Solve of BPSC syllabus:

Epithelial tissue:

Functions of epithelium: Protection, Absorption, secretion, and ion transport, Filtration, Forms slippery surfaces

Classification & Naming of Epithelial tissue

- ✓ Squamous – cells wider than tall (plate or "scale" like)
- ✓ Cuboidal – cells are as wide as tall, as in cubes
- ✓ Columnar – cells are taller than they are wide, like columns

The name may also include any accessory structures : Goblet cells**,**Cilia**,**Keratin

Simple Squamous Epithelium:	**Simple Cuboidal Epithelium:**	**Simple Columnar Epithelium**
Functions : ☐ Passage of materials by passive diffusion and filtration ☐ Secretes lubricating substances in serosa **Location:** Renal corpuscles, Alveoli of lungs , Lining of heart, blood and lymphatic vessels,Lining of ventral body cavity (serosae)	**Function :** secretion and absorption **Location** : ✓ kidney tubules, ✓ secretory , portions of small glands, ✓ ovary & thyroid follicles	**Function :** ☐ Absorption; secretion of mucus, enzymes, ☐ Ciliated type propels mucus or reproductive cells **Location :** ☐ Non-ciliated form :Lines digestive tract, gallbladder, ducts of some glands ☐ Ciliated form : Lines small bronchi, uterine tubes, uterus

Pseudostratified Columnar Epithelium	**Stratified Squamous Epithelium**	**Transitional Epithelium**
Locations: **Non-ciliated type** :Ducts of male reproductive tubes , Ducts of large glands **Ciliated variety:** Lines trachea and most of upper respiratory tract**.**	**Function:**Protects underlying tissues in areas subject to abrasion **Location :** ✓ Keratinized – forms epidermis ✓ Non-keratinized – forms lining of esophagus, mouth, and vagina	Basal cells usually cuboidal or columnar, Superficial cells dome-shaped or squamous **Function:** stretches and permits distension of urinary bladder **Location :** Lines ureters, urinary bladder and part of urethra

Skeletal Muscle Tissue	**Smooth Muscle Tissue**	**Cardiac Muscle Tissue**
Characteristics: Long, cylindrical cells, Multinucleate , Obvious striations present. **Functions:** ➢ Voluntary movement ➢ Manipulation of environment ➢ Facial expression **Location:** Skeletal muscles attached to bones (occasionally to skin)	**Characteristics:** Spindle-shaped cells with central nucleus,Arranged closely to form sheets, No striations **Functions:** ✓ Propels substances along internal passageways ✓ Involuntary control **Location**: Mostly walls of hollow organs	➢ **Characteristics**: Branching cells, Uni-nucleate, Intercalated discs must present ➢ **Function:** Contracts to propel blood into circulatory system ➢ **Location** : Occurs in walls of heart

Connective Tissue

Main classification: Connective tissue proper**,** Blood – Fluid connective tissue**,** Cartilage**,** Bone tissue

Components of connective tissue: Cells (varies according to tissue)**,** Matrix

Cells found in connective tissue proper Fibroblasts, Macrophages, lymphocytes (antibody producing cells), Adipocytes (fat cells), Mast cells, Plasma cells , Stem cells

Fibers:

- ✓ Collagen – very strong & abundant, long & straight
- ✓ Elastic – branching fibers with a wavy appearance (when relaxed)
- ✓ Reticular – form a network of fibers that form a supportive framwork in soft organs (i.e. Spleen & liver)

Hyaline Cartilage	**Elastic Cartilage**	**Fibrocartilage**
Function	**Function**	**Function**
Supports and reinforces	Maintains shape of structure	Tensile strength and ability
Resilient cushion	Allows great flexibility	absorb compressive shock
Resists repetitive stress	**Location**	**Location**
Location:	Auricle,auditory tube	Intervertebral discs
Ends of long bones	Epiglottis	Pubic symphysis
Costal cartilage of ribs		Meniscus
Cartilages of nose,		Acetabular labrum
trachea, and larynx		

Nervous Tissue

- ✓ Function: Transmit electrical signals from sensory receptors to effectors
- ✓ Location : Brain, spinal cord, and nerves
- ✓ .Contains two types of cells: Neurons – excitatory cells, Supporting cells (neuroglial cells)

Events of hemostasis are:

a) Vascular constriction
b) Formation of platelet plug
c) Formation of blood clot as a result of blood coagulation
d) Eventual growths of fibrous tissue

Essential / primary clotting factors:

- Factor I – Fibrinogen
- Factor II – Prothrombin
- Factor III – Tissue factor
- Factor IV – Calcium ion (Ca^{++})

Vitamin-K dependant blood clotting factors:

- Factor II – Prothrombin
- Factor VII – Stable factor
- Factor IX – Christmas factor
- Factor X – Stuart-Prower factor

Differences between extrinsic and intrinsic pathway

Traits	Extrinsic pathway	Intrinsic pathway
1) Initiation	Begins with the trauma to blood vessel or exposure of blood to extravascular tissue	Begins with trauma to blood itself or exposure of blood to sub-endothelial matrix
2) Clotting factors involved in prothrombin activation	Factor III, IV, V, VII, X	Factor IV, V, VIII,IX, X, XI, XII
3) Duration	Rapid process	Slower process

Events of cardiac cycle:

a) Atrial events:

Atrial systole
Atrial diastole .

b) Ventricular events:

Ventricular systole

- Isometric contraction
- Minimum ejection
- Maximum ejection
- Reduced ejection

Ventricular diastole

- Protodiastole
- Isometric relaxation
- First rapid filling
- Slow filling
- Last rapid filling

Products of cardiac cycle:

1) **Changes in pressure:**
   - Intra-atrial pressure change
   - Intra-ventricular pressure change
   - Pressure changes in aorta
   - Pressure changes within pulmonary artery
2) **Changes in volume:**
   - Atrial volume change
   - Ventricular volume change
3) Production of heart sounds.
4) Production of apex beat.
5) Production of pulse.
6) Electrical changes (studied by ECG).

