M. Sc. PERFUSION TECHNOLOGY

1. Preamble :

Perfusion technologist is absolutely essential during the process of open heart surgery. He is highly trained personnel who maintains the circulation of blood to vital organs of the body like brain, kidney, liver etc. When heart is stopped & arrested by cardioplegic solutions for doing corrective surgeries.

Although during bachelors training in perfusion technology, these things are taught but in M.Sc. Perfusion technology, a candidate further specializes in infant, paediatric or adult perfusion during corrective cardiac surgeries.

2. Objectives :

Trained Master perfusion technologists are needed in the present day medical care in India for the following reasons;

a. Cardiac diseases are increasing in India which requires open heart surgery for that a trained perfusion technologist is required.
b. A trained perfusion technologist is solution to the nation's shortage of health personnel.
c. A trained perfusion technologist is a means of saving health care consumer's money.
d. A trained perfusion technologist is an easy way of providing primary, preventive and emergency medical care.
e. A trained perfusion technologist profession ultimately is a means of improving quality of health care which is available, accessible and affordable.

3. Duration of Course : This is a 2 years course
1 year for lateral entry

4. Eligibility :

a. Direct Entry

i. B.Sc. Perfusion technology
ii. B.Sc. Anaesthesia technology
iii. B.Sc. Cardiac Care technology
iv. B.Sc. Echocardiography
v. MBBS / BAMS / BHMS

b. Lateral entry

Science graduate with 10 years experience in perfusion technology in a recognized hospital.

Method of selection:

The eligible students can seek admission through an entrance examination followed by interview conducted by the KLE University. Preference will be given to perfusion technology course students.

5. Course Contests

The course consists of lectures, seminars and practical classes for the first year in Basics of Perfusion Technology & Perfusion Technology for Common Conditions. At the end of first year the students take up internal exams in these subjects. During the second year they will be taught about Perfusion Technology in Special Situations and Recent Advances in Perfusion Technology. At the end of two years they will appear for university examination.

I YEAR THEORY

1. BASICS OF PERFUSION TECHNOLOGY Total hours : 400 hrs

I. INTRODUCTION

a. **Introduction to Perfusion Technology:**

Introduction to the Operating room &ICU- Concept, Zoning, environment & protocols, Biomedical waste & its management, Cardiopulmonary resuscitation – Basic & Advanced cardiac life support, Sterilization – material & methods, Introduction to the various components of Cardiopulmonary bypass system, Introduction to the basics of CPB procedures. (5 hrs)

b. **History & Concept of 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/nonhypothermic non-CPB surgery including Gross's well technique and controlled cross circulation. (20 hrs)

c. **Monitoring and instrumentation:**

Concepts of monitoring- Piped and non-piped gas delivery systems and connections, Basic physics related to medically used gases. Natural laws pertaining to gas and fluid flow (Boyle's law, Graham's law, Dalton's law, Poiseuille's law, Ohm's law, etc). (40 hrs)

d. **Blood Pumps:**

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. (60 hrs)

e. **Extracorporeal Gas Exchange:**

Gas transfer in an artificial oxygenator, diffusion coefficient, permeation coefficient, standards of blood oxygenator testing methods, various types of oxygenators, film-screen-cylinder-disc–bubble-membrane, components-functional characteristics, Designing-advantages-complication & limitation. (60hrs)

f. **CPB components:**

Heat Exchangers-Functional design of exchangers, complications, Efficiency, Tubings-PVC-Silicon– Biocompatibility-wear characteristics-spallation, Filters, Gross primary filtration – defoaming –emboli protection-Reservoir hold up, Flow characteristics-efficiency-Bubble trap, Cardioplegia delivery system- Myocardial preservation-Storage devices –online systems, Controlled re perfusion, myocardial protection for specific clinical problems, Complications of cardioplegia, re perfusion injury. (60 hrs)

II. PHARMACOLOGY RELATED PERFUSION TECHNOLOGY (60 hrs)

General concepts about pharmacodynamic and pharmacokinetic principles involved during activity.

