PHYSIOLO-
GY

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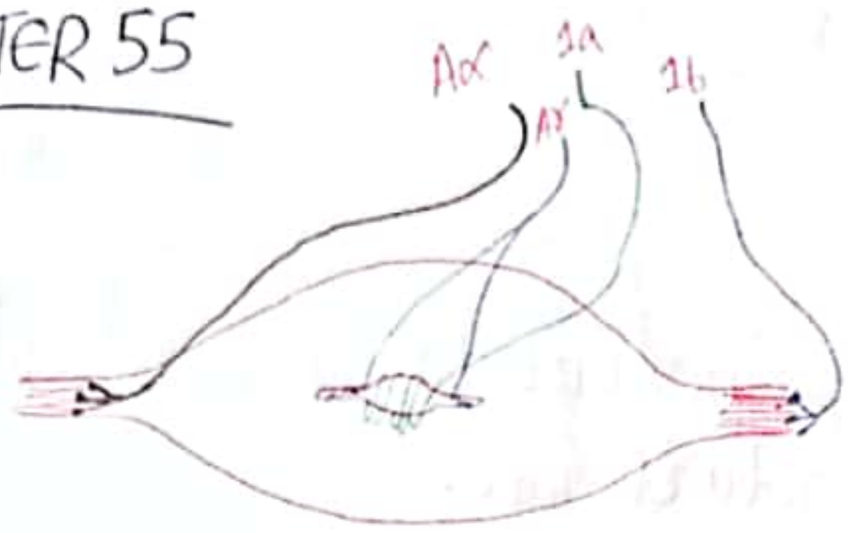
CHAPTER 55

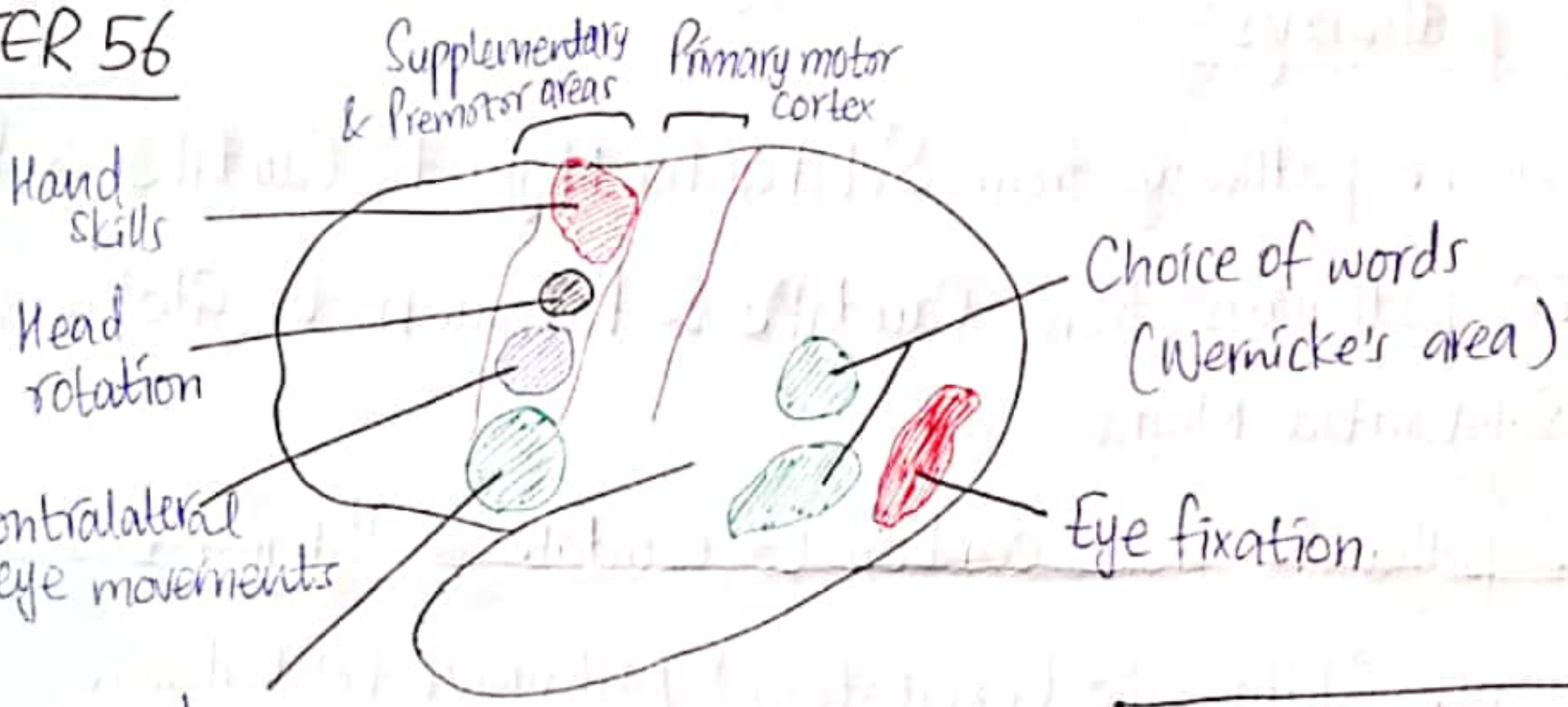


Aα → Extrafusal fibers
Aγ → Intrafusal fibers
1a → Spindle (Muscle Spindle)
1b → Golgi Tendon Organ

NOTE

- Muscle Spindle → Tone → L or ΔL excites it.
- Golgi Tendon → Tension → Tension or ΔTension excites it.

CHAPTER 56



Corticospinal Tracts
→ Primary motor cortex (30%.)
→ Premotor & Supplementary motor cortex (30%.)
→ Somatosensory areas (40%.)