Waves & segments of a normal ECG:

- **P wave:** Represents atrial depolarization.
- **P-R interval:** Represents the time taken for the cardiac impulse to spread over the atrium and through AV node and His' Purkinje system.
- **QRS:** Represents ventricular depolarization.
- **T wave:** Represents ventricular repolarization.

Types of blood pressure:

1) **Systolic blood pressure:** Is the maximum pressure during systole. Normal adult value is 100 – 140 mm Hg (average 120 mm Hg).
2) **Diastolic blood pressure:** Is the minimum pressure during diastole. Normal adult value is 60 – 90 mm Hg (average 80 mm Hg).
3) **Pulse pressure:** Is the difference between systolic and diastolic pressure. Normal adult value is 40 mm Hg.
4) **Mean pressure:**
   - Diastolic pressure + $1/3^{rd}$ of pulse pressure **or**
   - $2/3^{rd}$ of diastolic pressure + $1/3^{rd}$ of systolic pressure
   - **Calculation:** $2/3^{rd}$ of 80 + $1/3^{rd}$ of 120 = 93.3 mm of Hg

Factors regulate / influence / control arterial blood pressure:

1) Pumping action of heart
2) Cardiac output: BP = Cardiac output × Total peripheral resistance.
3) Peripheral resistance
4) Elasticity of arterial walls
5) Blood volume
6) Viscosity of blood

Cardiac output (CO): The volume of blood ejected by each ventricles per minute is called cardiac output. It is also known as minute volume.

Cardiac output (CO) = Stroke volume (SV) × Heart rate (HR)

Factors influence cardiac output:

1) **Physiological factors:**
    i. **Age:** With the increase of age, cardiac output increases.
    ii. **Sex:** Because the surface area is less in female, the CO will be 5% less.
    iii. **Surface area:** Large surface area means large CO.
    iv. **Emotion:** Excitement and anger increases CO, while grief and shock decrease it.
    v. **Digestion:** Depends on the quantity of food taken, the CO will vary.
    vi. **Temperature:** Increase temperature causes increased CO.
    vii. **Pregnancy:** CO increases during pregnancy.
    viii. **Exercise:** During exercise, CO increases.
2) **Pathological factors:**

CO increased in: Hyperthyroidism, Anemia, Fever, Arterio-venous fistula, Paget's disease

CO decreased in: Hypothyroidism, Hemorrhage, CCF, Shock, Oligaemia

Shock:

Types / classification of shock with causes:

1) **Hypovolemic shock (decreased blood volume)**: Hemorrhage, Trauma, Surgery, BurnsFluid loss due to vomiting or diarrhea
2) **Distributive shock (marked vasodilation; also called vasogenic or low-resistance shock)** : Fainting (neurogenic shock), Anaphylaxis, Sepsis (also causes hypovolemia due to increased capillary permeability with loss of fluid into tissues)
3) **Cardiogenic shock (inadequate output by a diseased heart)** : Myocardial infarction. Congestive heart failure, Arrhythmias
4) **Obstructive shock (obstruction of blood flow)** : Tension pneumothorax,Pulmonary embolism, Cardiac tumor, Cardiac tamponade
5) **Endocrine shock**

Clinical features of shock:

1) Hypotension
2) Rapid, thready pulse
3) Cold, pale, clammy skin
4) Intense thirst
5) Rapid respiration
6) Restlessness or, alternatively, torpor.

Regional blood flow

Local tissue blood flow:

- **Highest blood flow in**
    - ✓ Kidney: 400 ml/min/100 gm
    - ✓ Adrenal gland: 300 ml/min/100 gm
    - ✓ Thyroid: 160 ml/min/100 gm
- **Low blood flow in skeletal muscle:** 4 ml/min/100 gm
- **Angiogenesis and blood flow regulated by**
    - Vascular endothelial growth factor (VEGF)
    - Fibroblast growth factor
    - Angiogen
- $\uparrow K^+$, $\uparrow Mg^{++}$, $\uparrow Na^+$, $\uparrow H^+$,$\uparrow CO_2$ causes vasodilatation and $\uparrow Ca^{++}$ causes vasoconstriction.

Percent of cardiac output in different organs:

- Cerebral circulation (Brain): 14%
- Coronary circulation (Heart): 4%
- Bronchi: 2%
- Renal circulation (Kidney): 22%

- Hepatic circulation (Liver): 27%
- Muscle: 15%
- Bone: 5%
- Skin: 6%
- Thyroid gland: 1%
- Adrenal glands: 0.5%
- Other tissues: 3.5%

Pulmonary volumes:

- Tidal volume: 500 ml
- Inspiratory reserve volume: 3000 ml
- Expiratory reserve volume: 1100 ml
- Residual volume: 1200 ml

Pulmonary capacities:

- Inspiratory capacities: 3500 ml
- Functional residual capacity: 2300 ml
- Vital capacity: 4600 ml
- Total lung capacity: 5800 ml

Transport of O_2 in the blood: O_2 is transported in the blood in two ways –

- **In the from of O_2-Hb:** About 97% of O_2 is carried in the form of O_2-Hb. O_2 combines with Hb by the process of oxygenation.
- **As dissolved state:** Remaining 3% of O_2 is transported as the dissolved state in the water of the plasma & cells.

