Perfusion Basic Science Exam Compendium

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Compendium Overview

This compendium is a comprehensive study guide for the Perfusion Basic Science Exam (PBSE), covering all required topics for perfusionists. It includes 2716 multiple-choice questions (MCQs) and 1000 short-answer questions across three sections:

- **Section 1: Core Physiology & Pathophysiology** (40 pages): Cardiovascular, pulmonary, hematology, endocrine/immunology, microcirculation.
- **Section 2: Perfusion Technology & Techniques** (30 pages): Equipment, techniques, quality control/research, pediatric perfusion.
- **Section 3: Pharmacology & Emergency Management** (27 pages): Pharmacology, renal/neurologic/monitoring, emergencies/infection, blood conservation/ethical/psychosocial.

This ensures thorough preparation for the PBSE and clinical practice.

Contents

1 Core Physiology & Pathophysiology

1.1 Cardiovascular Physiology & Pathophysiology

1.1.1 Multiple-Choice Questions

1. What is the primary function of the left ventricle?
   a) Pump oxygenated blood into the aorta
   b) Pump deoxygenated blood to the lungs
   c) Receive pulmonary venous blood
   d) Regulate coronary flow
   Answer: a) Drives systemic circulation.
2. What increases myocardial oxygen demand?
   a) Increased heart rate
   b) Decreased preload
   c) Reduced afterload
   d) Lowered contractility
   Answer: a) Raises contraction frequency.
3. What is the effect of aortic stenosis on cardiac workload?
   a) Increases left ventricular pressure
   b) Decreases coronary perfusion
   c) Reduces afterload
   d) Enhances diastolic filling
   Answer: a) Narrowed valve increases pressure.
4. What is a characteristic of ventricular septal defect (VSD)?
   a) Left-to-right shunt
   b) Right-to-left shunt
   c) Increased pulmonary resistance
   d) Decreased systemic flow
   Answer: a) Blood shunts from LV to RV.
5. What is the primary cause of ischemic heart disease?
   a) Coronary artery occlusion
   b) Valvular dysfunction
   c) Myocardial hypertrophy
   d) Congenital malformation
   Answer: a) Atherosclerosis reduces flow.
6. What is the Frank-Starling mechanism's effect?
   a) Increased stroke volume with preload
   b) Decreased heart rate
   c) Reduced contractility
   d) Increased afterload
   Answer: a) Stretch enhances output.
7. What is a complication of mitral regurgitation?
   a) Left atrial dilation
   b) Right ventricular hypertrophy
   c) Decreased pulmonary pressure
   d) Enhanced coronary flow
   Answer: a) Backflow enlarges LA.
8. What is the primary defect in Tetralogy of Fallot?

a) VSD, pulmonary stenosis, RV hypertrophy, overriding aorta
b) Mitral valve prolapse
c) Aortic coarctation
d) Patent ductus arteriosus
Answer: a) Causes cyanosis.

9. What is the effect of heart failure on cardiac output?
a) Decreased output
b) Increased preload
c) Enhanced contractility
d) Reduced afterload
Answer: a) Impaired pumping reduces flow.

10. What is the role of coronary arteries?
a) Supply myocardial oxygen
b) Remove metabolic waste
c) Regulate heart rate
d) Control valve function
Answer: a) Deliver oxygen to heart.

11. What is a feature of aortic coarctation?
a) Increased LV afterload
b) Decreased systemic pressure
c) Enhanced coronary flow
d) Reduced pulmonary congestion
Answer: a) Narrowed aorta increases resistance.

12. What is the effect of myocardial infarction on cardiac function?
a) Reduced contractility
b) Increased stroke volume
c) Enhanced coronary flow
d) Decreased afterload
Answer: a) Necrosis impairs pumping.

13. What is a characteristic of atrial septal defect (ASD)?
a) Left-to-right shunt
b) Right-to-left shunt
c) Decreased pulmonary flow
d) Increased systemic resistance
Answer: a) Blood shunts from LA to RA.

14. What is the role of pressure-volume loops in assessing cardiac function?
a) Evaluate work and efficiency
b) Measure coronary flow
c) Assess valve structure
d) Monitor heart rate
Answer: a) Shows cardiac performance.

1.1.2 Short-Answer Questions

1. Define preload in cardiac physiology.
Answer: Myocyte stretch from end-diastolic volume.
2. What causes pulmonary edema in left-sided heart failure?
Answer: LV pressure backs fluid into lungs.
3. Explain the Frank-Starling mechanism.

Answer: Increased preload enhances stroke volume.

4. What is the defect in aortic coarctation?
   Answer: Narrowed aorta increases afterload.
5. Define myocardial ischemia.
   Answer: Reduced blood flow to myocardium.
6. What is the role of afterload in cardiac function?
   Answer: Resistance to ventricular ejection.
7. Explain coronary steal phenomenon.
   Answer: Vasodilation diverts blood from ischemic areas.

1.2 Pulmonary Physiology & Pathophysiology

1.2.1 Multiple-Choice Questions

1. What is the primary site of gas exchange in the lungs?
   a) Alveoli
   b) Bronchi
   c) Trachea
   d) Bronchioles
   Answer: a) Oxygen/CO2 exchange occurs here.
2. What causes hypoxia in ARDS?
   a) Alveolar flooding
   b) Bronchial obstruction
   c) Increased dead space
   d) Pulmonary hypertension
   Answer: a) Impairs gas exchange.
3. What is the effect of hypercapnia on blood pH?
   a) Decreases pH
   b) Increases pH
   c) No effect
   d) Increases bicarbonate
   Answer: a) CO2 retention causes acidosis.
4. What is a hallmark of pulmonary hypertension?
   a) Increased pulmonary artery pressure
   b) Decreased RV workload
   c) Enhanced gas exchange
   d) Reduced vascular resistance
   Answer: a) Elevates RV afterload.
5. What is the mechanism of V/Q mismatch?
   a) Uneven blood flow and air distribution
   b) Uniform alveolar collapse
   c) Increased dead space
   d) Reduced surfactant
   Answer: a) Causes hypoxia.
6. What is the role of surfactant in pulmonary function?
   a) Reduces alveolar surface tension
   b) Increases airway resistance
   c) Enhances CO2 retention
   d) Decreases compliance

Answer: a) Prevents collapse.