- When Corticospinal Tract is not functioning, corticorubrospinal tract can take its place.
  So, most of the functions are gonna be fine EXCEPT fine movement of the fingers & hands.

Pontine reticular nuclei Excite Extensors (Antigravity) (PEE) & v.v for medullary reticular nuclei.

34,000 of these giant Betz cells fibers in each CS Tract.

only in PRIMARY MOTOR CORTEX

NOTE: Some of the giant fibers of Pyramidal (Corticospinal) Tract originate from giant pyramidal cells (Betz cells) → 16/Hm

CHAPTER 57 Cerebr

CHAPTER 57

NOTE

Agnosia → Sensory system works fine but brain can't interpret (perceive) ~~this~~ it into actual info.

Lesion of Post. parietal cortex ⇒ Personal Neglect Syndrome.
(lesion on right → person ignores his/her left side).

Some pathways

- Dopamine pathways from Substantia Nigra to Caudate & Putamen
- GABA pathways from Caudate & Putamen to Globus Pallidus & Substantia Nigra.
- Ach. pathways from cortex to caudate & Putamen.
- Multiple Glutamate (excitatory) pathways to balance out the inhibitory pathways.
- Multiple general pathways (NE, Serotonin, Enkephalin etc).

Huntington's Disease

- → loss of GABA → Tremors
- → loss of Ach. → Dementia

NOTE :

The abnormal gene for Huntington has been found to have many-times repeating codon "CAG". It codes for extra Glutamine in the molecular structure of an abnormal neuronal cell protein called HUNTINGTON

CHAPTER 58

Cerebral Cortex :

3 types of neurons :

- Granular → short axons → act as INTERNEURONS
- Fusiform
- Pyramidal

→ give rise to almost all the output fibers from the cortex

6 layers :

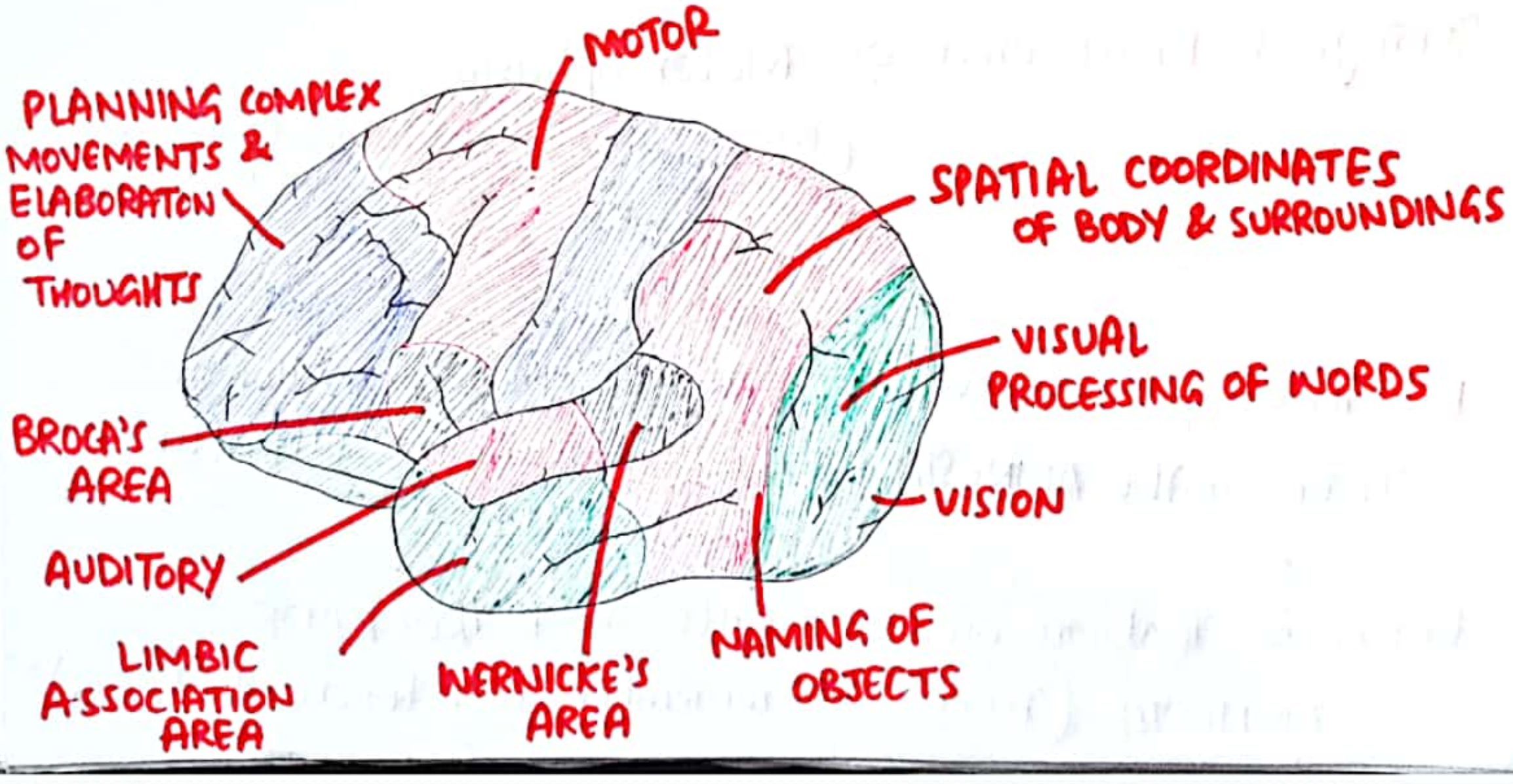
- I → Molecular
- II → Ext. granular
- III → Ext. pyramidal

→ perform most of the intracortical association functions

- IV → Int. granular → most of the incoming sensory signals from body terminate
- V → Int. pyramidal → very large fibers to brainstem & cord arise
- VI a → Ganglionic
- VI b → Multiform

→ most of the output signals leave the cortex

→ Terminate tremendous fibers into thalamus



Damage to medial undersides of both occipital lobes & along the medioventral surfaces of the temporal lobes ⇒ Prosopagnosia (inability to recognize faces)

Damage to the angular gyrus (Wernicke's area intact) ⇒ Dyslexia (word blindness)

- In dyslexia, person can still interpret auditory experiences as usual, but the stream of visual experiences passing into Wernicke's area is blocked
- So, NO INTERPRETATION OF VISUAL STIMULI.