Factors influence shifting the curve:

1. Factors shifting the curve to the right:

- Decreased pH (increased H^+ concentration)
- Increased CO_2 concentration
- Increased temperature.
- Increased 2,3-biphosphoglycerate (BPG)

2. Factors shifting to the left:

- Increased pH (decrease H+ concentration)
- Decreased temperature.
- Decreased PCO_2.
- Fetal hemoglobin.
- Decreased 2,3-biphosphoglycerate (BPG)

Transport of CO_2 in the blood:

1. Transport as HCO_3
2. Transport as carbamino compounds
3. Transport as dissolved CO_2

The respiratory centers with their locations:

- Dorsal respiratory group: Dorsal portion of the medulla (nucleus tractus solitarius)
- Ventral respiratory group: Ventrolateral part of the medulla
- The pneumotaxic centre: Dorsally in the superior portion the pons.
- Apneustic centre: Lower part of the pons

Stimuli affecting respiratory centers:

1. Nervous factor or direct stimulation of respiratory centre from motor cortex.
2. Indirect stimulation from proprioceptors.
3. Chemical factors: Low O_2, high CO_2 and low pH.

The lung function tests:

1. **Test for ventilatory efficiency:**
    a) **Spirometry:**
        - **Vital capacity:** Male 3.2 to 4.6 liter, Female : 2.9 to 4.2 liter.
        - **FEV1 or timed vital capacity:** 80% in first second.
        - **Peak expiratory flow rate (PEFR):** About 6 to 15 liters/second.
    b) **Residual volume (RV):**

c) **Flow volume loop.**
d) **Pressure volume loop.**

2. **Tests for measuring gas exchange or diffusing capacity:** Carbon monooxide diffusion measurement (TL_{CO}).
3. **Test to evaluate the alveolar ventilation:** Determination of dead space volume (In a young adult man anatomical dead space is about 150 ml). Uniform distribution of air measured by nitrometer.
4. **Test evaluating alveloar ventilation & perfusion ratio:** About 0.84 depending on continuous analysis of-the carbon dioxide percentage of the expired air by carbondioxide analyser.)
5. **Measurement of maximum oxygen uptake:** 250 ml/minute.
6. **Blood gas analysis:**$PaCO_2$, PaO_2, Blood pH

FEV_1 change in restrictive airway disease:

FEV_1 is not decreased (decreased but less).

FEV_1/FVC ratio remains normal (as both are decreased proportionately).

FEV_1 change in obstructive airway disease:

FEV1 is decreased.

FEV_1/FVC ratio also decreased.

Cyanosis Types:

1) **Central cyanosis:** Due to heart and lung causes (e.g. congenital cyanotic heart disease like Fallot's tetralogy, ventricular septal defect; lung causes like severe asthma, emphysema, chronic bronchitis etc.).
2) **Peripheral cyanosis:** Due to vascular cause (e.g. vasoconstriction, venous occlusion etc.).

Hypoxia: It is a clinical condition in which there is O_2 deficiency at the tissue level.

Types of hypoxia: Four types of hypoxia-

1) Hypoxic hypoxia (anoxic hypoxia)
2) Anemic hypoxia
3) Stagnant hypoxia (ischemic hypoxia)
4) Histotoxic hypoxia

Type-1 respiratory failure:

In this type of respiratory failure, there is only low PaO_2 , Here $PaCO_2$ is normal (40 mmHg

Causes:

Acute: Lobar pneumonia**,** Pulmonary edema

Chronic: Emphysema**,** Lung fibrosis

Type-2 respiratory failure: low PaO_2 (hypoxia) and high $PaCO_2$ (hypercapnia)

Causes:

- Severe COPD
- Severe asthma
- Narcotics(heroin) poisoning
- Sleep apnea
- Tracheal / bronchial obstruction.

Movements of GIT:

a) **Movements of stomach:**
- Mixing movement – Mixing.
- Propulsive movement – Peristalsis.

b) **Movements of small intestine:**

- Mixing movement - Segmentation.
- Propulsive movement - Peristalsis.
- Antiperistalsis
- Pendular movement.

Digestive juice	Water	Solid	Organic	Inorganic
1. Saliva	99.5%	0.5%	• Enzymes: ptyalin (Salivary α-amylase), Lingual lipase, Lysozyme. • Mucin , Secretory IgA • Cells: Yeast cell, bacteria, protozoa.	• Cation: Na^+, K^+, $Ca2^+$ • Anion: Cl-, HCO_3^-
2. Gastric juice	99.5%	0.5%	• Enzymes: Pepsin, Gastric lipase, Rennin. • Intrinsic factor of Castle, Mucus. • HCl	• Cation: Na^+, K^+, Mg^{2+}, H^+ • Anion : Cl-, PO_4^{3-}, SO_4^{2-}
3. Pancreatic juice	98.5%	1.5%	• Carbohydrate splitting enzymes : Pancreatic amylase • Proteolytic enzymes: Trypsin, Chymotrypsin, Carboxypolypeptidase, Elastase. • Lipolytic enzymes : • Pancreatic lipase, Cholesterol esterase, PhospholipaseA_2, colipase. • Nuclease:	• Cation : Na^+, K^+, Ca^{2+}, Mg^{2+} • Anion: HCO_3^-, Cl^-, SO_4^{2-}, HPO_4^{2-}
4. Succus entericus	98.5%	1.5%	• Carbohydrate splitting enzymes: Sucrase, Maltase, Lactase, Isomaltase, α- Dextrinase, Trehalase. • Proteolytic enzymes: Enteropeptidase, Aminopeptidase, Carboxypeptidase, Endopeptidase, Dipeptidases. • Lipolytic enzymes: Intestinal lipase • Nuclease: RNAase, DNAase. • Activator enzyme: Enterokinase.	• Cation : Na+, K+, Ca2+, Mg2+ • Anion: HCO^{3-}, Cl^-, HPO_4^{2-}, SO_4^{2-}.