Nervous system: Anatomy & functional organization, list of drugs acting on ANS & CNS including dose, route of administration, indications, contra indications and adverse effects. Alcohol, Sedatives, Hypnotics and Narcotics, CNS stimulants, Neuromuscular blocking agents and Muscle relaxants. (10 hrs)

a. **Cardiovascular drugs**: Enumerate the mode of action, side effects and therapeutic uses of the following drugs. (10 hrs)

   i. Antihypertensives
   a. Beta adrenergic antagonists
   b. Alpha adrenergic antagonists
   c. Peripheral vasodilator
   d. 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 haemostasis : anticoagulants, thrombolytics and antithrombolytics

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

x. Priming solutions – history, principles and types.

xi. Drugs used in the treatment

b. **Anesthetics and Analgesics:**

Definition and Classification-Routes of administration, Pharmacokinetics and Pharmacodynamics, Mechanism of action duration of action and methods to prolong the duration of action. Preparation , dose and routes of administration-side effects and management of anesthetics , non opiod and opioid analgesics.

(10hrs)

c. **Pharmacological protection of organs during CPB and emergency drugs:** Cerebral protective drugs during DHCA, Low flow perfusion & Ischemia, Renal protective drugs – Diuretics-Site of action of diuretics-Adverse effects. (10 hrs)

d. **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. (5 hrs)

e. **Corticosteroids:**

Classification, mechanism of action, adverse effects and complications, Preparation, dose and routes of administration. (5 hrs)

f. **Chemotherapy of infections:**

Definition, Classification and mechanism of action of antimicrobial agents, Combination of antimicrobial agents, Chemo prophylaxis, Classification, spectrum of activity, dose, routes of administration and adverse effects of penicillin, cephalosprins, amino glycosides, tetracycline's, chloramphenicol , antitubercular drugs, Immunosuppressive agents. (5 hrs)

g. **Fluids and Electrolytes:**

IV fluids – Various preparations and their usage, Electrolyte supplements, Drugs used in metabolic and electrolyte imbalance, plasma expanders and oxygen carrying solutions (5 hrs)

III. MEDICINE RELEVANT TO TECHNOLOGY (60 hrs)

a. **Vascular System. (8 hrs)**

   a. Atherosclerosis- Definition, risk factors, briefly pathogenesis & morphology, clinical significance and prevention
   b. Hypertension-definition, types and briefly pathogenesis and effects of hypertension
   c. Aneurysms- definition, classification Pathology and complication.

b. **Cardiac system-Congenital (8 hrs)**

   a. Congenital heart diseases-basic defect and effects of important types of congenital heart diseases.
   b. Pathophysiology of heart failure

c. **Cardiac system-Acquired** **(8 hrs)**

a. Cardiac hypertrophy causes, pathophysiology & progression to heart failure.
b. Ischemic heart diseases-definition, types. Briefly pathophysiology, pathology & complications of various types of IHD
c. Valvular heart diseases-causes pathology & complications. Complications of artificial valves.
d. Cardiomyopathy-definition, types, causes and significance
e. Pericardial effusion-causes, effects and diagnosis.

d. **Haematology** **(8 hrs)**

a. Anaemia-definition, morphological types and diagnosis of anemia.
b. Brief concept about hemolytic anemia and polycythaemia.
c. Leukocyte disorders-briefly leukemia, leukocytosis, agranulocytosis etc.
d. Bleeding disorders-definition, classification, causes & effects of important types of bleeding disorders. Briefly various laboratory tests used to diagnose bleeding disorders.

e. **Respiratory System** **(8 hrs)**

a. chronic obstructive airway diseases- definition and types briefly causes, pathology and complications of each type of COPD
b. Briefly concept about obstructive versus restrictive pulmonary disease pneumoconiosis-definition, types, pathology and effects in brief.
c. pulmonary congestion and edema
d. pleural effusion – causes, effects and diagnosis.

f. **Renal System** **(8 hrs)**

a. Clinical manifestations of renal diseases.
b. Briefly causes, mechanism effects and laboratory diagnosis of ARF & CRF. Briefly glomerulonephritis and pyelonepheritis.
c. End stage renal disease-definition, causes, effects and role of dialysis and renal transplantation in its management.