Damage to auditory association area ⇒ Word deafness (can't interpret the sound heard)

Damage to Wernicke's area ⇒ Wernicke's aphasia (can't interpret the thoughts expressed)

Damage to Broca's area ⇒ Motor aphasia (person knows what he wants to say but can't say it → talks random)

NOTE

Angular gyrus has visual association area

Global aphasia is when damage spreads from Wernicke's area to angular gyrus (visual AA) & auditory AA.

NOTE

Both Hippocampi are removed for treating epilepsy → results in ANTEROGRADE AMNESIA (person don't remember stuff after the removal).

Lesion of Thalamic areas → results in RETROGRADE AMNESIA (person don't remember stuff before the lesion)

CHAPTER 59

Neurohormonal systems in human brain:

① Locus Ceruleus

↳ Located bilaterally & post. at the juncture b/w pons & midbrain.

→ Secrete NE

→ Leads to REM sleep (produce dreams).

② Substantia Nigra

→ Anterosuperior to midbrain.

→ Secrete Dopamine.

③ Raphe Nuclei

→ Midline of Pons & Medulla (several thin nuclei)

→ Secrete Serotonin.

④ Gigantocellular neurons of reticular formation

→ Reticular formation of midbrain & pons.

→ Secrete Ach.

Destruction of ant. parts of both temporal lobes ⇒ KLÜVER-BUCY SYNDROME

CHAPTER 60

- Nuclei Raphe (b/w pons & medulla) synthesize Serotonin, which induces natural sleep.
- Nucleus of Tractus solitarius, rostral (ant.) part of Hypothalamus, mainly in the suprachiasmal area + occasional area in the diffuse nuclei of thalamus => all causes sleep when stimulated.

NOTE

Muramyl peptide accumulates in CSF & urine of animals kept alive for several days. Micrograms of its injection into 3rd ventricle can cause instant sleep for several hours. (A similar substance "Nonapeptide" produce similar effects).

- Drugs that mimic the action of Ach. induces REM sleep.
- Orexin (aka Hypocretin) => produced by neurons in Hypothalamus
  ↳ causes brain excitation (wakefulness)

↓Orexin or ↓Orexin receptors → NARCOLEPSY

Stages of slow-wave sleep:

- Stage 1 → α waves
- Stage 2 & 3 → Theta waves
- Stage 4 → Delta waves

↑Dopamine can cause Schizophrenia (at risk → patients getting treatment for Parkinson)

→ Drugs that are used for treatment ↓Dopamine (risk for Parkinsonism)

Cortical Connections with thalamus sets up signals in thalamocortical system at frequency of 8-13Hz i.e. produce α-waves

Patients with Down's Syndrome have 3 copies of gene for amyloid precursor protein → develop Alzhiemer

Mental depression psychosis → ↓NE or Serotonin (or BOTH)

(treated with ① MAO inhibitors ② Tricyclic antidepressants e.g imipramine, amitriptyline etc.).

HYPOTHALAMIC NUCLEI

Post. & lateral ⇒ ↑ Arterial pressure & heart rate.

Preoptic area ⇒ ↓ Arterial pressure & heart rate.

Anterior HT ⇒ Causes COOLING of the body.

Lateral HT ⇒ Has thirst & hunger centers.

Suproptic ⇒ Synthesizes ADH

Paraventricular ⇒ Synthesizes Oxytocin

Ventromedial ⇒ Causes satiety

Mammillary bodies ⇒ Partially control feeding reflexes (e.g. licking lips, swallowing)

NOTE

- Major reward centers are the hunger (LATERAL) & the satiety (VENTROMEDIAL) centers of HT.
- Major punishment centers are the central gray area surrounding acqueduct of Sylvius in midbrain + Periventricular zones of HT & Thalamus.

DESI TIP

Think of the HT as a car.

↳ It has Air Conditioner ANTERIORLY, which causes cooling.

→ It has exhaust POSTERIORLY, which causes heating.

→ It has that fuel tank LATERALLY from where you put the fuel in (The hunger & thirst center)

→ It has the engine present VENTROMEDIALLY, which works when fuel's full (Satiety center)

→ This car has that car ceiling SUPERIORLY (Suprachiasmatic) from which you can look at the sky; if it's dark you know it's time to sleep (Circadian rhythms).

OREXINS are synthesized by HT & received by orexin receptors. It keeps the brain active throughout the day to keep it awake.

↓ Orexin or destruction of its receptors can cause NARCOLEPSY.

BRAIN WAVES

- ALPHA → Relaxed state (8–13 cycles/s)
  → Occipital region of brain.

- BETA → Intense mental activity OR Fright (>13 cycles/s)
  → Frontal & Parietal regions of brain.

- THETA → Psychomotor state (e.g. depression)
  (< 8 cycles/s)
  → Parietal & Temporal regions of brain

- DELTA → Deep sleep, infancy, Serious organic brain disease.
  → Occurs SPECIFICALLY in cortex, independent of activities in lower region of brain.