Difference between liver bile & gall bladder bile:

Traits	Liver bile	Gall bladder bile
1. Concentration	It is diluted.	It is concentrated.
2. Mucin	0.4%	3%
3. pH	7.8 – 8.6	7.0 – 7.4
4. Specific gravity	1.01	1.04

5. Concentration of bile salt, bilirubin, cholesterol, fatty acid, lecithin, Na^+, K^+, Ca^{++}	Less	More
6. Concentration of Cl^- & HCO_3^-	More	Less.

End products of digestion of carbohydrate: Monosaccharides (Glucose, fructose & galactose).
End products of digestion of protein: Amino acids & peptides.
End product of digestion of fat: Fatty acids, glycerol, monoacyl glycerol and diacyl glycerol.
Site of absorption of nutrients:

Site	Nutrient
Jejunum	• Glucose • Monoacylglycerols, fatty acids, glycerol, cholesterol. • Amino acids, peptides. • Electrolytes, iron, calcium, water.
Ileum	• Bile acids • Vitamin B_{12} • Electrolytes • Water.

Mechanism of formation of urine: Urine formation takes place by the following three mechanisms-

A) Formation of glomerular filtrate
B) Tubular reabsorption
C) Tubular secretion

Factors affecting GFR:

1. **Changing in renal blood flow:** ↑renal blood flow → ↑GFR.
2. **Glomerular hydrostatic pressure:** It is normally 60mm Hg. It increases GFR.
3. **Glomerular capillary colloidal osmotic pressure:** It is 32 mm Hg. It decreases GFR.
4. **Bowman's capsule hydrostatic pressure:** It is 18 mm Hg. It decreases GFR.
5. **Arterial pressure:** Increase or decrease in arterial pressure → autoregulation of renal blood flow → GFR remains relatively constant.
6. **Size of the capillary bed:** ↓size of capillary bed → ↓glomerular filtration co-efficient → ↓GFR.
7. **Permeability of glomerular capillary:** ↑permeability → ↑GFR
8. **Glomerular filtration co-efficient (Kf):** Kf = Permeability × surface area of glomerular capillary. ↓Kf → ↓GFR.
9. **Sympathetic stimulation:** ↓GFR

Renal function tests:

1. **Routine examination of urine:**
2. **Blood analysis:**
   - Blood urea level (15 – 40 mg /dl)
   - BUN (Blood urea nitrogen) level.
   - Plasma uric acid level. (2 – 7 mg /dl)
   - Plasma creatinine level (0.6 – 1.5 mg /dl)
   - Plasma electrolytes.
3. **Clearance tests:**
   - Creatinine clearance test (Usually used: 70 – 140 ml/min)
   - Urea clearance test (60 – 70ml/min)
   - Inulin clearance test
4. **Special test:**
   - Water loading test

- Water deprivation test
- Acidification test.
- Renal biopsy.

6. **Imaging tests:**
   - Plain X-ray KUB region
   - Intravenous urography (IVU)
   - Ultrasonogram
   - CT scan
   - Pyelograph
   - Renal biopsy

Juxtaglomerular apparatus:

The juxtaglomerular cells (JG cells), the macula densa and the lacis cells are collectively known as the juxtaglomerular apparatus.

Types of cells:

Types of cells	Location
1. JG cells	Afferent arteriole (in tunica media) & efferent arteriole.
2. Macula densa (specialized epithelial cell)	Distal tubule
3. Lacis cells / cell of Polkinsion	Junction of outer layers of afferent and efferent arterioles.

Peculiarities of renal blood flow (RBF) with their importance:

1. **It is a portal system containing-**
   - Glomerular capillary – It is designed for filtration of plasma.
   - Peritubular capillary – It is designed for the reabsorption of desirable substances from the filtrate.
2. **Rate of blood flow is very high** (3.5 – 4 ml/gm/min). 22% of cardiac output flows to kidney.
   Importance: This helps to clear the waste products very rapidly.
3. **Kidney has a high pressure capillary bed.** Hydrostatic pressure in glomerular capillary is very high (60 mm of Hg).
   Importance: Hydrostatic pressure facilitates the filtration of blood.
4. **Blood flow is selective, not uniform.** It is 98 – 99% in cortex and 1 – 2% in medulla. Maximum, about 100% glomerular capillary lies in cortex. So blood flow in cortex is very high.
   Importance:
   - High blood flow in cortex ensures the filtration.
   - Less blood flow in medulla ensures the concentrated urine formation.
5. **Auto-regulation of RBF by kidney itself.**

Regulation of water balance:

1. Role of Kidney:
   a) Renal-body fluid feedback mechanism:
   b) Renin-angiotensin mechanism:
2. Thirst mechanism
3. Sympathetic nervous system:
4. Role of atrial natriuretic peptide (ANP)

Classification of hormones:

1. According to their chemical structure:

A) **Proteins and polypeptides:** Including hormones of anterior and posterior pituitary gland, the pancreas (insulin, glucagon), the parathyroid hormone, and many other hormones.

B) **Steroids:** The adrenal cortex hormones (aldosterone, cortisol, androgens) the ovarian hormones (estrogen and progesterone), the hormones of testes (testosterone) and the hormones of placenta (estrogen and progesterone).

C) **Derivatives of the amino acid tyrosine:** The thyroid hormones (thyroxine, triiodothyronine), the hormones of adrenal medullae (epinephrine and norepinephrine).

2. **According to their distribution of receptors:**

A) **In or on the surface of the cell membrane:** The protein, polypeptide and catecholamine hormones.

B) **In the cytoplasm:** Steroid hormones.