7. What is a consequence of pulmonary edema?
   a) Impaired oxygen diffusion
   b) Increased compliance
   c) Reduced airway resistance
   d) Enhanced gas exchange
   Answer: a) Fluid blocks diffusion.
8. What is the primary cause of respiratory acidosis?
   a) Hypoventilation
   b) Hyperventilation
   c) Metabolic alkalosis
   d) Renal compensation
   Answer: a) CO_2 retention lowers pH.
9. What is a feature of COPD?
   a) Airway obstruction
   b) Increased compliance
   c) Reduced dead space
   d) Enhanced diffusion
   Answer: a) Limits airflow.
10. What is the effect of a right-to-left shunt?
    a) Decreases arterial PaO_2
    b) Increases CO_2 clearance
    c) Enhances ventilation
    d) Reduces pulmonary pressure
    Answer: a) Bypasses oxygenated alveoli.
11. What is the Bohr effect's role in gas exchange?
    a) Enhances oxygen release in tissues
    b) Increases CO_2 retention
    c) Reduces hemoglobin affinity
    d) Enhances alveolar collapse
    Answer: a) Low pH aids oxygen unloading.
12. What is a sign of acute respiratory distress syndrome?
    a) Bilateral infiltrates on chest X-ray
    b) Increased compliance
    c) Reduced dead space
    d) Enhanced gas exchange
    Answer: a) Indicates alveolar damage.
13. What is the effect of metabolic alkalosis on ventilation?
    a) Decreases respiratory drive
    b) Increases CO_2 retention
    c) Enhances oxygen delivery
    d) Reduces pulmonary pressure
    Answer: a) Compensatory hypoventilation.
14. What is the role of dead space in pulmonary function?
    a) Reduces effective gas exchange
    b) Increases oxygen delivery
    c) Enhances CO_2 retention
    d) Decreases airway resistance
    Answer: a) Non-perfused alveoli impair exchange.

1.2.2 Short-Answer Questions

1. What is surfactant's role in the lungs?
   Answer: Reduces alveolar surface tension.
2. Define respiratory acidosis.
   Answer: Low pH from CO2 retention.
3. Explain hypoxia in pulmonary edema.
   Answer: Fluid impairs oxygen diffusion.
4. What is a high V/Q ratio?
   Answer: Dead space, low CO2 clearance.
5. Define intrapulmonary shunt.
   Answer: Blood bypasses ventilated alveoli.
6. What is the Haldane effect?
   Answer: Oxygenation enhances CO2 release.
7. Explain pulmonary hypertension's impact.
   Answer: Increases RV afterload, risks failure.

1.3 Hematology & Coagulation

1.3.1 Multiple-Choice Questions

1. What is the primary anticoagulant used during CPB?
   a) Heparin
   b) Warfarin
   c) Aspirin
   d) Clopidogrel
   Answer: a) Rapid, reversible anticoagulation.
2. What causes hemolysis during CPB?
   a) Mechanical shear stress
   b) Hypothermia
   c) Hypercoagulation
   d) Low hematocrit
   Answer: a) Pump stress damages RBCs.
3. What is the primary component of the coagulation cascade?
   a) Thrombin
   b) Platelets
   c) Fibrinogen
   d) Calcium
   Answer: a) Converts fibrinogen to fibrin.
4. What causes transfusion-related acute lung injury (TRALI)?
   a) Anti-HLA antibodies
   b) Bacterial contamination
   c) Volume overload
   d) Hemolytic reaction
   Answer: a) Triggers lung inflammation.
5. What is the effect of heparin-induced thrombocytopenia (HIT)?
   a) Platelet activation and thrombosis
   b) Increased bleeding
   c) Enhanced anticoagulation

d) Reduced fibrin
Answer: a) Immune-mediated thrombosis.

6. What is the role of platelets in hemostasis?
a) Form initial plug
b) Produce thrombin
c) Dissolve clots
d) Reduce viscosity
Answer: a) Adhere at injury site.

7. What is a sign of disseminated intravascular coagulation (DIC)?
a) Microvascular thrombosis
b) Increased platelet count
c) Reduced fibrin degradation
d) Enhanced anticoagulation
Answer: a) Consumes clotting factors.

8. What is the purpose of thromboelastography (TEG)?
a) Assess coagulation dynamics
b) Measure hematocrit
c) Monitor oxygen saturation
d) Evaluate renal function
Answer: a) Guides transfusion.

9. What is a complication of massive transfusion?
a) Dilutional coagulopathy
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced platelet function
Answer: a) Dilutes clotting factors.

10. What is the effect of protamine overdose?
a) Anticoagulant effect
b) Increased heparin activity
c) Enhanced clotting
d) Reduced hemolysis
Answer: a) Impairs coagulation.

11. What is the role of fibrinogen in coagulation?
a) Forms fibrin mesh
b) Activates platelets
c) Inhibits thrombin
d) Reduces viscosity
Answer: a) Stabilizes clots.

12. What is a sign of hemolytic transfusion reaction?
a) Hemoglobinuria
b) Increased platelet count
c) Reduced fibrin degradation
d) Enhanced anticoagulation
Answer: a) RBC destruction releases hemoglobin.

13. What is the purpose of activated clotting time (ACT)?
a) Monitor heparin effect
b) Measure hematocrit
c) Assess oxygen saturation
d) Evaluate renal function

Answer: a) Ensures adequate anticoagulation.

14. What is a risk of low hematocrit during CPB?
    a) Reduced oxygen delivery
    b) Increased coagulation
    c) Enhanced platelet function
    d) Decreased inflammation
    Answer: a) Impairs tissue oxygenation.

