers

##### ii. Antiarrhythmic drugs

##### iii. Cardiac glycosides

##### iv. Sympathetic and non-sympathetic inotropic agents.

##### v. Coronary vasodilators.

##### vi. Antianginal and anti-failure agents

##### vii. Lipid lowering & anti atherosclerotic drugs.

##### viii. Drugs used in hemostasis anticoagulants thrombolytics and antithrombocytes

##### ix. Cardioplegia drugs. History, principles and types of cardioplegia

##### x. Priming solutions – history, principles and types.

#### III. Anesthetic agents

Definition of general and local anaesthetics

Classification of general anaesthetics

Pharmacokinetics and pharmacodynamics of inhaled anaesthetic agents

Intravenous general anaesthetic agents

Local anaesthetics classification, mechanism of action, duration of action and methods to prolong the duration of action. Preparation, dose and routes of administration

#### IV. Analgesics

Definition and classification

Routes of administration, dose, and frequency of administration, side effects and management of non-opioid and opioid analgesics



**V. Antihistamines and antiemetic**

Classification, mechanism of action, adverse effects, preparations, dose and routes and administration

**VI. CNS stimulants and depressants.**

Alcohol  
Sedatives, hypnotics and narcotics  
CNS stimulants  
Neuromuscular blocking agents and muscle relaxants.

**VII. Pharmacological protection of organs during CPB**

**VIII. Inhalational gases and emergency drugs.**

**IX. Pharmacotherapy of respiratory disorder**

Introduction- modulators of bronchial smooth muscle tone and pulmonary vascular smooth muscle tone  
Pharmacotherapy of bronchial asthma  
Pharmacotherapy of cough  
Mucokinetic and mucolytic agents  
Use of bland aerosols in respiratory care

**X. Corticosteroids-** classification, mechanism of action, adverse effects and complications.

Preparation, dose and routes of administration

**XI. Diuretics**

Renal physiology  
Site of action of diuretics  
Adverse effects  
Preparations, dose and routes of administration

**XII. Chemotherapy of infections.**

Definition  
Classification and mechanism of action of antimicrobial agents  
Combination of antimicrobial agents  
Chemoprophylaxis  
Classification, spectrum of activity, dose, routes of administration and adverse effects of penicillin, cephalosporins, amino glycosides, tetracyclines, chloramphenicol, anti-tubercular drugs

**XIII. Miscellaneous.**

IV fluids – various preparations and their usage  
Electrolyte supplements  
Immunosuppressive agents  
New drugs included in perfusion technology.  
Drugs used in metabolic and electrolyte imbalance.

Aprotinin / Tranexamic acid  
Vasodilators  
Anti inflammatory drugs  
Insulin  
Adenosine

**PART B**

**APPLIED PERFUSION TECHNOLOGY**

**Cardiopulmonary bypass and perfusion technology**

Cardiac surgery team, profession and terminology, scope of perfusion technology

History of cardiac surgery and perfusion

- Specific reference of Gibbon, Lillehei, Carrel.
- Pre CPB surgery
- Azygous flow principle.
- Hypothermic/non hypothermic non-CPB surgery including gross's well technique and controlled cross circulation.

### **Monitoring and instrumentation**

Concepts of monitoring- Instrumentation technology of ECG machine, pressure transducers, syringe and peristaltic pumps, monitors, ventilators, pulse oximetry, temperature probes and thermo regulatory monitoring, defibrillators and fibrillators. Piped and non-piped gas delivery systems and connections.

Basic physics related to medically used gases.

- Natural laws pertaining to gas and fluid flow
- Haemodynamic monitoring.
- Haemostatic monitoring.
- Hematologic monitoring.
- Neurological monitoring (SSPE, EEG and cerebral function monitor.)
- Aseptic technique.