C) **In the cell nucleus:** Thyroid hormones.

Hormones of pituitary gland:

- **Anterior pituitary hormones:**
  - Growth hormone
  - Thyrotropin / thyroid stimulating hormone (TSH)
  - Adrenoorticotropic hormone (ACTH)
  - Gonadotropin (FSH & LH)
- **Posterior pituitary hormones:**
  - Antidiuretic hormone (ADH)
  - Oxytocin.

5 factors that stimulate the secretion of growth hormone:

1) Exercise
2) Starvation
3) Stressful stimuli
4) Deep sleep
5) Hypoglycemia
6) Excitement

5 factors that inhibits the secretion of growth hormone:

1) Increase Glucose
2) Increase Cortisol
3) Increase Free fatty acids
4) Growth hormone (by negative feedback mechanism)
5) Aging

Disorders of pituitary gland:

Parts involved	Hyper-activity	Hypo-activity
Anterior pituitary	• Gigantism • Acromegaly • Acromegalic gigantism • Cushing's disease	• Dwarfism • Acromicria • Simmond's disease
Posterior pituitary	• SIADH (Syndrome of inappropriate hypersecretion of ADH)	• Diabetes insipidus
Anterior and posterior pituitary (Both)		• Dytrophia adiposogenitalis

Acromegaly:

Clinical features:

Skeletal changes:

1. Enlargement of hands and feet
2. Protrusion of lower jaw (progmathism)

3. Prominet supraorbital ridges
4. Kyphosis

Soft tissue changes:

1. Skin thickening
2. Enlargement of lips nose tongue
3. Enlargement of thyroid gland, heart, liver
4. ↑ heel pad thickness

Metabolic effects:

1. Glucose intolerance (25%)
2. Diabetes mellitus (10%)
3. Hypertension (25%)

ADH: It is a posterior pituitary hormone. also called ,vasopressin and pitresin.

Functions/physiological effects:

1. It causes reabsorption of water in DCT, CT & CD of the nephrons of the kidney, thus regulates water balance.
2. It causes vasoconstriction, thus elevates blood pressure.
3. It causes contraction of smooth muscle like ureter, urinary bladder, intestine etc.

Thyroid hormones:

1. Thyroxine (T_4)
2. Triiodothyronine (T_3)
3. Calcitonin

Factors increasing the thyroid hormone secretion:

1) Low basal metabolic rate.
2) Leptin.
3) Alpha melanocyte stimulating hormone.

Factors decreasing the thyroid hormone secretion:

1) Stress.
2) Somatostatin.
3) Glucocorticoids.
4) Dopamine.

The thyroid function tests:

1) **Measurement of thyroid hormones:**
   a) Estimation of T3 and T4 levels.
   b) Estimation of TSH.
2) **Tests to determine the aetiology of thyroid dysfunction:**
   a) Antibodies against thyroid peroxidase (TPO) and thyroglobulin (Tg).
3) **Radioiodine uptake test.**
4) **Thyroid scanning.**
5) **Thyroid ultrasound.**

Clinical features of Hyperthyroidism:

1. Nervousness
2. Weight loss, but increased appetite
3. Heat intolerance
4. Tremor of hands
5. ↑ pulse pressure
6. ↑ Sweating
7. ↑ BMR

8. Extreme fatigue but inability to sleep.

Hypothyroidism:

Clinical features:

General:

- Weight gain
- Cold intolerance
- Puffy face
- Fatigue, somnolence
- Hoarseness of the voice
- Constipation

Neuromuscular:

- Carpal tunnel syndrome
- Muscle stiffness
- Deafness
- Depression
- Psychosis(myxedema madness)

Dermatological:

- Dry skin
- Dry hair
- Alopecia

***Reproductive*:**

- Menorrhagia
- Infertility
- Galactorrhoea
- Impotence

The forms of Ca^{++} in plasma:

Normal plasma concentration of calcium: 9.4 mg/dl

Distribution:

a. **Non diffusible (plasma protein bound):** 41 percent (1 mmol/L)
b. **Diffusible combined with anionic substances(with citrate and phosphate):** 9 percent (0.2 mmol/L)
c. **Diffusible ionized:** Remaining 50 percent (1.2 mmol/L)

The hormones controlling blood calcium level:

I. Parathyroid hormone.
II. Thyrocalcitonin.
III. Vitamin D (1, 25-. Dihydroxycholecalciferol)
IV. Parathyroid hormone related protein (PTHrP)

Hypocalcaemia: Decreased blood calcium level below its normal level is called hypocalcaemia.

Causes:

1. Parathyroid dysfunction
    a. Hypoparathyroidism
        - Surgical
        - Idiopathic
        - Infiltrative carcinoma
    b. Pseudohypoparathyroidism
2. Vitamin-D deficiency:
    a. Nutritional vit-D deficiency
    b. Malabsorption

3. Acute pancreatitis
4. Chronic renal failure.
5. Hypomagnesaemia

Clinical feature/effects:

1. Neuromuscular: Tetany, paraesthesia, myopathy, seizures.
2. Cardiovascular: Hypotension, ECG - prolonged QT interval.
3. Osteoporosis
4. Psychosis
5. Cataract
6. Rickets in children & Osteomalacia in adults

Functions of insulin:

A) Carbohydrate metabolism:

Insulin decreases blood glucose level by –

- ↑ glycogenesis
- ↑ glycolysis
- ↑ glucose uptake by cells
- ↑ fatty acid synthesis
- ↓ glycogenolysis
- ↓ gluconeogenesis
- ↓ lipolysis

B) Fat metabolism:

Insulin exerts anabolic (synthetic) role in fat metabolism. It causes –

- ↑ lipogenesis
- ↑ glycerol synthesis
- ↑ triglyceride deposition
- ↓ lipolysis by inhibition of hormone sensitive lipase
- ↓ ketogenesis

C) Protein metabolism:

Insulin exerts anabolic (synthetic) role in protein metabolism. It causes –

- ↑ amino acid uptake by cells
- ↑ protein synthesis
- ↓ protein breakdown

Effects of insulin deficiency:

1. Diabetes mellitus – because of inability to use glucose, blood glucose level rises above normal.
2. Insulin deficiency causes fat utilization for energy and finally causes ket-acidosis.
3. Insulin deficiency causes –
    - Polyuria (Increased formation of urine)
    - Polydypsia (Increased thirst)
    - Polyphagia (Increased appetite)
    - Asthenia (Weakness)

Consequences of hyperglycaemia:

1) Microvascular:

- Diabetic retinopathy: Leading to blindness
- Diabetic nephropathy: Leading to renal failure
- Neuropathy: Peripheral neuropathy, autonomic neuropathy

2) Macrovascular:

- Atherosclerosis: Stroke, myocardial infarction

- Diabetic myopathy
- Hypertension

Hormones of adrenal gland:

1. **Hormones of adrenal cortex:**

   Zona glomerulosa (15%): (*mineralocorticoids*)
   - Aldosterone
   - Deoxycorticosterone
   - Corticosterone
   - Cortisol (hydrocortisone)

   Zona fasciculata(75%): (*glucocorticoids*)
   - Cortisol (hydrocortisone)
   - Corticosterone

   Zona reticularis(10%): (*sex hormones*)
   - Androgen (most important is dehydroepiandrosterone & androstenedion)

2. **Hormones of adrenal medulla:** (*Catecholamines*)
   - Adrenaline / epinephrine
   - Nor-adrenaline / nor-epinephrine

Addison's disease:

Causes: Adrenocortical atrophy (due to auto immune disease) ,Tuberculous destruction of the adrenal gland

Clinical features:

1. Weight loss
2. Weakness
3. Anorexia
4. Nausea & vomiting
5. Diarrohea & constipation
6. Hypotension
7. Pigmentation of skin & mucus membrane

Treatment:

Administration of glucocorticoids & mineralocorticoids.

Cushing's syndrome:

Clinical features:

1. Moon face (due to deposition of fat in the face)
2. Buffalo hump (due to deposition of fat in the back of neck)
3. Pendulous abdomen (due to deposition of fat in the abdomen)
4. Reddish purple abdominal striae.
5. Wasting and weakness of proximal thigh muscle
6. Osteoporosis
7. Poor wound healing
8. Hypertension
9. Hyperglycemia

Sex hormones in male (androgens) :

- Testosterone
- Dihydrotestosterone (DHT)
- Inhibin
- Andostenedione

Sex hormones in female:

- Estrogen
- Progesterone
- Relaxin
- Inhibin

The reproductive functions of the male: Three major subdivisions –

(1) Spermatogenesis, which means simply the formation of sperm;
(2) Performance of the male sexual act; and
(3) Regulation of male reproductive functions by the various hormones.

Hormonal factors that stimulate of spermatogenesis:

Several hormones play essential roles in spermatogenesis. Some of these are as follows –

- **Testosterone:** this hormone is essential for the growth and division of the testicular germinal cells, which is the first stage in forming sperm.
- **Luteinizing hormone:** secreted from anterior pituitary gland, stimulates the Leydig cell to secrete testosterone.
- **Follicle stimulating hormone:** secreted from anterior pituitary gland, stimulates the Sertoli cells without this stimulation, the conversion of the spermatids to sperm (spermiogenesis) is not possible.
- **Estrogen:** Formed form testosterone by the Sertoli cells, essential for spermiogenesis.
- **Growth hormone:** GH is required for controlling background metabolic functions of the testes. It promotes the early division of the spermatogonia.

Semen:

Characters:

Color: White
Specific gravity: 1.028
pH: 7.35-7.50
Sperm count: average 100 million/ml with fewer than 20% abnormal forms.

Composition of semen:

1) **Sperm**
2) **Other components:**
   A) From seminal vesicle (60% of total volume):Fructose, Phosphorylcholine, Ergothineine, Ascorbic acid , Flavins, Prostaglandins
   B) From prostate (20% of total volume): Spermine, Citric acid , Cholesterol, phospholipids, Fibrinolysin, fibrinogenase, Zinc, Acid phosphatase
   C) Hyaluronidase

Secondary sexual characteristic of female:

a. Onset of menstruation.
b. Enlargement of breast.
c. Change in voice (high pitched low frequency)
d. Maturation of female sex organs.
e. Appearance of pubic and axillary hair.
f. Enlargement of pelvis in all diameter (Gynaecoid pelvis)
g. Feminine distribution of the fat
h. Increase attraction to opposite sex

Menstruation:

It has following stages:

- Proliferation of the endometrium
- Development of the secretory changes of the endometrium
- Desquamation of the endometrium, which is known as menstruation

Clinical features of menopause:

1) "hot flushes" characterized by extreme flushing of the skin,
2) psychic sensations of Dyspnoea,
3) irritability,
4) fatigue,
5) anxiety,
6) occasionally various psychotic states, and
7) Decreased strength and calcification of bones throughout the body.

Indicators (sign-symptoms) of ovulation:

- Basal body temperature usually rises.
- Slight pain felt in the side of ovulation of the lower abdomen.
- Others direct evidence-
  - ✓ LH level very high, FSH level fall
  - ✓ High level of estrogen
  - ✓ Urinary excretion estrogen
  - ✓ Imaging of the lower abdomen-ultrasound.