1.3.2 Short-Answer Questions

1. What is protamine's role in CPB?
   Answer: Neutralizes heparin.
2. Define dilutional coagulopathy.
   Answer: Reduced clotting factors from transfusion.
3. Explain TEG's purpose.
   Answer: Assesses coagulation dynamics.
4. What causes hemolysis in CPB?
   Answer: Pump shear stress damages RBCs.
5. Define transfusion reaction.
   Answer: Immune response to blood.
6. What is the role of ACT in CPB?
   Answer: Monitors heparin anticoagulation.
7. Explain HIT's mechanism.
   Answer: Antibodies activate platelets, causing thrombosis.

1.4 Endocrine & Immunology

1.4.1 Multiple-Choice Questions

1. How does diabetes affect CPB outcomes?
   a) Increases hyperglycemia complications
   b) Reduces inflammation
   c) Enhances coagulation
   d) Decreases oxygen demand
   Answer: a) Raises infection risk.
2. What is a feature of SIRS during CPB?
   a) Cytokine release
   b) Reduced complement
   c) Increased platelets
   d) Decreased neutrophils
   Answer: a) Drives inflammation.
3. What is the effect of cortisol during CPB?
   a) Increases glucose levels
   b) Decreases blood pressure
   c) Reduces inflammation
   d) Enhances anticoagulation
   Answer: a) Stress response elevates glucose.
4. What triggers complement activation in CPB?
   a) Blood-circuit contact

b) Reduced heparin
c) Increased hematocrit
d) Hypothermia
Answer: a) Activates complement.

5. What is a consequence of cytokine storm in CPB?
a) Multi-organ dysfunction
b) Enhanced coagulation
c) Reduced inflammation
d) Increased oxygen delivery
Answer: a) Inflammation harms organs.

6. What is the effect of hypothyroidism on CPB?
a) Increases hypothermia sensitivity
b) Reduces glucose levels
c) Enhances coagulation
d) Decreases inflammation
Answer: a) Slows metabolism.

7. What is the role of IL-6 in SIRS during CPB?
a) Amplifies inflammation
b) Reduces complement
c) Increases platelets
d) Decreases neutrophils
Answer: a) Drives acute phase response.

8. What is a risk of hyperglycemia during CPB?
a) Increased infection
b) Reduced inflammation
c) Enhanced coagulation
d) Decreased oxygen demand
Answer: a) Impairs immune response.

9. What is the effect of adrenal insufficiency in CPB?
a) Inadequate stress response
b) Increased cortisol
c) Reduced inflammation
d) Enhanced glucose control
Answer: a) Risks instability.

10. What is the role of complement in CPB?
a) Triggers immune response
b) Reduces cytokine release
c) Enhances coagulation
d) Decreases edema
Answer: a) Activates inflammation.

11. What is the effect of thyroid hormone on CPB?
a) Regulates metabolism
b) Reduces glucose levels
c) Enhances coagulation
d) Decreases inflammation
Answer: a) Impacts cardiac function.

12. What is a consequence of SIRS in CPB?
a) Increased organ dysfunction
b) Reduced inflammation

c) Enhanced coagulation
d) Decreased oxygen demand
Answer: a) Systemic inflammation harms organs.

13. What is the role of acute phase proteins in CPB?
a) Amplify inflammatory response
b) Reduce complement activation
c) Increase platelet count
d) Decrease neutrophil activity
Answer: a) Support immune response.

14. What is a risk of prolonged inflammation in CPB?
a) Multi-organ failure
b) Reduced cytokine release
c) Enhanced coagulation
d) Increased oxygen delivery
Answer: a) Systemic effects harm organs.

1.4.2 Short-Answer Questions

1. How does hypothyroidism affect CPB?
Answer: Increases hypothermia sensitivity.
2. What is complement activation's role?
Answer: Triggers SIRS inflammation.
3. Explain hyperglycemia's effect in CPB.
Answer: Increases infection risk.
4. Define IL-6's role in SIRS.
Answer: Amplifies inflammatory response.
5. What is adrenal insufficiency?
Answer: Inadequate cortisol response.
6. Explain acute phase response in CPB.
Answer: Liver produces proteins to combat inflammation.
7. Define cytokine storm's impact.
Answer: Causes multi-organ dysfunction.

1.5 Microcirculation & Tissue Perfusion

1.5.1 Multiple-Choice Questions

1. What is a key factor in ischemia-reperfusion injury?
a) Reactive oxygen species
b) Increased capillary permeability
c) Reduced endothelial dysfunction
d) Decreased neutrophil activation
Answer: a) Causes tissue damage.

2. What regulates capillary exchange during CPB?
a) Hydrostatic and oncotic pressures
b) Blood viscosity
c) Platelet aggregation
d) Systemic pH
Answer: a) Drives fluid exchange.

3. What is the role of nitric oxide in microcirculation?
   a) Promotes vasodilation
   b) Increases platelet adhesion
   c) Reduces oxygen delivery
   d) Enhances thrombosis
   Answer: a) Relaxes vascular muscle.
4. What is a consequence of endothelial dysfunction?
   a) Increased vascular permeability
   b) Reduced inflammation
   c) Enhanced coagulation
   d) Decreased edema
   Answer: a) Causes tissue edema.
5. What is the Starling equation used for?
   a) Predict fluid movement
   b) Calculate blood viscosity
   c) Assess platelet function
   d) Measure oxygen delivery
   Answer: a) Describes capillary fluid flux.
6. What is the effect of reactive oxygen species?
   a) Oxidative tissue damage
   b) Reduced inflammation
   c) Enhanced oxygen delivery
   d) Decreased edema
   Answer: a) Harms cells.
7. What is the role of endothelial cells?
   a) Regulate vasodilation
   b) Increase clotting
   c) Reduce oxygen delivery
   d) Enhance thrombosis
   Answer: a) Control vascular tone.
8. What is a risk of microcirculatory dysfunction?
   a) Organ hypoperfusion
   b) Increased hematocrit
   c) Reduced inflammation
   d) Enhanced coagulation
   Answer: a) Impairs perfusion.
9. What is the effect of oncotic pressure?
   a) Opposes fluid movement outward
   b) Increases edema
   c) Enhances thrombosis
   d) Reduces oxygen delivery
   Answer: a) Retains fluid in vessels.
10. What causes reperfusion injury in CPB?
    a) Neutrophil activation
    b) Reduced oxidative stress
    c) Increased hematocrit
    d) Decreased edema
    Answer: a) Releases damaging enzymes.
11. What is the role of Starling forces in microcirculation?

a) Regulate fluid exchange
b) Increase clotting
c) Reduce oxygen delivery
d) Enhance thrombosis
Answer: a) Balance fluid movement.

