01

CHAPTER 01
PHYSIOLOGY

High-yield revision notes for BMDC examination

CHAPTER 01 - PHYSIOLOGY

Sites Of Undescended Testis

- In the abdomen just above the internal ring, extra peritoneally
- Inguinal canal
- Superficial inguinal ring
- Deep inguinal ring
- Root of the scrotum

Sites Of Ectopic Testis

- Superficial inguinal pouch
- Perineum
- Root of the penis / under skin of penis
- Femoral triangle or canal
- Skin of lower part of abdomen
- Under skin of front of thigh
- Perineum behind scrotum
- Peno-pubic area

Hemodynamic Effect Of Respiration

- **Inspiration**
  - JVP falls
  - Blood pressure falls
  - Heart rate accelerated
  - Second heart sound split
- **Expiration**
  - JVP rises
  - Blood pressure rises
  - Heart rate slow
  - 2nd heart sound fuses

Physiological Role Of Surfactant

- Dipalmityl lecithin decreases surface tension of alveolar fluid lining
- Prevents lung collapse during expiration
- Prevents pulmonary edema
- Helps expansion of newborn lungs, prevents IRDS
- Has bactericidal effects

- Increases compliance & stability of lungs
- Helps expiration of lungs
- Reduces elastic recoil pressure
- Stabilizes size of alveoli
- Reduces pulmonary capillary filtration

Deficiency Of Surfactant Causes

- Respiratory distress syndrome
- Lung edema
- Inequality of alveoli
- Lung collapse
- Pneumonia

Factors Shifting Oxygen-Hb Curve To Right

- H+ increase, pH decrease
- PCO2 increase
- Temperature increase
- 2,3-DPG increase
- HbS (abnormal hemoglobin)
- P50 increase
- PO2 increase
- High altitude (oxygen decrease)
- Hypoxia
- Exercise
- Thyrotoxicosis (high T3, T4)
- Polycythemia, erythrocytosis

Causes Of Hypoxic Hypoxia

- Deficiency of oxygen at high altitude
- Hypoventilation
- Neuromuscular disease
- Ventilation-perfusion imbalance
- Poliomyelitis
- Collapse of lung
- Obstruction of air passage
- Pneumothorax, pneumonia, asthma, emphysema
- Pulmonary edema

Causes Of Anemic Hypoxia

- Anemia
- Carbon monoxide (CO) poisoning
- Abnormal Hb

Causes Of Stagnant/Ischemic Hypoxia

- Congestive cardiac failure
- Hemorrhage
- Shock
- Decreased venous return to heart

Causes Of Histotoxic Hypoxia

- Cyanide poisoning
- Narcotics

Effects Of Hypercapnia

- Dyspnea
- Acidosis (CO_2 increase, pH falls)
- Tachycardia, hypertension, flushing skin
- Peripheral vasodilation
- Headache, depression, laziness
- Fine tremors
- Generalized convulsion

Causes Of Hypercapnia

- Brainstem lesion
- Central sleep apnea
- Peripheral neuropathy
- Myasthenia
- Myopathy
- Kyphoscoliosis
- Ankylosing spondylitis
- Trauma
- Chronic obstructive airway disease

Respiratory Failure

- **Type 1 (acute)**
  - Acute asthma

    - Pulmonary edema
    - Pneumonia
    - Lobar collapse
    - Pneumothorax
    - Pulmonary embolism
    - ARDS
- **Type 1 (chronic)**
    - COPD
    - Lung fibrosis
    - Lymphangitis carcinomatosa
    - Right-to-left shunt
- **Type 2 (acute)**
    - Acute severe asthma
    - Acute exacerbation of COPD
    - Upper airway obstruction
    - Acute neuropathy/paralysis
    - Narcotic drugs
    - Pulmonary alveolar hypoventilation
    - Flail chest injury
- **Type 2 (chronic)**
    - Cyanosis
    - Sleep apnea
    - Kyphoscoliosis
    - Myopathies, muscular dystrophy
    - Ankylosing spondylitis
    - Flapping tremor
    - Hypercapnia

Causes Of Vasodilation

- Increased CO2, decreased O2
- Increased K+, H+, adenosine, lactate
- Increased local temperature
- Decreased local pH
- Nitric oxide
- Kinins, histamine, bradykinin, prostaglandin, prostacyclin
- Epinephrine (vasodilation in skeletal muscle & liver only)
- Serotonin

- Substance P
- ANP (Atrial natriuretic peptide)
- VIP (Vasoactive intestinal polypeptide)
- CGRP-alpha