### **Physiology of extracorporeal circulation**

Materials used in EC circuit

- Bio compatibility
- Criteria for establishing biocompatibility
  - Metals-PVC-Latex-Silicon-Antifoam-Nylon-polyesters-polycarbonate
  - Polypropylene-pyrolytic carbon
- wear characteristics

### **Heart-Lung Machine**

Blood pumps

- The ideal blood pump
- Types of blood pump
  - Kinetic
  - Positive displacement
    - Rotary pumps
    - Reciprocating pumps
  - Pulsatile versus non-pulsatile
  - Occlusion – Method – Hazards of Over or Under Occlusion
  - Occlusive & non-occlusive pumps
  - Routine Inspection & preventive maintenance of pumps

-EXTRACORPOREAL GAS EXCHANGE

- Oxygen transfer in an artificial oxygenator
  - Diffusion coefficient - permeation coefficient
- Carbon dioxide transfer in an artificial oxygenator
  - Diffusion coefficient - permeation coefficient
- Standards of blood oxygenator testing Methods
  - Blood flow principle
  - Oxygen flow principle
  - Reference blood flow
  - Index of hemolysis
  - static priming volume
  - Dynamic loss

-polarographic systems-oximetry-gas chromatography

-VARIOUS TYPES OF OXYGENATORS

-Film oxygenators

-Screen

-Cylinder

-Disc

- Components-functional characteristics

-Bubble oxygenators

-Components of assembly

-Functional characteristics

-Gas exchange -Venous back pressure

-Designing-advantages – limitations – complications

-Membrane oxygenators

-Micro porous – solid

Membrane types

-spiral coil

-flat plate

-hollow fibre

-Flow pattern –external v/s internal blood flow

-Gas exchange

-Comparison of Bubble & Membrane gas exchange

-Designing-advantages-complication & limitation

-Heat Exchangers

-Functional design of exchangers

-Advantages & complications

-Over heating- Blood –water leak

-Efficiency

-Tubings

-PVC-Silicon– Biocompatibility-wear characteristics-Spallation

-Filters

-Cardiotomy filters & reservoirs

-Gross primary filtration – defoaming –emboli protection

-Reservoir hold up-excessive volume- gravity – vacuum drainage

Arterial filters

-characteristics

-types

-Screen- depth

Materials – Nylon –Polyester

Flow characteristics-efficiency

Bubble trap

Cardioplegia delivery system

Myocardial preservation-Intermittent cross clamping-

Coronary perfusion-topical hypothermia

Constituents of cardioplegia solutions-crystalloid –blood

Substrate enhancement

Hypothermic-normothermic cardioplegia

Antegrade-retrograde delivery-delivery pressures

Storage devices –online systems

## Perfusion technique

- Preparing the CPB circuit- aseptic technique-connections

- Priming the CPB circuit

  - Priming fluids

    - Isotonic-hypertonic –hypotonic

    - Crystalloid-colloid-blood products

  - Hemodilution-selection of priming fluids

- Anticoagulation on CPB-its monitoring-reversal-complications

## Connection of vascular system with extracorporeal circulation

- Arterial and Venous cannula –cannulation sites

- Connecting tubes and connectors

- Vents - Suckers

- Venous drainage

- Hemodynamics of arterial return-venous drainage-cardioplegia delivery- Venting

## Conduct and monitoring of CPB

- Initiating CPB

- Hemodynamics of CPB

  - Adequacy of perfusion

  - Perfusion pressure-blood flow-vascular resistance

  - Control of circulating volume-line pressure

  - Pressure and flow relationship

  - Metabolic aspects of CPB

    - Blood flow requirements

    - Whole body oxygen consumption-hypothermia

    - Acid-base balance-fluid balance

- Monitoring during CPB

  - Clinical observations-Hemodynamic monitoring-laboratory studies

  - On-line monitoring-collecting, interpreting and

    - Responding to lab/hemodynamic data

- Adequacy of perfusion

  - Ideal perfusion-hemodynamic signs-metabolic signs-organic signs

  - Method of control

- Termination of CPB

  - Weaning-post CPB assessment of patient

## Complications of CPB

- Assembly

  - breaks in aseptic technique-faulty tubing or connections

    - Leaks in the system- Mechanical problems with the pump

  - Priming Contamination

    - Wrong solution-wrong additives/medications

    - Overdosage of medication-venous side priming without gas flow

    - Introduction of air into primed filter-foam formation

    - Primetemperature-others

  - No gas flow-contamination- incorrect line attachment to patient

  - Leaks-water-blood –air-recirculation-power loss-mal occlusion of pump

  - Onset of CPB-

    - loss of gas flow

    - loss of power-inadequate anticoagulation-lines clamped

    - Obstruction of venous return-causes of inadequate venous drainage

    - malrotation of pumps-tubing separation or rupture

Dissection; introduction of air into the circuit  
Oxygenator Failure-Causes, Diagnosis, changing oxygenators  
Component Failure-cardiotomy reservoir-pressurization –regulation of Cardiotomy suction  
Arterial filter-causes-diagnosis -correction