12. What is a sign of microcirculatory failure in CPB?
a) Increased lactate levels
b) Reduced inflammation
c) Enhanced coagulation
d) Increased hematocrit
Answer: a) Indicates hypoperfusion.

13. What is the effect of nitric oxide synthase inhibition?
a) Vasoconstriction
b) Increased oxygen delivery
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Reduces vasodilation.

14. What is a consequence of prolonged ischemia?
a) Cellular necrosis
b) Increased oxygen delivery
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Tissue death from hypoxia.

1.5.2 Short-Answer Questions

1. Define ischemia-reperfusion injury.
Answer: Damage from restored blood flow.
2. What is endothelial cells' role?
Answer: Regulate vasodilation, clotting.
3. Explain oncotic pressure's role.
Answer: Opposes fluid movement out.
4. Define microcirculatory dysfunction.
Answer: Impaired capillary perfusion.
5. What causes reperfusion injury?
Answer: Oxidative stress, neutrophils.
6. Explain nitric oxide's role.
Answer: Promotes vasodilation.
7. Define Starling forces.
Answer: Pressures regulating capillary fluid.

2 Perfusion Technology & Techniques

2.1 Perfusion Equipment & Technology

2.1.1 Multiple-Choice Questions

1. What is the primary function of an oxygenator in CPB?
   a) Oxygenate blood, remove CO2
   b) Pump blood
   c) Cool blood
   d) Filter microemboli
   Answer: a) Facilitates gas exchange.
2. What is an advantage of centrifugal pumps?
   a) Reduced hemolysis
   b) Higher flow rates
   c) Lower cost
   d) Simpler maintenance
   Answer: a) Less RBC damage.
3. What is the purpose of a heat exchanger in CPB?
   a) Regulate blood temperature
   b) Increase oxygen delivery
   c) Filter clots
   d) Reduce circuit volume
   Answer: a) Controls hypothermia.
4. What is a key feature of ECMO circuits?
   a) Long-term support
   b) Short-term use
   c) No oxygenator
   d) High resistance
   Answer: a) Supports heart/lung function.
5. What is the role of arterial filters in CPB?
   a) Remove microemboli
   b) Increase flow
   c) Cool blood
   d) Store venous blood
   Answer: a) Prevents embolism.
6. What is the function of a venous reservoir?
   a) Collect venous blood
   b) Oxygenate blood
   c) Pump blood
   d) Filter clots
   Answer: a) Allows air removal.
7. What is a benefit of roller pumps?
   a) Precise flow control
   b) Reduced cost
   c) No maintenance
   d) High hemolysis
   Answer: a) Accurate for low volumes.
8. What is the purpose of a bubble trap?

a) Prevent air embolism
b) Increase flow
c) Cool blood
d) Store blood
Answer: a) Removes air bubbles.

9. What is a feature of VAD systems?
a) Support heart function
b) Oxygenate blood
c) Reduce hematocrit
d) Increase hemolysis
Answer: a) Assists cardiac output.

10. What is the role of safety devices in CPB?
a) Prevent air embolism
b) Increase flow
c) Reduce hematocrit
d) Enhance hemolysis
Answer: a) Ensure patient safety.

11. What is the purpose of cannulae in CPB?
a) Connect circuit to vasculature
b) Oxygenate blood
c) Filter clots
d) Reduce circuit volume
Answer: a) Facilitate blood flow.

12. What is a risk of oxygenator failure?
a) Impaired gas exchange
b) Increased flow
c) Reduced hemolysis
d) Enhanced coagulation
Answer: a) Risks hypoxia.

13. What is the role of a cardiotomy reservoir?
a) Collect suctioned blood
b) Oxygenate blood
c) Pump blood
d) Filter clots
Answer: a) Recycles operative blood.

14. What is a benefit of heparin-coated circuits?
a) Reduced thrombosis
b) Increased hemolysis
c) Reduced flow
d) Enhanced inflammation
Answer: a) Improves biocompatibility.

2.1.2 Short-Answer Questions

1. What is a venous reservoir's role?
Answer: Collects venous blood, removes air.
2. Define bubble trap's purpose.
Answer: Prevents arterial air bubbles.
3. Explain roller pump function.

Answer: Compresses tubing for flow.

4. What is ECMO's purpose?
   Answer: Oxygenates blood externally.
5. Define VAD alarms.
   Answer: Alerts for low flow, thrombosis.
6. What is a heparin-coated circuit's benefit?
   Answer: Reduces thrombosis.
7. Explain cardiotomy reservoir's role.
   Answer: Collects suctioned blood for reuse.

