

Physiology At a Glance



by
Prashant Gupta

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by

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Foreword

It is a great pleasure for me to introduce “Physiology at a Glance” written by Associate Professor Dr. Pratibha Gupta. She has vast experience in the field of Physiology teaching for undergraduates and postgraduates and also in research.

I am quite confident that this booklet on Physiology questions will help our students as a ready reference in a long way of their continued learning.

Prof Dr. Syed Hassan Ahmad

Dean

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Preface

Since I joined Unimas on 29.9.03, I was looking forward to carry out some academic work in favor of students and then this desire became quite strong while providing extra coaching to students who took part in 2nd Intermedical Physiology quiz in 2004 & stood second out of nine teams.

This “Physiology at a Glance” is an attempt to help students for quick reference to the systems of Physiology in form of single statements and it is the beginning.

I dedicate this book to Unimas students who inspired me and to my husband for his support for this humble endeavor.

Dr. Pratibha Gupta

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General and Cell Physiology

- ▶ Ratio of Intra Cellular Fluid [ICF] to Extra Cellular Fluid [ECF] → 2:1.
- ▶ Substance used to measure total body fluid → 150 mg of sucrose is injected [IV route] in 70 kg man or if plasma volume & hematocrit are measured then total blood volume can be measured.
- ▶ Plasma volume is measured using → Evans blue.
- ▶ No. of Calories to be added to raise body temperature by 1°C or 1.8°F → 58 calories.

- ▶ ECF is measured using → inulin a polysaccharide.
- ▶ Walter B. Canon → termed homeostasis.
- ▶ Thickness of plasma membrane → 7-10 nano meters.
- ▶ Function of intrinsic protein → mainly act as enzymes.
- ▶ Function of transmembrane protein → serve as channels, carriers, pumps and receptors.
- ▶ Membrane of two cells are opposed and outer layers approximates [still having gap] → tight junctions.
- ▶ Location of tight junctions → intestinal mucosa, renal tubules & choroids plexus.
- ▶ Two cell membrane are separated by 150-350 Å → desmosomes → skin.
- ▶ In electric transmission [rapid transmission], the impulse is carried → by gap junction → cardiac & smooth muscle.
- ▶ Apoptosis → process of programmed cell death. Body cell dies & gets absorbed [phagocytosis].

- ▶ Facilitated diffusion → carrier mediated process → large molecules diffuse like glucose transport across intestinal epithelium through GLUT, RBC, muscle, adipose tissue.
- ▶ Osmolarity → is number of osmoles/liter.
- ▶ Osmolality → is number of osmoles /kilogram of the solvent.
- ▶ Osmolaity of a solution relative to plasma is called isotonicity.
- ▶ Osmolaity of normal plasma is 290 mosm/L.
- ▶ Active transport of ions /substances across cell membrane is → against chemical or electrical gradient → energy dependent → like K^+ - K^+ pump [or Na^+ - K^+ ATPase, Ca^{2+} pump, K^+ - H^+ pump [gastric mucosa & renal tubule].
- ▶ Na^+ - K^+ pump also known as electrogenic pump.
- ▶ Na^+ - K^+ pump maintains high K^+ & low Na^+ in cell [moving 3 Na^+ out & bring 2 K^+ in].
- ▶ Normal Na^+ concentration → 2mEq/L of plasma → above this thirst mechanism is stimulated and this is **called threshold for**

drinking and this restores ECF osmolarity bringing Na^+ level to normal.

- ▶ **Uniporters** → carriers that transport a single particle in one direction [facilitated diffusion of glucose].
- ▶ **Symporters** → [co-transporters] transport two particles together in same direction [secondary active transport of glucose].
- ▶ **Antiporters** [counter transporters] → transport molecules in opposite directions like they exchange one substance for another like Na^+ - K^+ pump.
- ▶ **Vesicular transport process** → through membrane like endocytosis & exocytosis.
- ▶ **Intercellular communication means** → cells communicate through chemical messengers → amines, amino acids, steroids, polypeptides.
- ▶ **Neural communication via synaptic junction** like acetylcholine → at myoneural junction.
- ▶ **Paracrine communication** → products of cell diffuse in ECF to affect neighboring cells.
- ▶ **Autocrine communication** → products of cell diffuse into the same cell through specific

receptors to regulate its secretion.