NOTE

- Lesions of Post. Parietal Cortex ⇒ AGNOSIA
  ↳ Lesion of right post. parietal cortex ⇒ patient neglects its left side.
  (PERSONAL NEGLECT SYNDROME)

- PROSOPAGNOSIA
  ↳ Inability to recognize faces
  (lesions on medial undersides of both occipital lobes & along medioventral surfaces of temporal lobes).

- DYSLEXIA
  ↳ Word blindness
  (Angular gyrus association area in temporal lobe comprehends visual info. & send it to Wernicke's area. Its lesion causes dyslexia).

- KLÜVER-BUCY SYNDROME

↳ Person is
- Not afraid of anything.
- Putting everything in mouth.
- F*@#ing everything.

- Occurs commonly during surgical treatments for epilepsy.

(Bitemporal removal of Ant. parts of both temporal lobes remove amygdala with it. It results in KBS.)

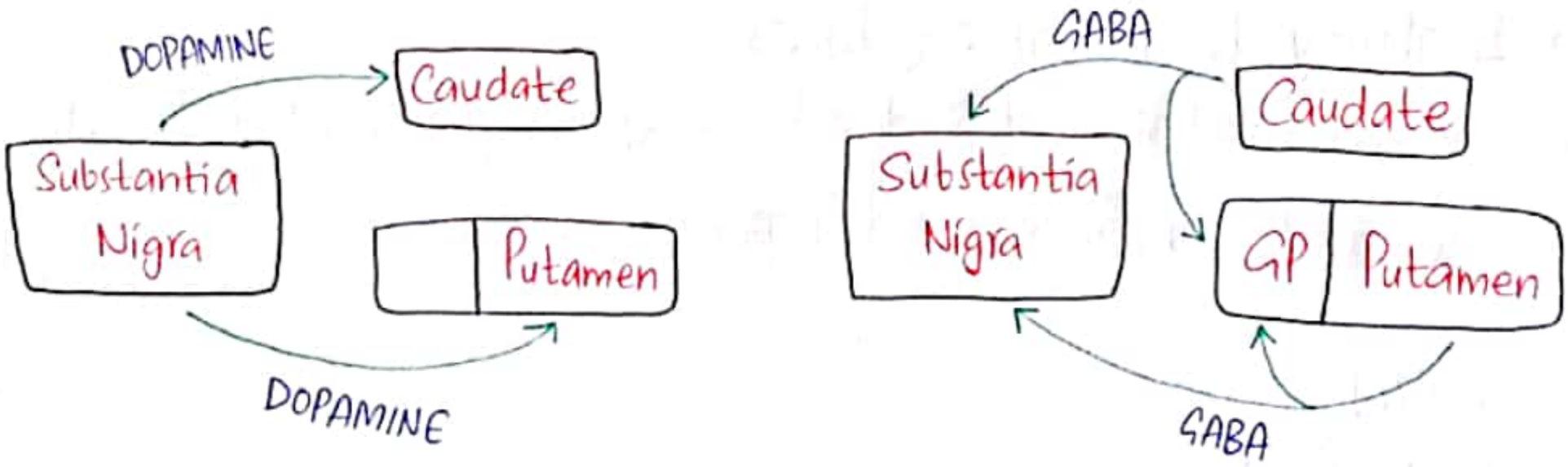
NOTE

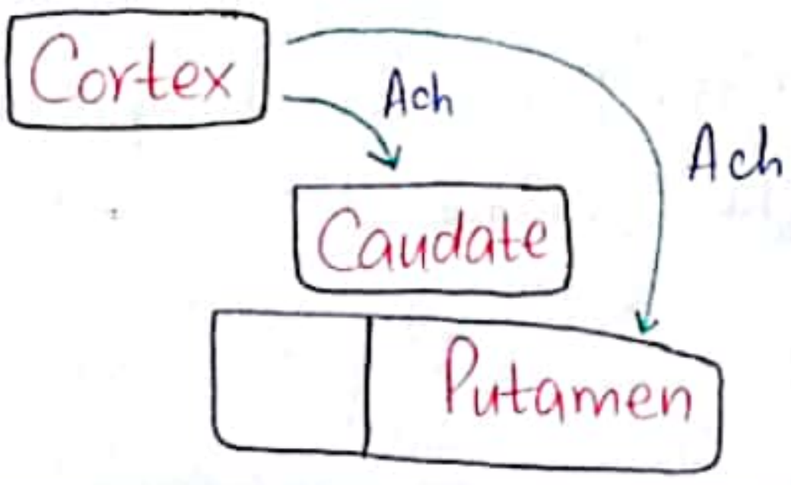
- Lesions of Hippocampus causes both types of amnesia but mostly ANTEROGRADE AMNESIA (nothing is remembered After the lesion).

Anterograde ⇒ Aagay kuch yaad nahi rahega.

NOTE

3 main pathways in Basal Ganglia:





EYE - II

- Orange monochromatic light ⇒ Ratio of stimulation of cones ⇒ red : green : blue = 99 : 42 : 0

- Blue light ⇒ 0 : 0 : 97
- Yellow light ⇒ 83 : 83 : 0
- Green light ⇒ 31 : 67 : 36

In Red-Green colour blindness,
- Loss of Red cones ⇒ PROTANOPE.
- Loss of Green cones ⇒ DEUTERANOPE.

- About equal stimulation of all red, blue & green cones ⇒ White Light

Each retina contains 100 million rods & 3 million cones (ratio of rods to cones is that 60 rods & 2 cones converge on each ganglion cell & the optic nerve fiber leading from ganglion cell to the brain).

b/c ganglion cell are 1·6 million in each retina.

The only retinal neuron that always transmit visual signals by means of action potentials are GANGLION CELLS.