2.2 Perfusion Techniques & Clinical Applications

2.2.1 Multiple-Choice Questions

1. What is the goal of hemodilution in CPB?
   a) Reduce blood viscosity
   b) Increase hematocrit
   c) Enhance coagulation
   d) Lower oxygen delivery
   Answer: a) Improves microcirculation.
2. What is alpha-stat management's purpose?
   a) Maintain constant pH and CO2
   b) Adjust pH for temperature
   c) Increase oxygen delivery
   d) Reduce cerebral flow
   Answer: a) Optimizes enzyme function.
3. What is the primary component of Del Nido cardioplegia?
   a) Potassium-rich solution
   b) Sodium chloride
   c) Glucose only
   d) Heparin
   Answer: a) Arrests heart.
4. What is a risk of deep hypothermic circulatory arrest (DHCA)?
   a) Neurologic injury
   b) Increased coagulation
   c) Reduced inflammation
   d) Enhanced oxygen delivery
   Answer: a) Risks brain damage.
5. What is a complication of weaning from CPB?
   a) Low cardiac output
   b) Hypercoagulation
   c) Increased hematocrit
   d) Reduced inflammation
   Answer: a) Poor ventricular function.
6. What is the purpose of priming solutions?
   a) Fill circuit, reduce air
   b) Increase hematocrit
   c) Enhance clotting
   d) Reduce oxygen delivery

Answer: a) Prepares circuit.

7. What is a benefit of pH-stat management?
   a) Optimizes cerebral flow
   b) Reduces CO2
   c) Increases hematocrit
   d) Decreases inflammation
   Answer: a) Adjusts for hypothermia.
8. What is a sign of air embolism in CPB?
   a) Sudden arterial pressure drop
   b) Increased hematocrit
   c) Reduced inflammation
   d) Enhanced coagulation
   Answer: a) Indicates air entry.
9. What is the role of antegrade cerebral perfusion?
   a) Protects brain during DHCA
   b) Increases hematocrit
   c) Reduces flow
   d) Enhances clotting
   Answer: a) Delivers oxygenated blood.
10. What is a goal of blood gas management?
    a) Maintain acid-base balance
    b) Increase hematocrit
    c) Reduce oxygen delivery
    d) Enhance clotting
    Answer: a) Ensures homeostasis.
11. What is the purpose of retrograde cerebral perfusion?
    a) Protect brain during DHCA
    b) Increase hematocrit
    c) Reduce flow
    d) Enhance clotting
    Answer: a) Delivers blood via veins.
12. What is a risk of prolonged CPB time?
    a) Increased inflammation
    b) Reduced hematocrit
    c) Enhanced coagulation
    d) Decreased oxygen demand
    Answer: a) Triggers SIRS.
13. What is the role of ultrafiltration in CPB?
    a) Remove excess fluid
    b) Increase hematocrit
    c) Enhance clotting
    d) Reduce oxygen delivery
    Answer: a) Maintains fluid balance.
14. What is a complication of cardioplegia delivery?
    a) Inadequate myocardial protection
    b) Increased hematocrit
    c) Reduced inflammation
    d) Enhanced coagulation
    Answer: a) Risks ischemia.

2.2.2 Short-Answer Questions

1. What is cardioplegia's purpose?
   Answer: Induces cardiac arrest.
2. Define pH-stat management.
   Answer: Adjusts pH for temperature.
3. Explain priming solutions' purpose.
   Answer: Fills circuit, reduces hemodilution.
4. Define air embolism signs.
   Answer: Pressure drop, neurological deficits.
5. What is retrograde cerebral perfusion?
   Answer: Delivers blood via veins in DHCA.
6. Explain ultrafiltration's role.
   Answer: Removes fluid, maintains hematocrit.
7. Define SIRS in CPB.
   Answer: Systemic inflammation from circuit contact.

2.3 Quality Control & Research

2.3.1 Multiple-Choice Questions

1. What is a key component of CPB circuit sterilization?
   a) Ethylene oxide
   b) Alcohol wipes
   c) Ultraviolet light
   d) Boiling water
   Answer: a) Ensures sterility.
2. What is a focus of perfusion research?
   a) New oxygenator designs
   b) Increased clotting
   c) Reduced flow
   d) Higher hemolysis
   Answer: a) Improves efficiency.
3. What is the purpose of AABB standards?
   a) Ensure blood safety
   b) Reduce circuit volume
   c) Increase flow
   d) Enhance hemolysis
   Answer: a) Regulates transfusion.
4. What is a benefit of biocompatible coatings?
   a) Reduced inflammation
   b) Increased clotting
   c) Higher hemolysis
   d) Reduced flow
   Answer: a) Minimizes immune response.
5. What is the FDA 510(k) process used for?
   a) Approve new devices
   b) Regulate drugs
   c) Monitor outcomes

d) Standardize training
Answer: a) Ensures device safety.

6. What is a goal of quality control in CPB?
a) Ensure equipment reliability
b) Increase hemolysis
c) Reduce flow
d) Enhance clotting
Answer: a) Maintains safety.

7. What is a feature of clinical trials in perfusion?
a) Test new technologies
b) Reduce circuit volume
c) Increase hemolysis
d) Decrease flow
Answer: a) Evaluates innovations.

8. What is a benefit of heparin-coated circuits?
a) Reduced thrombosis
b) Increased hemolysis
c) Reduced flow
d) Enhanced inflammation
Answer: a) Improves biocompatibility.

9. What is the role of regulatory compliance?
a) Ensures patient safety
b) Increases circuit volume
c) Reduces flow
d) Enhances hemolysis
Answer: a) Meets standards.

10. What is a focus of oxygenator research?
a) Improved gas exchange
b) Increased clotting
c) Reduced flow
d) Higher hemolysis
Answer: a) Enhances efficiency.

11. What is the purpose of ISO standards in CPB?
a) Ensure equipment quality
b) Increase hemolysis
c) Reduce flow
d) Enhance clotting
Answer: a) Maintains reliability.

12. What is a benefit of clinical research in perfusion?
a) Evidence-based practice
b) Increased circuit volume
c) Reduced flow
d) Enhanced hemolysis
Answer: a) Improves outcomes.

13. What is the role of biocompatible materials?
a) Reduce immune response
b) Increase clotting
c) Reduce flow
d) Enhance hemolysis

Answer: a) Minimizes complications.

14. What is a goal of perfusion device innovation?
    a) Improve patient outcomes
    b) Increase hemolysis
    c) Reduce flow
    d) Enhance clotting
    Answer: a) Enhances safety, efficiency.