### **Basic sciences**

- \* Medical ethics & the relevant medico legal aspects
  - Responsibilities and duties
  - Ethical behavior & conduct
  - Medico legal aspects & its relation to consumer protection act
  
- \* Basics of computer application
  - Basic structure of computers
  - Microprocessors in computers
  - Principles of programming
  - Principles of computer application in various fields
  - Data processing
  
- \* Basics of medical statistics
  - Common statistical terms
  - Sources and presentation of data
  - Measures of location – average and percentiles
  - Measure so central tendency and dispersion
  - Normaldistribution and normal curve
  - Sampling and probability
  - Sampling variability and its significance
  - Significance of difference in measurement
  - Chi-square test
  - Designing and methodology of an experiment of a study
  - Representation of data as tables and graphs
  - Demography of vital statistics
  - Standard deviation
  - P value and its significance
  - Recording of data and maintenance of records
  
- \* Electricity & electromedical equipment& safe guards  
Basics of electricity & functioning of electromedical equipment. Earthing & care of apparatus.  
Static electricity
- \*Biomedical waste & its management
- \* Cardiopulmonary resuscitation – Basic cardiac life support  
-Advanced cardiac life support
- Intensive coronary unit & recovery room concepts
- \* Sterilization – Material & methods
- \* Basic principles of blood transfusion & fluid therapy

1. Discuss the hazards associated with the administration of homologous blood and components
2. Discuss the relationships between vascular volume, blood pressure, organ perfusion, metabolicconsiderations and hemodilution of autologous blood and constituents.
3. Demonstrate knowledge of autologous blood conservation techniques including:
  - a. pre-operative phlebotomy
  - b. intra-operative hemodilution
  - c. intra-operative autologous blood collection, salvage, and transfusion (intra-op auto transfusion)
  - d. post-operative autologous blood collection, salvage, and transfusion

4. Discuss the differences, advantages and disadvantages between "whole-blood" and "cell-saving" techniques
5. Describe the requirements for anticoagulation in auto transfusion procedures
6. Discuss the impact of "massive" blood loss in autologous blood salvage techniques employed and anticoagulation considerations.
7. List "approaches" to and the general merits and contraindications for each in auto transfusion. These approaches include
  - a. regional anticoagulation with heparin
  - b. systemic Heparinization
  - c. citrate based anticoagulation
8. Identify and describe the relative contraindications for intra-operative and post-operative autotransfusion
9. Describe the usefulness of auto transfusion procedures for patients of certain religious beliefs who refuse homologous blood.
10. Identify good auto transfusion practices including:
  - a. labeling
  - b. "wash" volumes in cell-saving techniques
  - c. the processing of autologous blood containing certain biologic fluids, hemostatic agents, antibiotics, and irrigating solutions
  - d. appropriate pump and centrifuge speeds for various applications storage time(s)
  - e. filtration
11. Identify and contrast the types of auto transfusion techniques and approaches for elective V/s emergency surgery
12. Identify certain risks in autologous transfusion and describe methods which may be employed by the "autotransfusionist" to limit these risks.
13. Assemble and demonstrate your knowledge of the operation of an auto transfusion system.
14. Discuss the role of hypothermia in massive volume loss and replacement in terms of
  - a. oxygen delivery
  - b. pH disturbances
  - c. cardiac implications
  - d. coagulation
  - e. effecting reversal (i.e. re-warming)
15. Recognize the importance of intrinsic "pro-coagulant" vs. "anticoagulant" factors in autologous transfusion therapy.
16. Identify and describe at least two commercially available autotransfusion systems for each situation
  - a. intra-operative autotransfusion
  - b. post-operative autologous blood salvage
17. Assemble and operate an autotransfusion system under supervision and demonstrate clinical competency in the operative room.