There are 35,000 cones in fovea.

3 types of retinal ganglion cells:

- W cells ⇒ Slow velocity
  - ⇒ Receive most of their excitation from rods.
  - ⇒ Have broad fields in PERIPHERAL retina.
  - ⇒ Detect DIRECTIONAL movement.
  - ⇒ Important for crude rod vision under dark.

- X cells ⇒ Small fields.
  - ⇒ Responsible for COLOUR VISION of cones.
  - ⇒ Detect fine details of visual images.
  - ⇒ Show discrete retinal locations.

- Y cells ⇒ Largest size.
  - ⇒ Broad fields (even more than of W cells).
  - ⇒ Respond to rapid changes in visual images.
  - ⇒ Do not specify the location of the event with accuracy.

NOTE → Previous classification was in CATS. (2)
In PRIMATES, retinal ganglion cells are divided into P & M cells. (imp!)

PARVOCELLULAR (P cells)	MAGNOCELLULAR (M cells)
• Receptive fields are small.	v.v.
• Axons conduct impulses slowly.	v.v.
• Responses to stimuli are sustained for longer periods.	Responses are transient.
• Sensitive to colour.	Not sensitive to colour.
• Less sensitive to BLACK & WHITE stimuli.	• Highly sensitive to B & W stimuli.

EYE - III

Visual pathway ⇒

- Optic nerves ⟶ Optic chiasm ⟶ Dorsal lateral geniculate nucleus of thalamus ⟶ Geniculocalcarine fibers
(pass by optic radiations to primary visual cortex in the calcarine fissure area of medial occipital lobe.)

NOTE → Along this visual pathway, some fibers also pass to several older areas of brain:

① Suprachiasmatic nucleus of HT ⇒ Control circadian rhythms.
② Pretectal nucleus of Midbrain ⇒ Reflex movements of eyes.
③ Sup. colliculus ⇒ Control rapid directional movements of the two eyes.
④ Ventral lat. geniculate N. of Thalamus ⇒ Control some of the body's behavioral functions.

NOTE ⇒ Lateral Geniculate Body (Dorsal) has 6 layers:
• Layers I, IV & VI ⇒ receive signals from medial half of retina of opposite eye & v.v. (i.e. II, III & V → same eye's lateral half).

mple cells → Detect lines oriented in DIFFERENT directions in Primary visual Cortex.

Complex cells → " " " " SAME directions but in different positions in Primary visual cortex.

Detection of Colour

Colour is detected in same way that lines are detected i.e. by means of colour contrasts

- → Red is contrasted with Green (Really Gay)
- → Blue " " " Red (BRuh)
- → Green " " " Yellow (GuY)

→ All these colours can also be Contrasted against white colour

In Syphilis, pupil does not constrict with light but constrict during accomodation (ARGYLL-ROBERTSON PUPIL).

Pupil constriction (by stimulation of ParaSNS) → MIOSIS

Pupil dilation (by stimulation of SNS) → MYDRIASIS

CHAPTER 48

There are at least 6 different types of tactile receptors:

① Free Nerve Endings:

- Found everywhere in skin & many other tissues.
- Detect touch & pressure. (e.g. in cornea of the eye).

② Meissner's Corpuscle:

- High sensitivity.
- Large Aβ myelinated sensory nerve fibers.
- Present in non-hairy part of skin (e.g. fingertips, lips etc).
- Adapt in a fraction of second, which means they are particularly sensitive to movement of objects over the surface of skin, as well as to low-frequency vibration.

③ Merkel's Disc (Expanded Tip Tactile Receptor):

- Present in fingertips & other areas where Meissner's Corpuscle is present.
- Also present in hairy part of the skin.
- Slow adaptation.
- Large Aβ myelinated sensory nerve fibers (sensitive)
- Often grouped together in a receptor organ called the "Iggo dome receptor", which projects upward against the underside of the epithelium of the skin

④ Hair end-organ:

- Slight movement of any hair on the body stimulate it
- Adapts readily.
- Function just like Meissner's corpuscle.

⑤ Ruffini's endings:

- Adapt very slowly (Ruffini → Ro dee adaptation ke)
- Multibranched, encapsulated endings.
- Found in the deeper layers of the skin & also in still deeper internal tissues.

⑥ Pacinian Corpuscles:

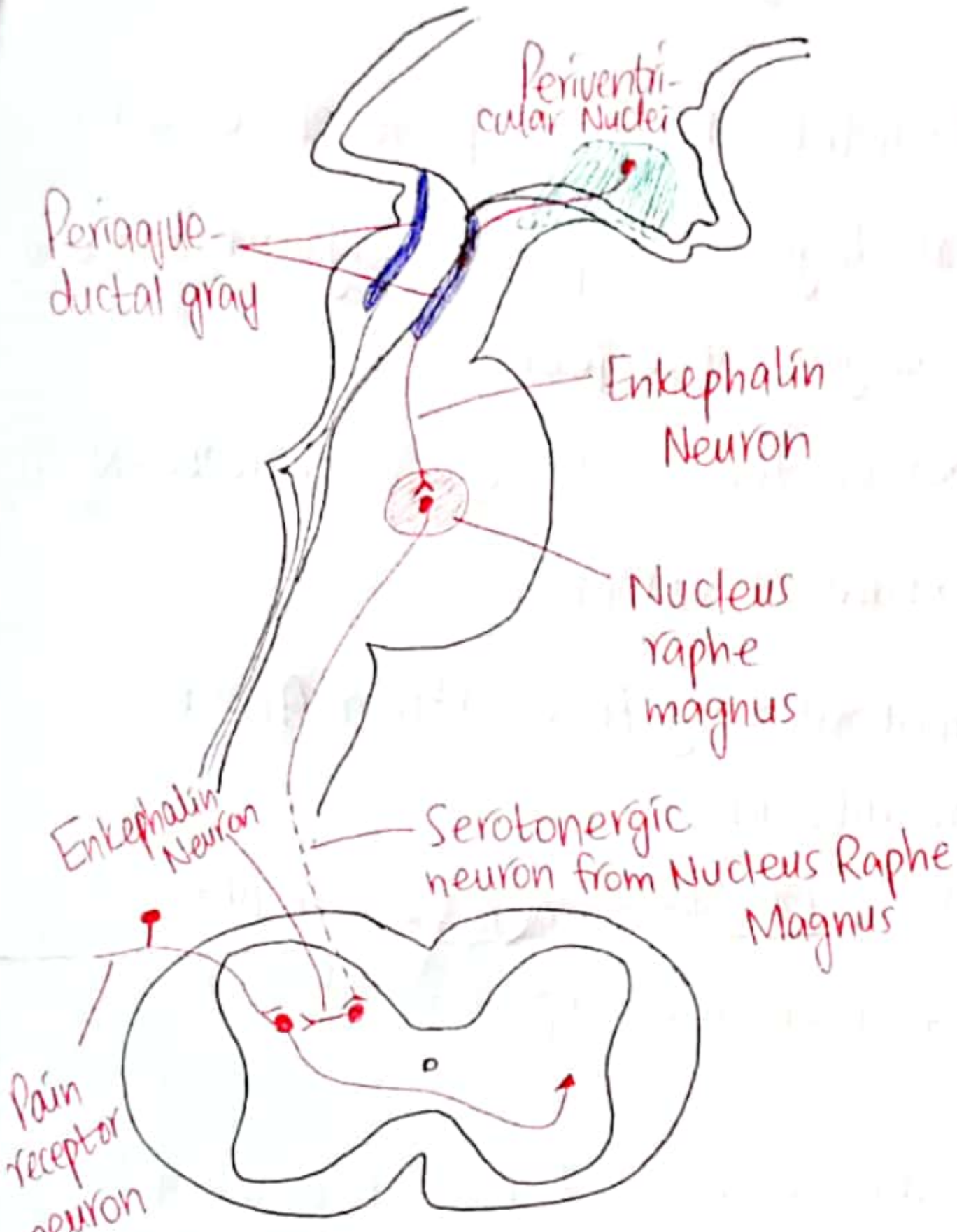
- Adapt in a few hundredths of a second.
- Stimulated only by local compression of the tissues.
- Particularly important for detecting tissue vibration or other rapid changes in the mechanical state of the tissues.
- Found immediately beneath the skin & deep in the fascial tissues of the body.

NOTE

Meissner's corpuscles, Iggo dome receptors, Hair end-organs, Pacinian corpuscles, Ruffini's endings → Aβ fibers (30-70 m/s)

Free nerve endings → Aδ (5-30 m/s)
→ Type C (2 m/s) → tickle + itch sensations

ANALGESIA SYSTEM



3 major components:

① Periaqueductal gray & Periventricular areas of Midbrain & Upper Pons

② Raphe Magnus Nucleus, in lower pons & upper medulla + Nucleus Reticularis Paragigantocellularis, laterally in medulla.

③ Pain inhibitory complex, in dorsal horns of spinal cord.

Analgesia system works by suppresing the pain fibers by releasing Enkephalins & Serotonin.

Important opiate-like substances are:

Met-enkephalin } → in Brain stem & Spinal Cord
Leu-enkephalin }

B-endorphin → Hypothalamus & Pituitary Gland

Dynorphin → Same areas as enkephalins (but ↓ quantities)

Bilateral damage to Somatosensory area 1 (Broddman's area 3,2,1) results in

- Unable to localize discretely the exact point of sensation
- Unable to judge critical degrees of pressure against the body
- Unable to judge the weights of objects.
- Unable to judge shapes or forms of objects (ASTEREOGNOSIS)
- Unable to judge texture of materials

Bilateral damage to Somatosensory Association Area (Broddman's area 5,7) results in

- The person loses the ability to recognize complex objects & complex forms felt on the opposite side of the body.
- Person loses most of the sense of form of his/her own body or body parts on the opposite side. In fact, the person is mainly oblivious to the opposite side of the body i.e. it forgets that it is there. Therefore, he/she forgets even to use the motor functions. (AMORPHOSYNTHESIS).

NOTE

- There's a similar lesion i.e when RIGHT Post Parietal Cortex is damaged, person neglects its LEFT side ⇒ PERSONAL NEGLECT SYNDROME

Insensitive Viscera
(does not feel any type of pain)

- LIVER PARENCHYMA
  (but Liver capsule & bile ducts are sensitive to pain)
- ALVEOLI OF THE LUNGS
  (but bronchi & parietal pleura are sensitive to pain)

Localization of Visceral Pain

- Heart ⇒ C3-T5 (side of the neck, shoulder, arm, upper chest, pectorals)
- Stomach ⇒ T7-T9 (ant. epigastrium, above the umbilicus)
- Appendix ⇒ $T_{10}-T_{11}$ (around umbilicus)

NOTE

- Very cold ⟶ cold-pain fibers stimulated.
- +10°C - 15°C ⟶ cold receptors are stimulated (not cold-pain)
- +30°C ⟶ warm receptors are stimulated
- +45°C ⟶ heat-pain fibers + cold fibers are stimulated.