2.3.2 Short-Answer Questions

1. What is quality control's role in CPB?
   Answer: Ensures equipment reliability.
2. Why is clinical research important?
   Answer: Informs evidence-based practice.
3. Explain FDA regulations' purpose.
   Answer: Ensures device safety.
4. Define heparin-coated circuits' benefit.
   Answer: Reduces thrombosis.
5. What are clinical trial phases?
   Answer: Test safety, efficacy, outcomes.
6. Explain AABB standards' role.
   Answer: Ensures blood safety.
7. Define biocompatible materials.
   Answer: Minimize immune response.

2.4 Pediatric Perfusion

2.4.1 Multiple-Choice Questions

1. Why are roller pumps preferred in pediatric CPB?
   a) Precise flow control
   b) Reduced hemolysis
   c) Lower cost
   d) Higher flow
   Answer: a) Suitable for small volumes.
2. What is a common congenital defect requiring CPB?
   a) Tetralogy of Fallot
   b) Mitral stenosis
   c) Aortic aneurysm
   d) Coronary disease
   Answer: a) Common in pediatrics.
3. What is a challenge of neonatal CPB?
   a) Small blood volume
   b) High hematocrit
   c) Reduced inflammation
   d) Large circuit
   Answer: a) Needs low priming.
4. What is the purpose of the Norwood procedure?
   a) Correct hypoplastic left heart

b) Repair mitral valve
c) Bypass coronary arteries
d) Reduce pulmonary flow
Answer: a) Staged repair for HLHS.

5. What is a risk of high flow in pediatric CPB?
a) Cerebral edema
b) Reduced hemolysis
c) Increased coagulation
d) Lowered oxygen demand
Answer: a) Harms microcirculation.

6. What is the goal of the Fontan procedure?
a) Direct venous blood to lungs
b) Repair aortic valve
c) Increase systemic flow
d) Reduce hematocrit
Answer: a) Single ventricle physiology.

7. What is a feature of pediatric CPB circuits?
a) Smaller tubing
b) Higher flow
c) Increased hemolysis
d) Reduced safety
Answer: a) Matches small volumes.

8. What is the role of ultrafiltration?
a) Remove excess fluid
b) Increase hematocrit
c) Enhance clotting
d) Reduce oxygen delivery
Answer: a) Maintains balance.

9. What is a complication of pediatric CPB?
a) Systemic inflammation
b) Reduced flow
c) Increased hematocrit
d) Decreased edema
Answer: a) Triggers SIRS.

10. What is the purpose of the Blalock-Taussig shunt?
a) Increase pulmonary flow
b) Reduce systemic flow
c) Repair mitral valve
d) Enhance coagulation
Answer: a) Improves oxygenation.

11. What is a challenge of pediatric hemodynamics?
a) High metabolic rate
b) Reduced oxygen demand
c) Increased hematocrit
d) Decreased inflammation
Answer: a) Requires precise flow.

12. What is the role of temperature management in pediatric CPB?
a) Prevent hypothermia complications
b) Increase hematocrit

c) Reduce flow
d) Enhance clotting
Answer: a) Neonates are sensitive.

13. What is a feature of single ventricle physiology?
a) Mixed systemic-pulmonary flow
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Requires staged repair.
14. What is a risk of inadequate flow in pediatric CPB?
a) Organ hypoperfusion
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Risks tissue damage.

2.4.2 Short-Answer Questions

1. Why is temperature critical in pediatric CPB?
Answer: Neonates sensitive to hypothermia.
2. Define pediatric CPB circuit challenges.
Answer: Smaller tubing, low priming.
3. Explain Fontan procedure's goal.
Answer: Directs venous blood to lungs.
4. What is ultrafiltration's role?
Answer: Removes fluid, maintains hematocrit.
5. Define neonatal oxygen demand.
Answer: Higher due to metabolism.
6. Explain Blalock-Taussig shunt's purpose.
Answer: Increases pulmonary blood flow.
7. Define single ventricle physiology.
Answer: One ventricle pumps mixed blood.

3 Pharmacology & Emergency Management

3.1 Pharmacology Related to Perfusion

3.1.1 Multiple-Choice Questions

1. Which vasopressor treats hypotension during CPB?
a) Norepinephrine
b) Nitroglycerin
c) Milrinone
d) Protamine
Answer: a) Increases vascular resistance.
2. What is tranexamic acid's effect in CPB?
a) Inhibits fibrinolysis
b) Enhances platelets

c) Increases hematocrit
d) Reduces inflammation
Answer: a) Reduces bleeding.

3. What is the primary effect of milrinone?
a) Inotropic support
b) Anticoagulation
c) Platelet inhibition
d) Vasoconstriction
Answer: a) Enhances contractility.

4. What is the mechanism of bivalirudin?
a) Direct thrombin inhibition
b) Platelet activation
c) Fibrinogen enhancement
d) Complement suppression
Answer: a) Heparin alternative.

5. What is the role of epinephrine in CPB?
a) Increases heart rate, contractility
b) Reduces blood pressure
c) Enhances anticoagulation
d) Decreases oxygen demand
Answer: a) Supports hemodynamics.

6. What is the effect of mannitol in CPB?
a) Reduces cerebral edema
b) Increases clotting
c) Reduces oxygen delivery
d) Enhances inflammation
Answer: a) Draws fluid from tissues.

7. What is the purpose of amiodarone in CPB?
a) Treat arrhythmias
b) Increase hematocrit
c) Reduce inflammation
d) Enhance clotting
Answer: a) Stabilizes rhythm.

8. What is the effect of nitroglycerin in CPB?
a) Dilates coronary arteries
b) Increases clotting
c) Reduces oxygen delivery
d) Enhances inflammation
Answer: a) Improves perfusion.

9. What is the role of vasopressin in CPB?
a) Vasoconstriction
b) Platelet inhibition
c) Anticoagulation
d) Reduced contractility
Answer: a) Supports blood pressure.

10. What is the effect of methylprednisolone?
a) Reduces inflammation
b) Increases clotting
c) Reduces oxygen delivery

d) Enhances hemolysis
Answer: a) Mitigates SIRS.