g. **Cerebral system:**

Cerebral circulation, intra-cranial pressure, cerebral edema**,** Cerebral aneurysms-Carotid stenosis-stroke. (6 hrs)

h. **Miscellaneous:**

Hyperthermia-cold reactive protein-sickle cell anaemia-methhaemoglobinuria-G6 PD deficiency- (6 hrs)

IV. BIOMATERIALS

a. **Synthetic Polymers:** Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization. (5 hrs)

b. **Biocompatibility:**

Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials , Effects of wear particles. Testing of implants: Methods of test for biological performance- In vitro implant tests, In vivo implant test methods. Qualification of implant materials. 10 hrs)

c. **Biopolymers:**

Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, yield strength and fracture strengths, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, polymers as biomaterials, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulfated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins. (10 hrs)

2. PERFUSION TECHNOLOGY FOR COMMON CONDITIONS

Total hour : 400 hrs

I. **Perfusion set up & technique:** Preparing the CPB circuit- aseptic technique-connections, Priming fluids - Hemodilution -Priming the CPB circuit, Anticoagulation on CPB-It's monitoring-reversal-complications, Connection of vascular system with extracorporeal circulation, Arterial and Venous cannula – cannulation sites & techniques, Vents Suckers-Venous drainage. (40 hrs)

II. **Conduct and monitoring of CPB:** Initiating CPB-Hemodynamics of CPB, Monitoring during CPB-Adequacy of perfusion-Termination of CPB, Post CPB assessment of patient-Complications during CPB. (40 hrs)

III. Pharmacokinetics and pharmacodynamics of cardiopulmonary bypass, Drugs (including anesthetic drugs) used in cardiopulmonary bypass - Anticoagulation on bypass , its monitoring , its reversal and complications. Heparin less bypass (40 hrs)

IV. 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 (40 hrs)

V. Blood cell trauma – Analysis of forces to fluid motion, effects of physical forces on blood cells, clinical effect. Complications of blood transfusion**,** Platelet aggregation and platelet dysfunction. Coagulopathies due to cardiopulmonary bypass and its management (40 hrs)

VI. Blood conservation, hemofiltration & dialysis during cardiopulmonary bypass including modified ultra filtration reverse autologuous priming and other methods Auto transfusion-Cell savers- Techniques (40 hrs)

VII. Micro emboli – gaseous and particulate, filters used in cardiopulmonary bypass circuit Micro pore filtration during cardiopulmonary bypass (40 hrs)

VIII. Adequacy of perfusion- General consideration, specific aspects of perfusion, monitoring, other concomitants which may affect its adequacy (40 hrs)

IX. Pulsatile perfusion – Introduction, theory & physiology of pulsatile flow, hemodynamic, metabolic effects, clinical use, hematological effects (40 hrs)

X. Myocardial protection warm heart surgery, advantages and disadvantages, Non-cardioplegic methods during cardiac surgery on cardiopulmonary bypass (40 hrs)

PRACTICAL
PERFUSION TECHNOLOGY CLINICAL & LAB WORK

Total duration 800 hrs

Experiment 1: Neatly draw and identify parts of any integrated membrane Oxygenator system

Experiment 2: Neatly draw , identify & describe different parts of Roller pump.

Experiment 3: Neatly draw, identify & describe different parts of Centrifugal pump.

Experiment 4: Neatly draw , identify & describe different parts of an Arterial line filter.

Experiment 5: Neatly draw , identify & describe different types of connectors & tubing's.

Experiment 6: Neatly draw , identify & describe different types of cannulae.

Experiment 7: Prepare & describe an Adult Extra Corporeal Bypass Circuit.

Experiment 8: Neatly draw, identify & describe parts of Online Cardioplegia delivery system.

Experiment 9: Assemble a Heart Lung machine with an Extra Corporeal circuit.

Experiment 10: Prime and deair an assembled Extra Corporeal Circuit.

Experiment 11: Prime & Deair an Online Cardioplegia delivery system.