### **Applied perfusion Technology**

1. Pharmacokinetics and pharmacodynamics of cardiopulmonary bypass
2. Drugs (including anesthetic drugs) used in cardiopulmonary bypass
3. Conduct and monitoring of cardiopulmonary bypass
4. Adequacy of perfusion- General consideration, specific aspects of perfusion, monitoring , other concomitants which may affect its adequacy
5. Pulsatile perfusion – Introduction, theory & physiology of pulsatile flow, hemodynamic, metabolic effects, clinical use, hematological effects
6. Cannulation techniques during cardiopulmonary bypass
7. Termination of cardiopulmonary bypass-principles and methodology

8. Myocardial protection and cardioplegia – pretreatment of the myocardium, cardioplegia, hypothermia, controlled reperfusion, myocardial protection for specific clinical problems, complications of cardioplegia. Non cardioplegic methods during cardiac surgery on cardiopulmonary bypass
9. Oxygenation – general considerations, bubble & membrane(including assessment and comparison of oxygenator function)
10. Heat exchanger – principles,function of heat exchangers & their assessment. Complications related to heat exchangers and their management
11. Priming fluids and hemodilution.
12. Blood cell trauma – analysis of forces of fluid motion effects of physical forces on blood cells, clinical effect. Complications of blood transfusion
13. Anticoagulation on bypass, its monitoring, its reversal and complications. Heparin less bypass. Platelet aggregation and platelet dysfunction. Coagulopathies due to cardiopulmonary bypass and its management

### Applied Perfusion Technology

1. Inflammatory response to cardiopulmonary bypass & its clinical effects. Methods to minimize the same. Immune response, neuroendocrine , renal, metabolic splanchnic response, pulmonary response and electrolyte response to cardiopulmonary bypass
  2. Blood conservation hemofiltration & dialysis during cardiopulmonary bypass including modified ultra filtration reverse autologous priming and other methods
  3. Micro emboli – gaseous and particulate, filters used in cardiopulmonary bypass circuit
  4. Micro pore filtration during cardiopulmonary bypass
  5. Counter pulsation techniques and assist devices
    - a. Describe the ideal goals of IABP.
    - b. List and discuss medical and surgical indications for IABP.
    - c. List and discuss absolute and relative contraindications for IABP.
    - d. List the determinants of myocardial supply and demand.
    - e. Discuss the relationship of myocardial work to IABP.
    - f. Summarize the objectives of IAB inflation and deflation and consequences of incorrect timing. Graphically describe IABP waveforms:
      - ✓ normal
      - ✓ early/late inflation
      - ✓ early/late deflation
    - a) Describe the trigger options for IABP.
    - b) Describe the proper positioning of the IAB including radiographic interpretation and the subsequent
    - c) Adversesequelae from Malposition.
    - d) Discuss the technique and hazards of central aortic pressure monitoring.
    - e) Describe the sequence of percutaneous placement of the balloon.
    - f) Describe basic differences between IAB systems.
    - g) Describe IABP complications and their relative frequency.
    - h) Describe appropriate set-up and check-out procedure initiation for an IAB system.
    - i) Discuss alarm systems for an IAB system.
    - j) Discuss alternative placement of the IAB for appropriate therapy.
    - k) Discuss considerations in the mobile/air transport of a patient on an IAB system.
7. Perfusion techniques for pediatric cardiac surgery
8. ECMO
- i. BASICS, Physiology

- ii. Selection criteria for ECMO
- iii. Murray Score and Oxygenation Index
- iv. Types of ECMO
- v. ECMO Circuit
- vi. Cannulation (Selection according to weight and flows)
- vii. Priming the ECMO circuit
- viii. Pre Assembled ECMO
- ix. Anticoagulation Protocol for ECMO
- x. Thromboelastogram (TEG)
- xi. Management of VA ECMO – Peripheral VA ECMO, Distal limb perfusion, North south syndrome
- xii. Management of VV ECMO
- xiii. Transfusion triggers and Bleeding Management
- xiv. Trouble shooting during ECMO Run
- xv. Weaning Protocol for VA and VV ECMO
- xvi. ECMO Retrieval and Transport
- xvii. ECMO Retrieval check list
- xviii. In house ECMO Transport
- xix. ECPR Protocols
- xx. Manpower Management (Perfusion team)
- xxi. Responsibilities and Job Description of the Bedside Perfusionist/student on ECMO duty
- xxii. Bedside Nursing Management during ECMO
- xxiii. Nutritional Management of the Patient on ECMO

9. Special perfusion techniques for special cardiac surgeries and medical conditions (including thoracic – Arch-Aortic surgeries deep hypothermia and circulatory arrest). Perfusion for non cardiac surgery (liver transplantation-intracranial tumors-regional perfusion), invasive cardiology and outside the operation suite