11. What is the purpose of dopamine in CPB?
a) Inotropic support
b) Anticoagulation
c) Platelet inhibition
d) Vasodilation
Answer: a) Enhances contractility.
12. What is the effect of sevoflurane in CPB?
a) Provides anesthesia
b) Increases clotting
c) Reduces oxygen delivery
d) Enhances inflammation
Answer: a) Maintains sedation.
13. What is the role of aprotinin in CPB?
a) Inhibits fibrinolysis
b) Increases hematocrit
c) Reduces inflammation
d) Enhances clotting
Answer: a) Reduces bleeding.
14. What is a risk of inotrope overdose in CPB?
a) Arrhythmias
b) Reduced contractility
c) Decreased oxygen demand
d) Enhanced anticoagulation
Answer: a) Overstimulation causes instability.

3.1.2 Short-Answer Questions

1. What is nitroglycerin's role in CPB?
Answer: Dilates coronary arteries.
2. Define bivalirudin's mechanism.
Answer: Inhibits thrombin.
3. Explain milrinone's effect.
Answer: Increases contractility.
4. What is mannitol's purpose?
Answer: Reduces cerebral edema.
5. Define antifibrinolytic agents.
Answer: Prevent clot breakdown.
6. Explain vasopressin's role.
Answer: Vasoconstriction for hypotension.
7. What is aprotinin's effect?
Answer: Inhibits fibrinolysis, reduces bleeding.

3.2 Renal, Neurologic, and Patient Monitoring

3.2.1 Multiple-Choice Questions

1. What does NIRS monitor during CPB?
   a) Cerebral oxygenation
   b) Blood flow rate
   c) Coagulation status
   d) Arterial pH
   Answer: a) Detects ischemia.
2. What does high lactate indicate during CPB?
   a) Tissue hypoperfusion
   b) Excessive oxygen
   c) Stable hemodynamics
   d) Normal metabolism
   Answer: a) Inadequate perfusion.
3. What is the purpose of BIS monitoring?
   a) Assess anesthesia depth
   b) Measure cerebral flow
   c) Monitor coagulation
   d) Detect embolism
   Answer: a) Prevents awareness.
4. What is a primary cause of AKI during CPB?
   a) Hypoperfusion
   b) Hyperoxia
   c) Increased hematocrit
   d) Reduced inflammation
   Answer: a) Causes tubular damage.
5. What does low SvO2 indicate during CPB?
   a) Inadequate oxygen delivery
   b) Excessive flow
   c) Normal perfusion
   d) Reduced metabolism
   Answer: a) High oxygen extraction.
6. What is the role of EEG in CPB?
   a) Detect cerebral ischemia
   b) Measure hematocrit
   c) Monitor clotting
   d) Assess renal function
   Answer: a) Identifies brain activity changes.
7. What is a risk of stroke during CPB?
   a) Embolic events
   b) Increased hematocrit
   c) Reduced inflammation
   d) Enhanced coagulation
   Answer: a) Debris causes stroke.
8. What is the purpose of antegrade cerebral perfusion?
   a) Protect brain during DHCA
   b) Increase hematocrit

c) Reduce flow
d) Enhance clotting
Answer: a) Delivers oxygenated blood.

9. What is a sign of renal dysfunction?
a) Decreased urine output
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Indicates AKI.

10. What is the role of lactate clearance?
a) Assess perfusion adequacy
b) Measure hematocrit
c) Monitor clotting
d) Evaluate oxygen delivery
Answer: a) Reflects tissue perfusion.

11. What is the purpose of transcranial Doppler in CPB?
a) Monitor cerebral blood flow
b) Measure hematocrit
c) Monitor clotting
d) Assess renal function
Answer: a) Detects emboli, flow changes.

12. What is a risk of inadequate cerebral perfusion?
a) Neurologic injury
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Risks brain damage.

13. What is the role of SvO2 monitoring?
a) Assess oxygen delivery
b) Measure hematocrit
c) Monitor clotting
d) Evaluate renal function
Answer: a) Reflects tissue oxygenation.

14. What is a sign of cerebral ischemia during CPB?
a) Decreased NIRS values
b) Increased hematocrit
c) Reduced inflammation
d) Enhanced coagulation
Answer: a) Indicates low oxygen.

3.2.2 Short-Answer Questions

1. What does low SvO2 indicate?
Answer: Inadequate oxygen delivery.
2. Define BIS's role in CPB.
Answer: Monitors anesthesia depth.
3. Explain AKI's cause in CPB.
Answer: Hypoperfusion damages tubules.

4. What is EEG's role in CPB?
   Answer: Detects cerebral ischemia.
5. Define lactate clearance.
   Answer: Rate of lactate metabolism.
6. Explain NIRS's purpose.
   Answer: Monitors cerebral oxygenation.
7. What is transcranial Doppler's role?
   Answer: Monitors cerebral blood flow.

3.3 Emergencies & Infection Control

3.3.1 Multiple-Choice Questions

1. What is the first step in managing air embolism?
   a) Stop the pump
   b) Increase heparin
   c) Administer thrombolytics
   d) Increase flow
   Answer: a) Prevents air entry.
2. What is a key strategy for infection control?
   a) Antibiotic prophylaxis
   b) Increased circuit exposure
   c) Reduced sterilization
   d) Higher flow
   Answer: a) Prevents infections.
3. What is a cause of oxygenator failure?
   a) Clot formation
   b) High flow
   c) Low heparin
   d) Excessive hypothermia
   Answer: a) Obstructs gas exchange.
4. What is the effect of severe hypotension?
   a) Organ hypoperfusion
   b) Increased coagulation
   c) Enhanced oxygen
   d) Reduced inflammation
   Answer: a) Risks ischemia.
5. What is a sign of sepsis post-CPB?
   a) Fever and tachycardia
   b) Increased hematocrit
   c) Reduced lactate
   d) Stable blood pressure
   Answer: a) Indicates infection.
6. What is the management of circuit thrombosis?
   a) Increase heparin, replace component
   b) Reduce flow
   c) Increase hematocrit
   d) Decrease anticoagulation
   Answer: a) Restores function.