Causes Of Bradycardia

- Fear
- Increased baroreceptor activity
- Increased intracranial pressure
- Norepinephrine
- Expiration
- Coughing reflex
- Stimulation of pain fibers in trigeminal nerve
- Stimulation of parasympathetic nerve
- Sleep
- Athletes
- Hypothermia
- Hypothyroidism
- Heart attack (MI)
- Congenital heart disease
- Degenerative aging
- Obstructive jaundice
- Drugs: beta-blockers, calcium channel blockers, antiarrhythmics, digoxin

Conditions With Decreased ESR

- Polycythemia
- Sickle cell anemia
- Congestive cardiac failure
- Afibrinogenemia
- Spherocytosis
- Macrocytosis
- Hyperviscosity
- Decreased fibrinogen level
- Severe leukocytosis

Target Cell (Causes)

- Liver disease

- Post-splenectomy
- Thalassemia
- Hemoglobin C disease

Classification Of Anemia

- **Microcytic hypochromic anemia**
  - Iron deficiency anemia
  - Thalassemia
  - Anemia of chronic disease
  - Sideroblastic anemia
  - Lead poisoning
- **Macrocytic anemia**
  - Megaloblastic anemia
  - Macronormoblastic erythropoiesis
  - Vitamin B12 deficiency
  - Folic acid deficiency
- **Normocytic normochromic anemia**
  - Acute blood loss
  - Anemia due to depression of erythropoiesis
  - Hemolytic anemia

Causes Of Iron Deficiency Anemia

- Menstrual blood loss
- GI blood loss (occult gastric/colorectal malignancy, gastritis, peptic ulcer, IBD, diverticulitis, polyps, angiodysplasia, hookworm, schistosomiasis, esophagitis, esophageal cancer)
- Menorrhagia
- Diphyllobothriasis
- Drugs: aspirin, NSAIDs
- Hemoptysis
- Hematuria
- Hematemesis
- Melena
- Pregnancy, breastfeeding
- Proton pump inhibitors, hypochlorhydria
- Celiac disease
- Increased reticulocytes

Blood Film In Iron Deficiency Anemia

- Microcytic hypochromic cells
- Occasional target cells
- Pencil-shaped cells
- Reticulocyte increase
- Platelet count increase

Hemolytic Anemia

- **Hallmark of hemolysis**
  - Increased LDH
  - Increased unconjugated bilirubin (UCB)
  - Increased reticulocytes
  - Increased urobilinogen
  - Decreased haptoglobin
- **Additional features of intravascular hemolysis**
  - Decreased hemoglobin
  - Increased methaemalbumin (MHA)
  - Positive urinary hemosiderin
  - Hemoglobinuria

Blood Clotting Factors

- I: Fibrinogen
- II: Prothrombin
- III: Thromboplastin
- IV: Calcium
- V: Proaccelerin (labile factor)
- VII: Proconvertin (stable factor)
- VIII: Antihemophilic factor A (AHF)
- IX: PTC/Christmas factor/AHF-B
- X: Stuart-Prower factor
- XI: PTA/AHF-C
- XII: Hageman factor (glass factor)
- XIII: Fibrin stabilizing factor
- **Site of synthesis**
  - Liver: all clotting factors except calcium
  - Platelets: I, IV, V and vWF

- **Essential coagulation factors**
  - I, II, III, IV
- **Pathways**
  - Common pathway: 1, 2, 5, 10 - PT + APTT increased
  - Intrinsic pathway: 8, 9, 11, 12 - APTT increased
  - Extrinsic pathway: 3, 7 - PT increased

Causes Of Increased BT/CT/PT/APTT

- **Increased BT (bleeding time)**
  - Thrombocytopenia
  - Thrombasthenia / abnormal platelet function
  - Aspirin, clopidogrel
  - von Willebrand disease (vWD)
  - DIC
- **Increased CT (clotting time)**
  - All clotting factor deficiency
  - Anticoagulants
  - DIC
- **Increased PT**
  - Liver disease
  - DIC
  - Warfarin therapy
  - Deficiency of factors 1, 2, 5, 7, 10
- **Increased APTT**
  - Deficiency of factors 1, 2, 5, 8, 9, 10, 11, 12
  - Defect in intrinsic & common pathway
  - Hemophilia A & B
  - vWD
  - DIC
- **Hemophilia patient**
  - BT normal
  - PT normal
  - CT increased
  - APTT increased
- **Factor VII deficiency**
  - BT normal
  - APTT normal