Hypothalamic hormones:

- **Releasing hormones:**
  - Growth hormone releasing hormone (GHRH)
  - Thyrotropin releasing hormone (TRH)
  - Corticotropin releasing hormone (CRH)
  - Gonadotropin releasing hormone (GnRH)
- **Inhibitory hormones:**
  - Growth hormone inhibitory hormone (GHIH, also called *somatostatin*)
  - Prolactin inhibiting factor (PIF).

Another two hormones synthesized in hypothalamus but secreted from neurohypophysis:

- Antidiuretic hormone(ADH)/vasopressin (mainly
- Oxytocin.

Functions of hypothalamus:

1) **Regulation of water balance:** Thirst center
2) **Formation of oxytocin and ADH (vasopressin):** (From supra-optic and para-ventricular nuclei).
3) Concerned with sleep, somnolence and wakefulness.
4) Regulation of body temperature.
5) Regulation of fat and carbohydrate metabolism.
6) Concerned with hunger, feeding, satiety and thirst.
7) Reflex center for emotional disturbance.
8) Concerned with sexual function.
9) Influence on autonomic activity → Control of both sympathetic and parasympathetic activity.
10) Concerned with release and regulation of releasing hormone secretion, thus control pituitary function.
11) Regulation of cardiovascular activities.
12) Influence on different cyclic phenomena.
13) Relation to adrenalin and noradrenalin secretion.

Parts of the neuron with functions:

a) Cell body:

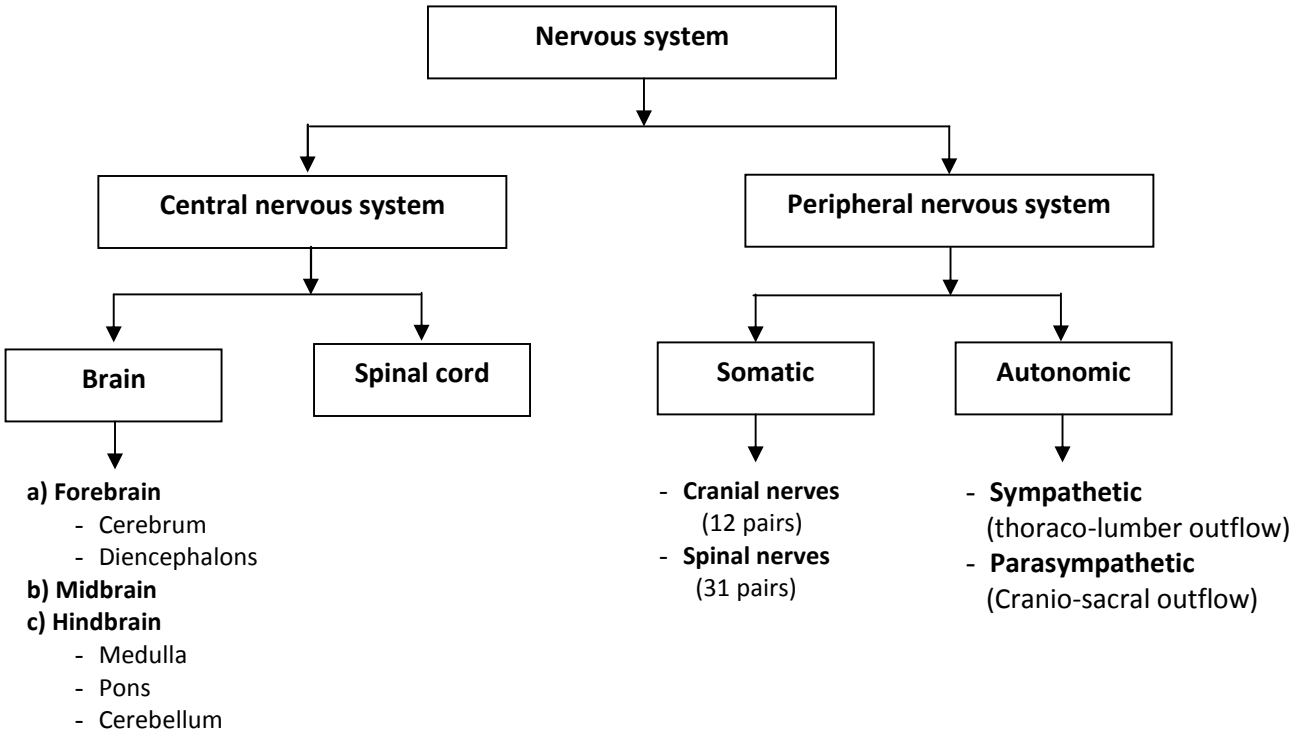
- ✓ **Cytoplasm:** Contains different organelles.

- ✓ **Nucleus:** Controls the cell function.

b) Cell processes:

- ✓ **Axon:** Conduct electrical impulse away from the cell body.
- ✓ **Dendrite:** Conduct electrical impulse towards the cell body.

Organization of nervous system:



Functions of glial cells:

Glial cell	Functions
Microglial cells	• Phagocytosis
Astrocytes	1) Provide supportive framework 2) Act as electrical insulator 3) Limit spread of neurotransmitter 4) Store glycogen 5) Take place of dead neurons 6) Produce neurotropic substances
Oligodendrocytes	• Formation of myelin sheath in CNS.
Ependymal cells	1) Line the cavities of the CNS and make up the walls of the ventricles. These cells create and secrete cerebrospinal fluid (CSF) and beat their cilia to help circulate that CSF.
Schwann cell	• Formation of myelin sheath in PNS.