- ▶ Endocrine communication → through hormones → to target cells.
- ▶ The body fluid composition in a 70 kg man → 42L water, 14 L in ECF & 28L in ICF.
- ▶ Breakdown products of protein metabolism accumulate in blood → uremia.
- ▶ Normal concentration of Na^+ in ECF → 142 mEq/Liter [3.5 million times greater].
- ▶ Two places of countercurrent exchangers in body → renal medulla, testis to keep it at low temperature → 3° less than body temperature.
- ▶ Astronaut pilot wear G-suit? → to prevent pulling of blood in veins.
- ▶ Vaccine produced in Paris → BCG [Bacillus Calmette Guerin → named after two French scientist, participated through testing in Canada [Montreal].

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Nerve, Muscle, CNS & Special senses and ANS

- ▶ **Muller's Doctrine of specific nerve energies [1935]→ If Pacinian corpuscle is stimulated in elbow by pressure the sensation evoked will be TOUCH [when nerve pathway from a particular sense organ is stimulated the sensation evoked is that for which the receptor is specialized no matter how or where along the pathway the activity is initiated].**
- ▶ **Tonic receptors→ adapt slowly & incompletely.**
- ▶ **Location of tonic receptors→ carotid sinus, muscle spindle, organs for cold & pain & lung inflation.**

- ▶ Touch Receptors adapt rapidly → Phasic receptors.
- ▶ Basic functional unit of nervous system → neuron.
- ▶ Davison → central & peripheral.
- ▶ Each of the two cerebral hemisphere comprised of → frontal, parietal, temporal & occipital lobe.
- ▶ Action Potential [AP] is first generated → axon hillock.
- ▶ Thalamus → large synaptic relay station.
- ▶ Type of summation → temporal & spatial.
- ▶ Brain stem comprised of → mid brain, pons, medulla.
- ▶ Relation between intensity of stimulus & magnitude → Weber Fechner's law.
- ▶ The sensory adaptation is → decrease in AP following a prolonged stimulation.
- ▶ When a small amount of pressure is applied to Pacinian corpuscle → a non propagated depolarizing potential resembling Excitatory

Postsynaptic Potential [EPSP] is recorded → Generator potential.

- ▶ Information about external environment perceived by → eye, ear, nose [tactile receptors], extero receptors.
- ▶ Extero receptors present in → skin.
- ▶ Internal receptors → chemo receptors, baroreceptors & volume receptors → internal environment of body.
- ▶ When maintained stimulus of constant strength is applied to a receptors → frequency of action potentials in its sensory nerve → ↓ over time & this is termed as ADAPTATION / desensitization.
- ▶ Sensory unit → single sensory axon and all its peripheral branches.
- ▶ On which part of the neuron you find most of the synaptic connections → dendrite.
- ▶ Sherrington → synapse junction → comprised of presynaptic & post synaptic cell membrane.
- ▶ Afferent fibers from muscle spindles [stretch receptors] pass directly to spinal motor neurons of the motor units supplying the same

muscle causing /producing EPSP with summation, propagated responses in postsynaptic motor neurons and at the same time Inhibitory post Synaptic Potential [IPSP]→ are produced in motor neurons supplying antagonist muscles.

- ▶ Receptors→ a structure specialize to respond most effectively to one or another stimulus→ touch, pressure [mechanical].
- ▶ Mechano receptors→ Ruffini's end organ, pacinian corpuscle, Krause's, Mercle disc & Messener's Corpuscle.
- ▶ Thermo receptors→ Ruffini's end organ→ degree of warmth.
- ▶ Noci receptors→ Necked nerve endings→ 'C' unmyelinated or myelinated Ad afferent fibers.
- ▶ Krause's end bulb→ conjunctiva, papillae of tongue→ mechanoreceptors.
- ▶ Weber Fechner law→ magnitude of generator potential is proportionate to intensity of stimulus.