NOTE

Alkalosis ⟶ INCREASES Neuronal excitability

(Alkalosis ⇑ $\downarrow H^+$ ⇒ $\downarrow K^+$ ⇒ $\uparrow Na^+$ ⇒ Na^+ ∝ neuron excitation)

Acidosis ⟶ DECREASES Neuronal excitability

(Acidosis ⇒ $\uparrow H^+$ ⇒ $\uparrow K^+$ ⇒ $\downarrow Na^+$ ⇒ Na^+ ∝ neuron excitation)

CHAPTER 47

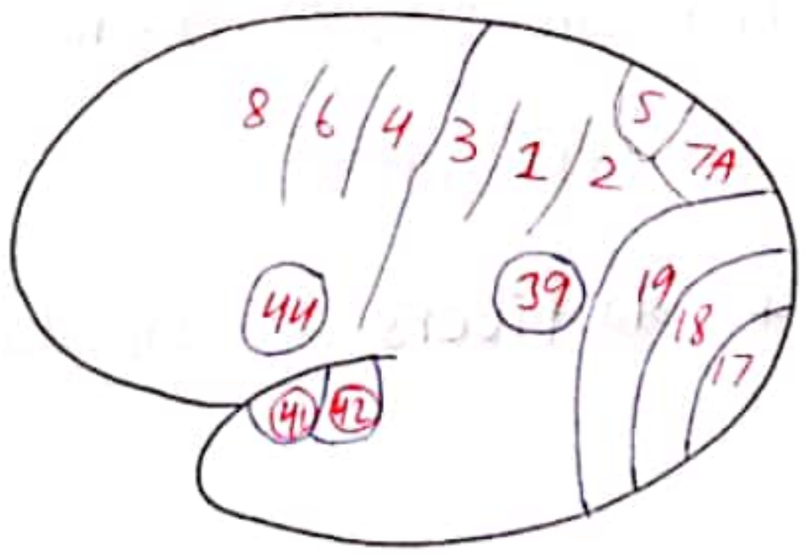
Divergence is of 2 types:

① Amplifying divergence:

- In Corticospinal tracts
- Input signal from one neuron spreads through successive orders of neurons in its path.

② Diverging into multiple tracts:

- In Dorsal Columns of spinal cord.
- Signal is transmitted in 2 directions from the neuronal pool.



GI PHYSIOLOGY

CHAPTER 63

- Gap junctions connect smooth muscles as a syncytium but still action potential travels rapidly ALONG THE LENGTH of the bundle than sideways.

2 types of potentials:

① SLOW WAVE (5-15mV)

- → Stomach (3)
- → Duodenum (12)
- → Terminal Ileum (8-9)

⇒ occurs t/c of Interstitial cells of Cajal, which are electrical pacemakers for smooth muscle cells.

Slow waves itself does not contract smooth muscle (EXCEPT in stomach) but ↓ the threshold for spike potential.

② SPIKE POTENTIALS (above -40mV)

- → Use Calcium-sodium channels. (NOTE - Slow wave only open Na^+-channel.)
- → Slow to open/close ⇒ action lasts longer than nerves.

NOTE

- Myenteric plexus helps in peristalsis. It is mostly excitatory but also inhibitory i.e VIP released by it helps in closing of sphincters.

No. of neurons in GI system are 100 million i.e. equal to that in whole spinal cord.

- Submucosal plexus is more concerned with controlling function within the inner wall eg. secretion, absorption, local contraction of submucosal muscle.

NOTE

Sympathetic NS inhibits intestinal tract smooth muscles EXCEPT Mucosal muscle, which it excites.

check table on page 802

80% of nerve fibers in Vagus N are AFFERENT than efferent.

- Usual stimulus for Peristalsis is distention of the gut, which produces a contractile ring 2-3cm behind this point.

(Peristalsis is characteristic of smooth muscle i.e not just of gut but also of bile ducts, glandular ducts, ureters etc).

NOTE

↳ ATROPINE blocks cholinergic fibers going to myenteric plexus → NO PSNS
→ NO MYENTERIC PLEXUS → NO PERISTALSIS

S → Secretin
K → GIP
L → GLP-I
I → Cholecystokinin
EC → Serotonin & Sub.P
MO → Motilin
D1 → VIP
G → Gastrin

CHAPTER 64

When jaw muscles close teeth
- → Incisors ⇒ 55 pounds
- → Molars ⇒ 200 pounds

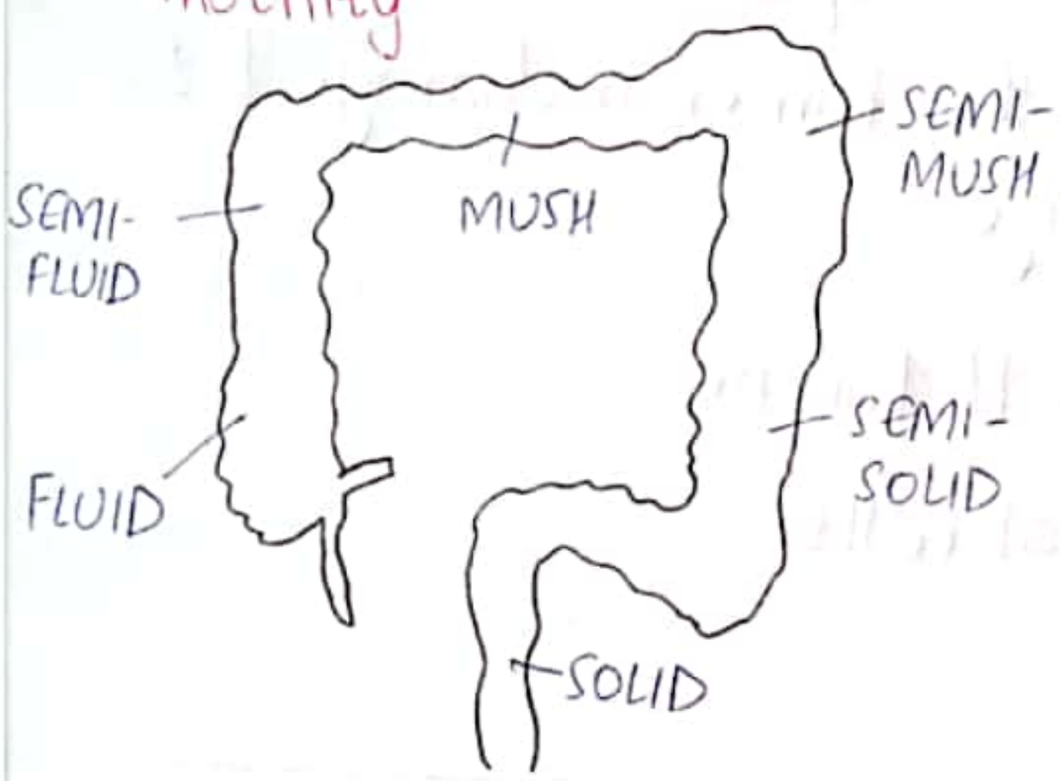
Deglutition / Swallowing centres are located in lower pons & Medulla.