10. Ventricular Assist Devices:

- a. General aspects of mechanical support
- b. Extracorporeal devices
- c. Intracorporeal devices
- d. Future devices

Criteria of patient selection, preparation of patient for implantation

(Medical preparation, psychological, economical preparations), switching from ECLS to CPB to Assist device - perfusion strategies. Long term survival results, present mortality and morbidity rates of every particular device

VADs- Short term and long term VADs

- a) Indications
- b) INTERMACS Classification
- c) Contraindications
- d) BiVAD support
- e) Durable VADS (Heartmate II, Heartmate III, Heartware, Ventra Assist)
- f) Devices used to bridge to transplantation
  - a. Thoratec VAD
  - b. Novacor LVAD
  - c. Heart mate



- d. Totally artificial heart
  - g) Destination therapy
  - h) Post VAD management
11. Robotic cardiac surgery:  
Cardio pulmonary bypass during port – access surgery and robotic surgery: endovascular catheter system, minimally invasive
12. Transplantation
- A. Heart transplantation  
Basic transplant immunology, Patient and donor selection, Matching donor to recipient, Donor preparation, Orthotropic/heterotrophic Cardiac transplantation, Intensive care management, Immunosuppression and rejection, Surgical complications and results.  
Contents of transplant kit, dimensions of transplant box for Heart, lung, heart and lung.  
TRANSMEDICS organ retrieval system
- B. Heart-lung transplantation  
Recipient selection, donor selection and graft harvest, surgical procedure, Pathophysiology before / after transplantation, preoperative management.
- C. Lung transplantation  
Recipient selection, Donor selection and graft harvest, surgical procedures of lung transplantation (single-lung / double-lung transplantation), Pathophysiology before / after transplantation, postoperative management.  
Perfadex and Perfadex plus solution for lung protection
- D. Liver transplantation: role of Perfusionist
- E. Renal transplantation: role of Perfusionist
- F. Prosthetic heart valves (Mechanical/ Bioprosthetic)
- G. Homografts
- H. Grafts – collagen impregnated grafts, trifurcated grafts, arch vessel, composite valved grafts
13. Complications and safety during cardiopulmonary bypass – bypass safety, organizational aspects, accidents, coagulopathies, mechanical and electrical failures, perfusion management, perfusion systems, safety for the Perfusionist and surgical team management of perfusion accidents.
14. Special considerations during CPB – Cold Agglutination-Malignant Hyperthermia  
-Sickle cell diseases-G6PD deficiency-Heparin induced Thrombocytopenia-Methemoglobinaemia-CPB in pregnancy- Jehovah’s Witness
15. Minimally invasive surgery and the Perfusionist
16. Recent advance in perfusion techniques
17. Experimental perfusion

#### Calculations & Practicals

1. Calculation of PCV on CPB and amount of blood to be added to bring the PCV  
✓ On CPB to a particular level.
2. Interpretation and correction of a given arterial blood gas
3. Interpretation and correction of a given electrolyte abnormality
4. Calculation of Body Surface Area; Body Mass Index
5. Circulating Oncotic pressure
6. Calculate Required Plasma to be added
7. Calculate DO<sub>2</sub>
8. Calculate Arterial Oxygen Content
9. Calculate VO<sub>2</sub>
10. Extraction Ratio

11. Performing and ACT estimation and interpretation of results
12. Setting of a dummy CPB circuit
13. Managing a simulated perfusion accident on a dummy CPB circuit including changing oxygenators when on CPB, managing falling/leaking reservoir levels, venous airlocks, air in the arterial line, cardioplegia delivery failure, increased arterial line pressure, recognition of a possible dissection, run away pump head, recognition of heat exchanger water leak into the CPB circuit, reaction time assessment etc.
14. Identification of various CPB circuit components and their uses, method of sterilization and complications related to them
15. Identification of drugs and their pharmacology
16. Calculating vascular resistance on CPB and management of increased perfusion pressure on bypass

## REFERENCES

### N.B candidate is not restricted to the following recommended references

#### Anatomy

- 1, Gray's Anatomy- Gray Henry Ed: P Williams, Edinburgh, Churchill Livingstone, 1989
- 2, Grant's Atlas of Anatomy- Anderson J E Ed: 7<sup>th</sup> Williams and Wilkins, 1978