- ▶ Tonic Receptors → continue to respond → muscle spindle, baroreceptors & chemoreceptors.
- ▶ Phasic Receptors → rapid, touch, olfactory, pressure receptors.
- ▶ Two theories that may explain referred pain → convergence & facilitation.
- ▶ Tissue/organs → innervated by somatic cholinergic nerves → sweat gland, skeletal muscle.
- ▶ Bell Magendie law → reflex arc → afferent, efferent & effectors.
- ▶ Receptors for sense of smell located → roof of nasal cavity → 10-20 million special sensory cells → bipolar neuron → receptor cells.
- ▶ Dendrites of receptor cells → olfactory rods → end in fine cilia → 10-12 on each rod.
- ▶ Life span of these cells → 60 days.
- ▶ Nervous system is closest to olfactory mucous membrane.
- ▶ Smell producing substances [odoriferous] combine with receptors → generator potential

- develops → action potential → travel along axons to olfactory bulb.
- ▶ Human can distinguish → 2000-40000 different odours.
 - ▶ Olfactory cortex along with parts of limbic system.
 - ▶ Sense of smell more acute → females.
 - ▶ Olfactory fatigue → adaptation to smell.
 - ▶ Anosmia → complete absence of sense of smell.
 - ▶ Parosmia → alteration in character of smell.
 - ▶ Hyposmia → reduction of sense of smell.
 - ▶ Patients with adrenal insufficiency have greatly increased sensitivity to smell.
 - ▶ Taste receptors → chemoreceptors.
 - ▶ Sweet and salt taste felt by → tip of tongue.
 - ▶ Bitterness felt by → back of tongue.
 - ▶ Sour taste felt at sides of the tongue.

- ▶ Sour taste is due to H^+ & degree of sourness is proportional to degree of dissociation of H^+ from an acid.
- ▶ Ageusia → absence of taste.
- ▶ Hypogeusia → diminished taste sensitivity.
- ▶ Dysegeusia → disturbed sense of taste.
- ▶ Aqueous humour → present in anterior chamber of eye and formed by → capillary of ciliary process.
- ▶ Aqueous humour → high content of vit. C → helps in glucose metabolism.
- ▶ Aqueous humour → high concentration of NaCl & lactic acid and low glucose.
- ▶ Sympathetic stimulation → ↓ intra ocular pressure.
- ▶ Refractive index of whole lens → 1.42 and lens → 1.40
- ▶ Refractive index of aqueous humour → 1.33.
- ▶ Refractive index of cornea → 1.38.
- ▶ Hutchison pupil is → Unilateral constricted pupil.

- ▶ Refractive index of Vitreous humour → 1.34.
- ▶ Lens free eye ball → Aphakic.
- ▶ Myopia → accommodation at rest & incident parallel rays are focused in front of retina.
- ▶ Hypermetropia → accommodation at rest & incident light rays are focused behind the retina.
- ▶ Astigmatism → accommodation at rest & incident light rays are never come to a common focus on retina.
- ▶ Bilateral loss of light reflex with intact near accommodation reflex → Argyll-Robertson pupil → common cause → neuro- syphilis.
- ▶ Hemianopias is seen in lesions of → optic chiasma.
- ▶ Bitemporal hemianopia [heteronymous hemianopia] → damage of both side of nasal nerve fibers at optic chiasma → loss of right half of visual field in one eye & left half of vision loss in other eye.
- ▶ Binasal hemianopia → lesion of outer margin of optic chiasma → loss of temporal visual field.