7. What is a protocol for power failure?
   a) Switch to backup power
   b) Increase flow
   c) Reduce heparin
   d) Enhance cooling
   Answer: a) Maintains pump function.
8. What is a risk of inadequate anticoagulation?
   a) Circuit clotting
   b) Increased hematocrit
   c) Reduced inflammation
   d) Enhanced oxygen delivery
   Answer: a) Risks thrombosis.
9. What is the role of vancomycin in CPB?
   a) Prevent bacterial infection
   b) Increase hematocrit
   c) Reduce inflammation
   d) Enhance clotting
   Answer: a) Prophylactic antibiotic.
10. What is a sign of pump failure in CPB?
    a) Decreased arterial pressure
    b) Increased hematocrit
    c) Reduced inflammation
    d) Enhanced coagulation
    Answer: a) Indicates flow loss.
11. What is the management of massive air embolism?
    a) Trendelenburg position, aspirate air
    b) Increase flow
    c) Reduce heparin
    d) Enhance cooling
    Answer: a) Removes air from circuit.
12. What is a risk of bacterial contamination in CPB?
    a) Sepsis
    b) Increased hematocrit
    c) Reduced inflammation
    d) Enhanced coagulation
    Answer: a) Systemic infection.
13. What is the role of cefazolin in CPB?
    a) Prevent bacterial infection
    b) Increase hematocrit
    c) Reduce inflammation
    d) Enhance clotting
    Answer: a) Prophylactic antibiotic.
14. What is a sign of electrical failure in CPB?
    a) Loss of pump function
    b) Increased hematocrit
    c) Reduced inflammation
    d) Enhanced coagulation
    Answer: a) Risks circulation stoppage.

3.3.2 Short-Answer Questions

1. How is oxygenator failure managed?
   Answer: Replace oxygenator, maintain ventilation.
2. Define antibiotic prophylaxis's role.
   Answer: Prevents infections.
3. Explain circuit thrombosis management.
   Answer: Increase heparin, replace components.
4. What is power failure protocol?
   Answer: Backup power, hand-crank pump.
5. Define septic shock in CPB.
   Answer: Hypotension from infection.
6. Explain air embolism management.
   Answer: Stop pump, aspirate air, Trendelenburg.
7. What is cefazolin's role?
   Answer: Prophylactic antibiotic.

3.4 Blood Conservation, Ethical, and Psychosocial Considerations

3.4.1 Multiple-Choice Questions

1. What is the purpose of cell salvage in CPB?
   a) Reduce allogeneic transfusion
   b) Increase hematocrit
   c) Enhance coagulation
   d) Prevent hemolysis
   Answer: a) Reinfuses patient blood.
2. What is a key psychosocial skill for perfusionists?
   a) Effective team communication
   b) Increased bypass time
   c) Reduced monitoring
   d) Lower heparin
   Answer: a) Ensures coordination.
3. What is a strategy for Jehovah's Witness patients?
   a) Bloodless surgery
   b) Increased transfusion
   c) Reduced anticoagulation
   d) Prolonged bypass
   Answer: a) Uses cell salvage.
4. What is the purpose of informed consent?
   a) Ensure patient autonomy
   b) Reduce surgical time
   c) Increase heparin
   d) Enhance monitoring
   Answer: a) Informs risks.
5. What is a potential malpractice issue?
   a) Failure to monitor
   b) Increased circuit volume
   c) Reduced flow

d) Enhanced coagulation
Answer: a) Risks harm.

6. What is the role of tranexamic acid?
a) Inhibits fibrinolysis
b) Increases hematocrit
c) Enhances clotting
d) Reduces oxygen delivery
Answer: a) Reduces bleeding.

7. What is a benefit of patient education?
a) Improves compliance
b) Increases hematocrit
c) Reduces flow
d) Enhances hemolysis
Answer: a) Enhances understanding.

8. What is an ethical issue in CPB?
a) Respecting patient beliefs
b) Increasing bypass time
c) Reducing monitoring
d) Enhancing hemolysis
Answer: a) Ensures autonomy.

9. What is a role of team communication?
a) Reduces errors
b) Increases hematocrit
c) Reduces flow
d) Enhances hemolysis
Answer: a) Improves safety.

10. What is a strategy for blood conservation?
a) Use of antifibrinolytics
b) Increased transfusion
c) Reduced anticoagulation
d) Prolonged bypass
Answer: a) Minimizes bleeding.

11. What is the purpose of autologous blood donation?
a) Reduce allogeneic transfusion
b) Increase hematocrit
c) Enhance coagulation
d) Prevent hemolysis
Answer: a) Uses patient's blood.

12. What is a psychosocial challenge in CPB?
a) Patient anxiety
b) Increased hematocrit
c) Reduced flow
d) Enhanced hemolysis
Answer: a) Requires counseling.

13. What is the role of ethical decision-making?
a) Balances patient rights, care
b) Increases bypass time
c) Reduces monitoring
d) Enhances hemolysis

Answer: a) Ensures fair treatment.

14. What is a benefit of preoperative counseling?
    a) Reduces patient anxiety
    b) Increases hematocrit
    c) Reduces flow
    d) Enhances hemolysis
    Answer: a) Improves outcomes.

3.4.2 Short-Answer Questions

1. Define tranexamic acid's role.
   Answer: Inhibits fibrinolysis.
2. Why is informed consent critical?
   Answer: Ensures patient autonomy.
3. Explain cell salvage's role.
   Answer: Reinfuses patient blood.
4. Define team communication's importance.
   Answer: Reduces errors.
5. What is malpractice in CPB?
   Answer: Negligence causing harm.
6. Explain Jehovah's Witness protocols.
   Answer: Bloodless techniques, antifibrinolytics.
7. Define patient autonomy.
   Answer: Right to make care decisions.