Experiment 12: Narrate any two methods of checking the occlusion in a roller pump.

Experiment 13: Narrate the method to calibrate the Heart Lung machine.

Experiment 14: Narrate the safety features of the Heart Lung machine.

Experiment 15: Calculate PCV on CPB and amount of blood to be added to bring the PCV to the target PCV. Calculate body surface area of an individual, Systemic Vascular Resistance.

Experiment 16: Interpretation and correction of a given arterial blood gas report. Interpretation and correction of a given electrolyte abnormality, Performing and ACT estimation and interpretation of results

II YEAR

1. PERFUSION TECHNOLOGY IN SPECIAL SITUATIONS AND RECENT ADVANCES IN PERFUSION TECHNOLOGY

Total hours : 400 hrs

I. **Counter pulsation techniques:** Principle of counter pulsation-IABP-Indication – contra indication-Complication-Insertion techniques-timing –monitoring-machine controls & emergency management (40 hrs)

II. **Pediatric surgery:** Anatomical and physiological consideration- significance during circuit designing ,priming , conducting CPB and weaning from CPB-myocardial protection – Cannulation techniques-inflammatory mediator response-post operative complications (40 hrs)

III. **Ventricular assist Devices:** Principle of ventricular assist-selection criteria-contraindication-complication, Circuit designing-priming-management-crisis management-RVAD-LVAD-BVAD. (40 hrs)

IV. **Extra corporeal membrane oxygenation:** Principle of Extra corporeal membrane oxygenation -selection criteria- contraindication-complication, Circuit designing-priming-management-crisis management, VV-ECMO, VA-ECMO, IV-ECMO (40 hrs)

V. **Special procedures:** 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, Perfusion techniques for transplants – Perfusionist role during transplants, Minimally invasive surgery and the perfusionist (80 hrs)

VI. **Perfusion safety:** 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. (40 hrs)

VII. **Special considerations:** Special considerations during CPB – Cold Agglutination-Malignant Hyperthermia -Sickle cell diseases-G6 P D deficiency-Heparin induced Thrombocytopenia-Methemoglobinaemia-CPB in pregnancy- Jehovah's witness. (40 hrs)

VIII. **Research and Development:** Recent advance in perfusion techniques, Experimental perfusion, Clinical Research – Research and development process and facilities-phases of clinical researches-clinical trials (40 hrs)

PRACTICAL

PERFUSION TECHNOLOGY CLINICAL & LAB WORK

Total duration : 800 hrs

1. Design an ideal pediatric CPB circuit describe the differences between adult and pediatric circuit
2. Design a LVAD / RVAD circuit and describe the components
3. Assemble the LVAD/RVAD circuit and prime.
4. Design a ECMO circuit and describe the components
5. Assemble an ECMO circuit and prime.
6. Design an ideal CPB circuit for an Aortic arch repair surgery and describe the advantages
7. Set up an IABP, identify the dicrotic notch, end diastolic point, unassisted systole, assisted systole
8. Describe proper timing, timing errors, complications and contra indications of IABP therapy. Draw a picture of pressure wave of proper 1:2 assist
9. Design a CPB circuit with a conventional circuit with conventional filtration and describe the filtration circuits components and function
10. Design a Modified Ultra filtration circuit and describe the component and functions
11. Narrate the steps involved with the change of oxygenator during CPB
12. Narrate the steps involved with change of pump loop
13. Narrate the steps involved with massive air embolism
14. Narrate steps involved with arterial pump failure
15. Manage 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.
16. Identification of drugs and their pharmacology related to CPB
17. Calculating vascular resistance on CPB and management of increased perfusion pressure on bypass.

6. Scheme of Examination:

At the end of first year, students take up internal examination of theory (100 marks), practical and viva-voce (50 marks each) in the subject of Basics of Perfusion Technology and Perfusion Technology for Common Conditions. 20% of the marks obtained will be taken as internal assessment marks to be added to the final tally of marks obtained at the end of II year in the examination conducted by the university.