- ▶ Lesion of optic tract or geniculate body → homonymous hemianopia → loss of same halves of visual fields in both eyes with hemianopic pupillary response [blindness with preservation of the pupillary light reflex usually → due to lesion behind the optic nerve.
- ▶ Quadrantanopia → loss of $\frac{1}{4}$ th of visual field in an eye.
- ▶ Optic power of eye is → 60 Diopters.
- ▶ Cones → concerned with bright light & color vision.
- ▶ Rods → concerned with dim light vision.
- ▶ After image effect → persistent visual impression even after removal of objects.
- ▶ Ferry porter law → critical fusion frequency is directly proportional to logarithm of light intensity.
- ▶ Hue → is a fundamental quality of color sensation.
- ▶ Blind spot is the area of scotoma in visual field.

- ▶ **Monochromatism**→ is a condition with complete loss of color vision.
- ▶ **Dichromatism**→ is a condition when one out of 3 primary color is not perceived.
- ▶ **Fovea centralis**→ is the part of retina where maximum visual acuity exists.
- ▶ **Primary visual area/visuo-sensory area**→ located medial surface of occipital lobe→ area 17.
- ▶ **Area**→ 18→ visuo –psychic area→ lateral surface of occipital lobe→ visual orientation, depth perception & relay of information from visual cortex to other parts of brain.
- ▶ **Area**→ 19→ occipital eye field→ located anterior to area 18→ concerned with deviation & movement of eye ball→ stimulation produces conjugate deviation opposite side and visual hallucination.
- ▶ **Surface area of tympanic area**→ 55 sq.mm.
- ▶ **Brodmann's area 41** in superior portion of temporal lobe→ primary auditory cortex.
- ▶ **Audiometer**→ used to measure auditory intensities, threshold, auditory range.

- ▶ Masking [effect] → presence of one sound → ↓ individual's ability to hear other sound.
- ▶ Difficulty in interpretation of sound is due to → bilateral destruction of auditory cortex.
- ▶ Auditory hair cells have → -70mV resting membrane potential.
- ▶ 0 decibel → auditory threshold → reference / standard sound.
- ▶ Pitch of an average male voice → 120 HZ.
- ▶ Pitch of an average female voice → 250 HZ.
- ▶ Human ear can perceive the pitch of sound → 16-20,000 HZ.
- ▶ Endolymph = ICF → scala media & rich in K⁺, formed by stria vascularis.
- ▶ Perilymph = ECF → scala vestibule & → scala tympani & rich in Na⁺.
- ▶ Inner hair cells → predominantly sensory.
- ▶ Von Bekesy carried out experiments on cadavers to study → mechanism of working of basilar membrane.

- ▶ Sound becomes painful → above 140 decibel.
- ▶ Semicircular canals → are organs for equilibrium.
- ▶ Cerebro Spinal fluid [CSF] formed from → choroids plexus in ventricles.
- ▶ Structure responsible to absorb CSF → Arachnoid villi.
- ▶ Excess of abnormal collection of CSF in cranial vault → Hydrocephalus.
- ▶ Normal pressure in CSF → 10mmHg.
- ▶ Normal amount of CSF → 150 ml [approximately].
- ▶ Spinal cord ← dorsal root ← sensory [afferent], ventral root → motor [efferent].
- ▶ Reflex delay → interval between application of stimulus and onset of reflex process.
- ▶ The involuntary response due to a sensory stimulus is called → reflex action.
- ▶ The center for papillary reflex is in → 3rd nerve nucleus.

- ▶ The junction where one neuron ends & another begins → Synapse.
- ▶ Poly synaptic → withdrawal reflex, abdominal, cremastic.
- ▶ Monosynaptic → knee jerk.
- ▶ Center for knee jerk → Lumber 2, 3 & 4.
- ▶ Center for planter reflex → 1st sacral.
- ▶ Center for cremestic reflex → Lumber 1 & 2.
- ▶ Knee jerk is abolished → lower motor neuron [LMN] lesion.
- ▶ Pendular Knee jerk is seen → cerebellar disease.
- ▶ In somato sensory cortex → upper most part of the body represented → leg Lower most part → tongue.
- ▶ Primary sensory area → S 1.
- ▶ Motor cortex → 4s, 4a, 4 y.