- PT increased
- CT increased

- **Liver failure**
  - BT normal
  - CT increased
  - APTT increased
  - PT increased

Disseminated Intravascular Coagulation (DIC)

- **Diagnosis of DIC**
  - Low platelet count
  - Low factors 1, 2, 5, 8, 10
  - High BT, CT, PT, APTT, thrombin time; low fibrinogen
  - Positive D-dimer
  - High fibrin degradation products (FDP)
  - Low thromboplastin generation time
- **Causes of DIC**
  - Infections: Gram-negative & meningococcal septicemia, severe falciparum malaria, viruses (HIV, hepatitis, varicella, CMV)
  - Malignancy
  - Obstetric complications: amniotic fluid embolism, placental abruption, eclampsia/pre-eclampsia, retained placenta, septic abortion, IUD
  - Hypersensitivity reactions
  - Anaphylaxis
  - Incompatible blood transfusion
  - Widespread tissue damage
  - Surgery or trauma
  - Severe burns
  - Vascular abnormality
  - Kasabach-Merritt syndrome
  - Leaking prosthetic valves
  - Cardiac bypass surgery
  - Vascular aneurysms
  - Miscellaneous: liver failure, pancreatitis, snake venom, hypo/hyperthermia, heat stroke, acute hypoxia, massive blood loss

Diagnostic Features Of Beta-Thalassemia

- **Major (homozygous)**
  - Profound hypochromic anemia
  - Evidence of severe red cell dysplasia
  - Erythroblastosis
  - Absence or gross reduction of HbA
  - Raised HbF
  - Both parents have thalassemia minor
- **Minor (heterozygous)**
  - Mild anemia
  - Microcytic hypochromic erythrocytes (not iron-deficient)
  - Some target cells
  - Punctate basophilia
  - Raised HbA2 fraction

Pre-Transfusion Screening Tests

- HBsAg
- VDRL
- MP (malaria parasite) test
- Anti-HCV
- Anti-HIV
- Blood group
- Rh status

Hazards Of Blood Transfusion

- Febrile reaction
- Allergic reaction (Type II hypersensitivity)
- Hemolysis
- Unconjugated jaundice
- Circulatory overload
- Renal failure
- Transmission of disease
- Viral hepatitis
- AIDS
- Syphilis
- Malaria
- Protozoal & bacterial infection

- Reaction due to infected blood
- Thrombophlebitis
- Hemosiderosis
- Post-transfusion purpura
- Hyperthermia

Hazards Of Massive Blood Transfusion

- Fluid overload
- Thrombocytopenia
- Hypocalcemia
- Hypomagnesemia
- Hypothermia
- Citrate toxicity
- Hypo & hyperkalemia
- Hypo & hypernatremia
- Left shift of O2-Hb curve
- Definition: 100% blood replaced within 24h, or 50% within 12h

Endocrine Functions Of Kidney

- Erythropoietin formation in response to hypoxia
- Secretes renin (converts angiotensinogen to angiotensin I)
- Forms active vitamin D (1,25-dihydroxycholecalciferol)
- Produces prostaglandins (PGI2, PGE2), nitric oxide, EDRF
- Maintains blood glucose during prolonged fasting via gluconeogenesis
- Important site for degradation of polypeptide hormones (insulin, glucagon, PTH)

Relaxation Of Mesangial Cells

- ANP
- Dopamine
- Prostaglandin E2
- cAMP
- Bradykinin
- Nitric oxide (NO)

Conditions Increasing Renin

- Increased sympathetic activity
- Increased circulating catecholamines
- Prostaglandins

- Sodium depletion
- Diuretics
- Hypotension
- Hemorrhage
- Upright posture
- Dehydration
- Cardiac failure
- Liver cirrhosis
- Constriction of renal artery or aorta
- Various psychological stimuli

Substances Used To Measure GFR

- Inulin (gold standard)
- Creatinine
- Mannitol
- Radioiodine-labeled hippuran
- EDTA

Characteristics Of Inulin

- Freely filtered
- Not reabsorbed
- Nontoxic
- Not stored in kidney
- No effect on filtration rate
- Not metabolized in body
- Easily measured in plasma and urine