#### Physiology & Pathology

- 1, Text book of medical physiology- Arthur C. Guyton, John E. Hall, 10<sup>th</sup> Ed; Philadelphia; Saunders 2000.
- 2, AmSECT Clinical self study modules;
  - Blood gas/ acid base
  - Acid base physiology
  - The biochemistry and physiology of Hemoglobin
  - Renal Physiology & Diuretic Therapy
- 3, Congenital malformation of the heart- Helen Taussig, The common wealth found, New York
- 4, Muir's Textbook of pathology- Anderson J R, 13<sup>th</sup> Ed 1995
- 5, Cardiac surgery- congenital heart disease- Monroe J, Shore G
- 6, Cardiopulmonary Bypass principles and practice- Gravlee GP, Davis RF, Kurusz M, Utley JR (Eds) 1999 Lippincott Williams & Wilkins 2<sup>nd</sup> Edition
- 7, Clinical Application of blood gases – Shapiro, Barry A, Chicago, Year book med pub; 4<sup>th</sup> Ed 1989.
- 8, The physiology of adequate perfusion- Berger EC

#### Pharmacology

- 1, Goodman & Gilman's The pharmacological basis of therapeutics.  
Ed Gilman AG, Rall TW, NeisAS and Taylor P 8<sup>th</sup> Ed 1990 Pergamon, Oxford
- 2, Drugs Affecting the nervous system, Pharmacology for Perfusionists  
James E Berger, AmSECT.
- 3, Basic pharmacological concepts for perfusion, AmSECT Clinical science self study modules
- 4, Drugs for the heart, Ed by Lionel H. Opie, 5<sup>th</sup> Ed Philadelphia; Saunders, 2001

#### Perfusion Technology

#### Biomedical electronics

- 1, Principles of applied Biomedical Instrumentation- Baker LE, Geddes LA, Pub; Wiley 1989 3<sup>rd</sup> Ed
- 2, cardiac pacing and electrophysiology- Nabil El-Sherif, Philip Samet, Pub; W B Saunders 1991 3<sup>rd</sup> Ed

#### MECHANICAL CIRCULATORY SUPPORT & ROBOTIC CARDIAC SURGERY

1. Cardiac assist devices, Daniel J. Goldstein & Mehmet C. Oz, Futura Publishing Company, 2000
2. Cardiopulmonary bypass; Principles and practice, Glenn P. Gravlee, Richard F. Davis, Mark Kurusz &

Joe R. Utley; 2nd edition; Lippincott Williams & Wilkins 2000.

3. Techniques in Extracorporeal circulation, Philip H. Kay & Christopher M. Munsch

#### **ORGAN TRANSPLANTATION**

1. Heart, lung and heart lung transplantation: In Kaplan's Cardiac Anesthesia, 5th Edition, Joel A Kaplan (Editor) Elsevier Saunders, Philadelphia 2006.

2. Oxford specialist handbook in surgery (Cardio thoracic surgery),

Indian Edition, Joanna Chikwe, Emma Beddow, Brain Glenville.

#### **PERFUSION TECHNOLOGY**

1. Cardiopulmonary bypass, Principles and practice, Fourth Edition and Fifth Edition

Ed Glenn P Gravelee, Richard F Davis, Joe R. Utley Pub; Williams & Wilkins

2. Heart lung bypass; Gallatti / Brecher Pub; Grune & Stratton

3. Techniques in extracorporeal circulation; Ionescu MI, 3<sup>rd</sup> Ed, Butterworth & Heinemann 1992, Kay P (Ed).

4. Cardiopulmonary bypass, Principles and management, Williams and Wilkins 1990, Taylor KM (Ed)

5. The physiology of adequate perfusion, CV Mosby Co, Berger E.

6. Cardiopulmonary Bypass, Reed, Kurus, Lawrence, Plenum.

7. The manual of clinical perfusion, Brodie/ Johnson Pub, Glendale Medical Crop.

8. Safety and techniques in perfusion, Reed, Kurusz, Lawrence, Pub Quali-Med.

9. Extracorporeal Life Support: The ELSO Red Book 5th Edition. Thomas V. Brogan, M.D; Laurence Lequier, M.D; Roberto Lorusso, M.D., Ph.D.; Graeme MacLaren, M.D; Giles Peek, M.D.