Properties of nerve fiber:

1) Excitability
2) Conductivity
3) All or none law

4) Refractory period
5) Summation
6) Adaptation
7) Accommodation
8) Indefatigability

List of neurotransmitters:

A) On the basis of mode of action:

1) Excitatory:

- Acetylcholine
- Adrenaline
- Noradrenalin
- Glutamate

2) Inhibitory

- Dopamine
- Glycine
- Alanine
- GABA
- Serotonin

3) Both excitatory and inhiobitory:

- 5-HT (hydroxytryptamine)
- Histamine
- Prostaglandin
- Noradrenalin

Classification of reflxes:

A) Clinical:

a) **Superficial:** e.g. plantar response, abdominal reflex, cremasteric reflex, corneal reflex, conjunctival reflex, sucking reflex etc.
b) **Deep reflexes:** Knee jerk, ankle jerk, biceps jerk, triceps jerk etc.
c) **Visceral reflexes:** Pupillary reflex, baro-receptor reflex, gastric reflexes.
d) **Pathological reflexes:** Babinski's sign.

B) Anatomical:

a) Segmental
b) Intersegmental
c) Suprasegmental

C) Physiological:

a) Flexor / withdrawal reflex
b) Extensor reflex

D) Inborn or acquired:

a) **Conditioned reflex:** Develop after birth and their appearance depends upon previous experiences.
b) **Unconditioned reflex:** All are inborn (present since birth).

Reflexes tested clinically:

a) **Superficial:** e.g. plantar response, abdominal reflex, cremasteric reflex, corneal reflex, conjunctival reflex, sucking reflex etc.
b) **Deep reflexes:** Knee jerk, ankle jerk, biceps jerk, triceps jerk etc.
c) **Visceral reflexes:** Pupillary reflex (light reflex).
d) **Pathological reflexes:** Babinski's sign.

Differences between the upper motor and lower motor neuron lesions:

Traits	Upper motor neuron lesion	Lower motor neuron lesion
1) Affected muscles	Opposite site of the body affected	Same side of the body affected
2) Type of paralysis	Spastic type of paralysis occur	Flaccid type of paralysis occur
3) Reflexes	All superficial reflexes are lost and deep reflex are exaggerated.	Both superficial and deep reflex are lost.
4) Muscle wasting	Muscle wasting absent.	Muscle wasting present.
5) Fasciculation	Fasciculation absent	Fasciculation present
6) Clonus	Clonus present	Clonus absent

Functions of cerebellum:

a. **Paleocerebellum:** It facilitates a smooth, coordinated voluntary movement.
b. **Neo-cerebellum:**
   - It plays an active role in the performance of voluntary movement.
   - By maintaining muscle toile, it helps in maintenance of posture.
c. **Archicerebellum:** It helps in regulation of posture and equilibrium.

Cerebellar nuclei:

There are four pairs of nuclei of cerebellum –

1) Nucleus fastigii
2) Nucleus globosus
3) Nucleus emboliformis
4) Nucleus dentatus

Signs of cerebellar lesion:

1. Dysmetria and astaxia: .
2. Past pointing:
3. Failure of progression:
   - Dysdiadochokinesia: Loss of rapid alternating movement is called *dysdiadochokinesia*.
   - Dysarthria: Difficulty to form verbal words.
4. Intention Tremor:
5. Cerebellar nystagmus:
6. Hypotonia

Tests for cerebellar lesions:

- Finger nose test
- Adiadochokinesis / dysdiadochokinesia
- Gait test – ataxic gait
- Speech test – Slurred speech
- Ocular movement (for cerebellar nystagmus)

Special senses with their receptors:

Name of special sense	Receptor
Vision	Rods and cones
Hearing	Hair cell of organ of corti
Olfaction or smell	Bipolar cell of olfactory mucosa
Taste	Taste bud of tongue
Equilibrium	Vestibular apparatus

Names of refractory / optical media:

1. Cornea
2. Aqueous humour
3. Lens

4. Vitreous humour.

Refractory error of the eye:

1. **Myopia:** Focus is formed in front of the retina.
2. **Hypermetropia:** Focus is formed behind the retina.
3. **Astigmatism:** No single point of focus is formed.
4. **Presbyopia:** Difficulty in both distant and near vision.

light reflex: Fall of light on cornea → refractive media → retina → received by rods and cones → optic nerve → Opitc chiasma → Optic tract → pretectal nucleus → Edinger Westphal nucleus of same side → Oculmotor nerve of same side → Ciliary ganglion → short ciliary nerve → sphincter pupilae of the eye of same side → constriction of pupil of the eye of same side.

Changes occur in accommodation reflex :

1. Convergence of the eyeballs.
2. Contraction of ciliary muscles.
3. Relaxation of suspensory ligament.
4. Curvature of the lens increases.
5. Constriction of the pupil.

Components of Visual Pathway:

1. Rods & cones of retina.
2. Optic nerve.
3. Optic Chiasma
4. Optic tract
5. Lateral geniculate body
6. Optic radiation
7. Visual Cortex.

Lesion in part of visual pathway	Effect
Optic nerve	Total blindness of eye
Optic chiasma	Bitemporal hemianopia
Optic tract	Homonymous hemianopia ➢ Loss of nasal vision of affected side ➢ Loss of temporal vision of opposite side
Optic radiation	Homonymous hemianopia

Pathway of hearing:

Air vibrate the tympanic membrane → impulse pass through malleus, incus and stepes → fenestra vestibule → endolymph → hair cell of the organ of corti (auditory receptor) → spiral ganglion (1^{st} order neuron) → cochlear nerve → dorsal and ventral cochlesr nucleus (2^{nd} order neuron) → auditory fiber → dorsal nucleus of trapezoid body (3^{rd} order neuron) → lateral leminiscus → inferior colliculus → medial geniculate body (4^{th} order neuron) → auditory radiation → auditory cortex (superior and inferior transverse temporal gyrus).