Hormone Classification By Chemistry

- **Amino acid derivatives**
  - Thyroid: T4 (thyroxine), T3 (triiodothyronine), calcitonin
  - Adrenal medulla: catecholamines (epinephrine, norepinephrine)
  - Other: prolactin-inhibitory hormone (dopamine)
- **Steroid hormones**
  - Adrenal cortex: aldosterone, deoxycorticosterone, corticosterone, cortisol, DHEA/testosterone, androstenedione, estrogen
  - Other: progesterone, glucocorticoids (cortisol), mineralocorticoids, vitamin D (calcitriol)

Pituitary Hormones

- GH (growth hormone / somatotropin) - acts on liver & other cells
- PRL (prolactin) - acts on breast
- TSH - thyroid gland
- FSH - ovaries & testes
- LH (luteinizing hormone) - ovaries & testes
- ACTH (corticotropin) - adrenal cortex

Clinical Features Of Hyperthyroidism

- Sweating
- Increased body temperature
- Warm vasodilated skin
- Heat intolerance
- Increased plasma glucose
- Weight loss
- Negative nitrogen balance
- Amenorrhea/oligomenorrhea
- Loss of libido
- Low blood triglycerides
- Fatigue
- Hypertension
- Alopecia
- Infertility, spontaneous abortion
- Decreased sleep

Clinical Features Of Hypothyroidism

- Feeling of coldness
- Cold intolerance
- Dry skin
- Positive nitrogen balance
- Weight gain
- Menorrhagia
- Poor libido
- Fatigue, carpal tunnel syndrome
- Alopecia
- Infertility
- Increased sleep

- Hypertension
- Anemia

Clinical Features Of Cushing Syndrome

- Hair thinning
- Hirsutism
- Alopecia
- Acne
- Plethora
- Moon face
- Peptic ulcer
- Loss of height & back pain (compression fracture)
- Hyperglycemia
- Menstrual disturbance
- Exuberant callus with fracture
- Osteoporosis
- Tendency to infection, poor wound healing
- Psychosis
- Cataract, mild exophthalmos
- Hypertension
- Centripetal obesity
- Striae
- Decreased skin thickness
- Wasting & weakness of proximal thigh muscles
- Bruising

Clinical Features Of Acromegaly

- Headache
- Enlargement of lips, nose & tongue
- Cardiomyopathy
- Cardiovascular disease
- Hypertension
- Hepatomegaly
- Enlarged hands
- Enlarged feet
- Increased heel pad thickness
- Arthropathy

- Carpal tunnel syndrome
- Prominent skull growth
- Supraorbital ridge with large frontal sinuses
- Prognathism, increased sweating
- Thickened skin
- Type 2 diabetes (IGT)
- Colonic cancer & myopathy

Insulin-Insensitive Cells

- RBC
- Leukocytes (WBC)
- Neurons
- Renal tubular cells
- Hepatocytes
- Enterocytes
- Pancreatic beta cells
- Placenta
- Retinal cells
- Lens & cornea

GLUT-4 Tissues

- Skeletal muscle
- Cardiac muscle
- Adipose tissue

Stimulators Of HCl Secretion

- Acetylcholine
- Histamine
- Gastrin
- Alcohol
- Caffeine
- Calcium
- Epinephrine
- Amino acids
- Hypoglycemia
- Gastric distension
- Presence of protein in food

- Anticipation or smell of food
- Vagal stimulation

Functions Of HCl

- Converts pepsinogen to active pepsin
- Provides acidic environment for pepsin
- Kills ingested bacteria
- Stimulates flow of bile & pancreatic juice
- Keeps iron in ferrous state for absorption
- Hydrolyzes sucrose into glucose & fructose

Bile Salts

- Sodium taurocholate
- Potassium taurocholate
- Sodium glycocholate
- Potassium glycocholate

Liver Functions

- **Storage**
  - Carbohydrates as glycogen
  - Vitamins A, D, B12
  - Iron as ferritin
- **Synthesis**
  - Plasma proteins (except immunoglobulins)
  - Vitamin D (25-hydroxycholecalciferol)
  - Urea
  - Natural anticoagulants
  - Albumin
  - Complement factors
  - Haptoglobin
  - Ceruloplasmin
  - Transferrin
  - Erythropoietin
  - Alpha-1 antitrypsin
- **Excretion**
  - Bile salts
  - Bilirubin

    - Drugs
    - Phospholipids
    - Cholesterol
- **Liver function tests**
    - Total protein
    - Serum albumin
    - Prothrombin time (factors 2,7,9,10 are vitamin K dependent)
    - Serum bilirubin
    - Albumin/globulin ratio
    - Alkaline phosphatase
    - SGPT (ALT)
    - SGOT (AST)
    - GGT