Esophagus
- → Upper 1/3rd ⇒ Skeletal muscle (Glossopharyngeal & Vagus N)
- → Lower 2/3rd ⇒ Smooth muscle (Vagus N + Esophageal myenteric NS)

∴ When food reaches stomach ⇒ VAGOVAGAL reflex initiates, which relaxes the stomach to its maximum limit ⇒ stores 0.8–1.5L.

Promotes intestinal motility ⇒ Gastrin, CCK, Insulin, GIP, Motilin, Serotonin

Inhibits intestinal motility ⇒ Secretin, Glucagon.



Sup & Inf. Salivatory nuclei are present at Junction of pons & Medulla

CHAPTER 65

All of the GI hormones are polypeptides or their derivatives.

NOTE

Salivation can be secondarily increased by PSNS b/c of moderately dilated blood vessels.

↳ Salivary cells secrete KALLIKREIN, which in turn acts as an enzyme & split α-2-globulin to bradykinin ⇒ Vasodilator.

- Stomach has 2 types of ~~cells~~ glands (in addition to mucus secreting cells)
  - → OXYNTIC GLANDS ⇒ Secrete HCl, Pepsinogen, Intrinsic factor & Mucus (HIP)
  - → PYLORIC GLANDS ⇒ Secrete mucus & gastrin.

Oxyntic cells ⇒ Proximal 80% of the stomach

Pyloric cells ⇒ Distal 20% of the stomach.

Stomach produce acid & in return gives HCO_3^- to blood. Hence, ↑acid secreted by stomach means ↑pH (alkalosis) of blood.

NOTE

Major part of stomach's acid backleak is prevented by ⇒ ① Alkaline mucus ② Tight junctions of epithelium

- Due to overuse of aspirin or alcohol, this barrier is damaged & can result in stomach mucosal damage.

- Ach
  - ⊕ → Parietal cells
  - → Peptic cells
  - → Mucous cells

- Gastrin & Histamine
  - ⊕ → Parietal cells

NOTE

Gastrin ⊕→ Histamine ⊕→ HCl

- Gastrin ↑ by pyloric glands
- Histamine ↑ by Entero-chromaffin like cells
- HCl ↑ by parietal cells

Gastrin is secreted in 2 forms
- → G-34 (contains 34 a.a)
- → G-17 ⇒ more abundant (contains 17 a.a)

NOTE

Pepsinogen secretion ↑ when:
- → Ach released by Vagus N OR by Gastric enteric nervous plexus (Parasympathetic NS)
- → Acid in the stomach

- 3 phases of gastric secretion:
  - Cephalic (30%)
  - Gastric (60%)
  - Intestinal (10%)

NOTE

Glucose & Galactose are coupled with Na^+ absorption from intestine

(No Na^+ absorption from SI → No Glu. & Gal. absorption)

- Fructose diffuses independently of Na^+.

Approx 94% of the bile salts are reabsorbed into the blood from Small intestine. Then enter portal blood & pass back to the liver.

↳ Hence, on average, bile salts make 17 circuits before being completely consumed.

- Feces are composed of:
  - 3/4th water
  - 1/4th solid matter
    - Dead bacteria (30%)
    - Fat (10-20%)
    - Inorganic matter (10-20%)
    - Protein (2-3%)
    - Undigested roughage (30%)

- Colour of feces is by STERCOBILIN & UROBILIN.
- Odour of feces is by INDOLE, SKATOLE, MERCAPTANS, HYDROGEN SULFIDE

NOTE

- Loss of parietal cells result in:
  - → Achlorhydria (b/c of ↓HCl)
  - → Pernicious anemia (b/c of ↓ Intrinsic Factor)

Intrinsic factor helps to absorb vit. B12 from the ileum.

NOTE

- A type of peptic ulcer called a marginal ulcer occurs wherever a surgical opening e.g. gastrojejunostomy has been made b/w the stomach & jejenum.
- H. pylori causes ulcer by virtue of its physical capability to burrow through the barrier & by releasing ammonium ions (NH_4^+) that liquefies the barrier & stimulates the secretion of HCl.
  (H pylori commonly cause ulceration at gastro-duodenal junction).
- Treatment for ulcer
  - → Antibiotics (to kill H. pylori)
  - → Ranitidine (Antihistaminic agent → ↓Histamine → ↓HCl)
    - ↓ gastric secretions
      70-80%
- Drugs such as Apomorphine, Morphine, Digitalis derivatives can trigger the vomiting centre (area postrema) & cause vomiting.
- If area postrema is damaged,
  - → NO drug-induced vomiting
  - → GI distention-induced vomiting still occurs.