Students will take up preliminary examinations about 1- ½ months prior to final university examination in the subject of Perfusion Technology in Special Situations and Recent Advances in above mentioned format. 20% of the marks obtained will be added to final tally.

At the end of 2 years students takes up final examination conducted by the university. There will be 3 theory papers (I, II & III), each of 3 hours duration. Examination scheme will as following:

Subject code	**Name of Subject**	**Examination scheme**		
		I A	**Exam**	**Total**
	Paper – I Perfusion technology (Basics)	20	80	100
	Paper – II Perfusion technology for common conditions	20	80	100
	Paper – III Perfusion technology Special Situation & Recent Advances	20	80	100
	Practical Perfusion technology Clinical & Lab Work	20	80	100
	Viva-voce	10	40	50
			Total	**450**

7**. Type of Question Papers**

Each theory paper consists of total of 80 marks each

a. Two essay type questions of 15 marks each (2 x 15 = 30 marks)
b. Five short easy type questions of 10 marks each (5 x 10 = 50 marks)

Practical consists of 40 marks for each exercise (total 80 marks)

1. Setting of CPB pump for adult
2. Setting of CPB pump for paediatric

Viva-voce - 80 marks

Criteria for pass in Final Examination:

For pass in theory a candidate should secure minimum of 50% marks in aggregate i.e. marks obtained in written examination and internal assessment marks added together in each subject. For pass in practical examination a candidate should secure minimum of 50% marks in aggregate i.e. marks obtained in practical examination and internal assessment marks along with viva-voce marks.

Declaration of class

a. A candidate having appeared in all the subjects in the same examination and passed that examination in the first attempt and secure 75% of marks or more of grand total marks prescribed will be declared to have passed the examination with **Distinction.**

b. A candidate having appeared in all the subjects in the same examination and passed that examination in the first attempt and secured 65% of marks or more but less than 75% of grand total marks prescribed will be declared to have passed the examination in **First Class.**

c. A candidate having appeared in the subjects in the same examination and passed that examination in the first attempt securing more than 50% and less than 65% of marks is placed in the **Second Class.**

d. A candidate passing the university examination in more than one attempt shall be placed in **Pass Class** irrespective of the percentage of marks secured by him/her in the examination.

8. Recommended Books

Sl. No	Title	Author	Publisher
1	Cardiopulmonary bypass	Glenn P. Gravlee, Mark Kurus Z, Richard F Davis, Joe R Utley	Lippinott Williams & Wilkins
2	Cardiopulmonary bypass in neonates, infants and young children	Jonas, Richard A	Elsevier Science Health Science Div.
3	Techniques in extra corporeal circulation	Kay, Philip H ed	A Hodder Arnold Publication
4	Safety and technique in perfusion	Reed, Charles	Surgimedics
5	Pharmacology & Pharmacotherapeutics	Sathoskar	Popular Prakashan
6	A practical approach to Cardiac Anesthesia	Fredrick A. Hensely	Little Brown Publishers
7	Clinical Pharmacology	Goodman & Gilman	Mcgraw Hill
8	Clinical Pharmacology	Tripati	Jaypee Brothers
9	Basic Pathology	Kumar & Kotran	W. B. Saunders company
10	Clinical pathology	Bhende	Popular Prakashan
11	Text book of pathology	Robins	W. B. Sauders
12	Cardiopulmonary anatomy and physiology	Matthews Des. Jordanian Terry Mate	Delmar Publishers
13	Critical heart diseases in infants & children	David Nichols G, Duke E Camaron	Elsevier Health Science
14	Cardiac assist devices	Daniel J Goldstien, MD, Mohmet OZ, MD	Wiley Black Well

15	Heart and heart-lung transplantation	Wallwork	
16	Warm Heart Surgery ,Ist edition	Salerno, Thomas Antonio	A Hodder Arnold Publication
17	Myocardial perfusion, reperfusion, coronary venous retroperfusion	Meerbaum, S ed	Springer

9. Journals:

1. Indian Journal of Extra Corporeal Circulation
2. American Society of Extra Corporeal Circulation
3. European Society of Extra Corporeal Technology