



Biology Handwritten Notes

On

Chemical Coordination and Integration



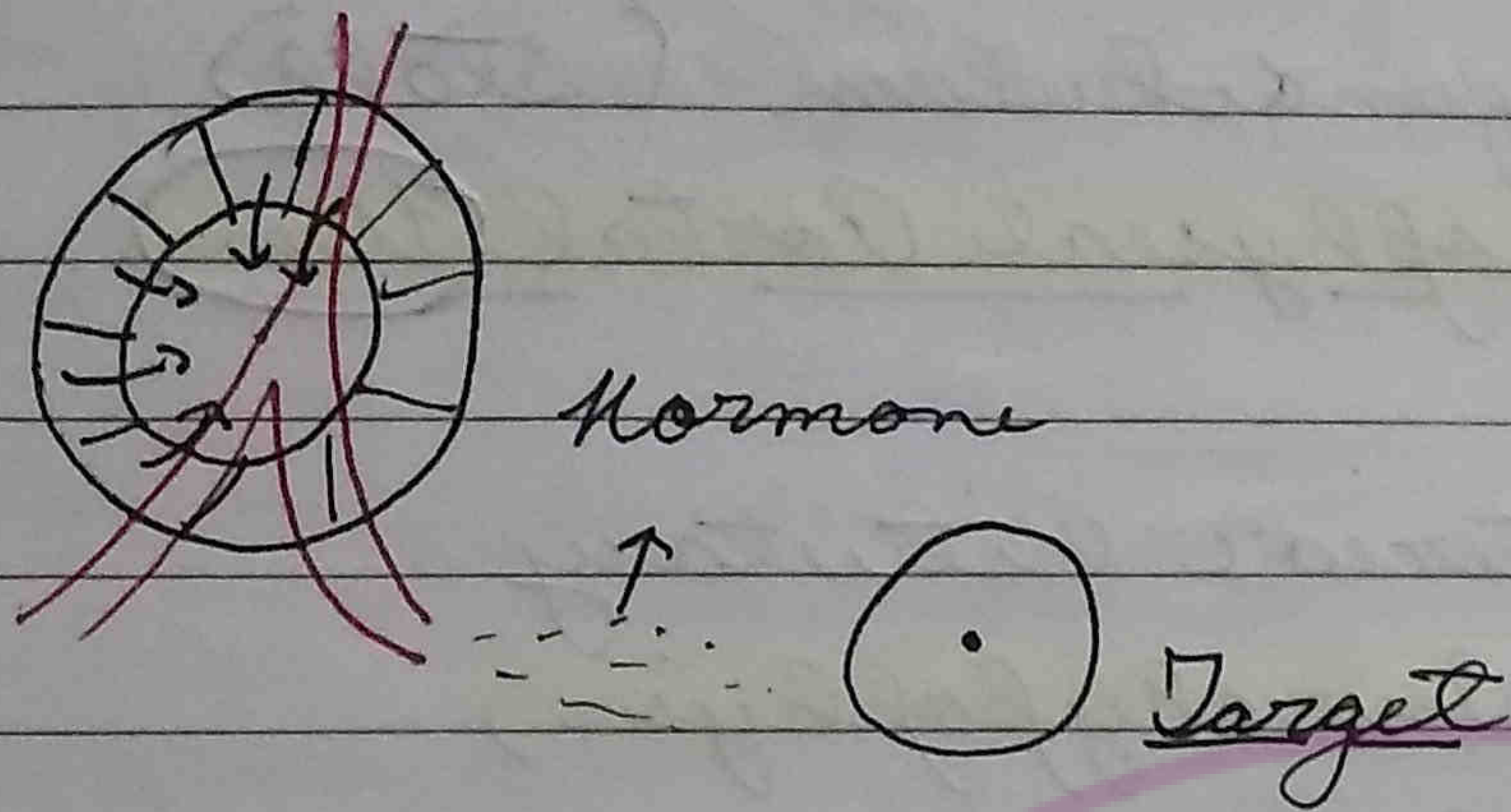
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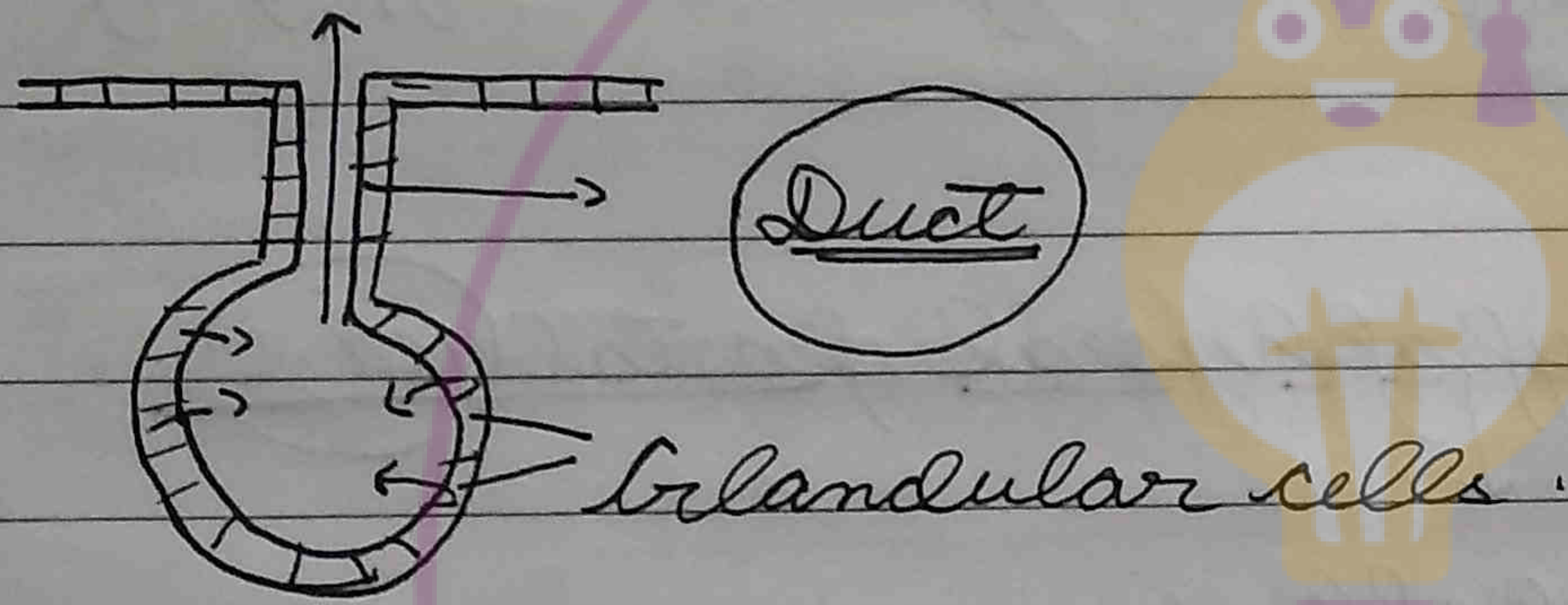
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Chemical Coordination and Integration

Endocrine Glands → Ductless glands.



Exocrine Gland →



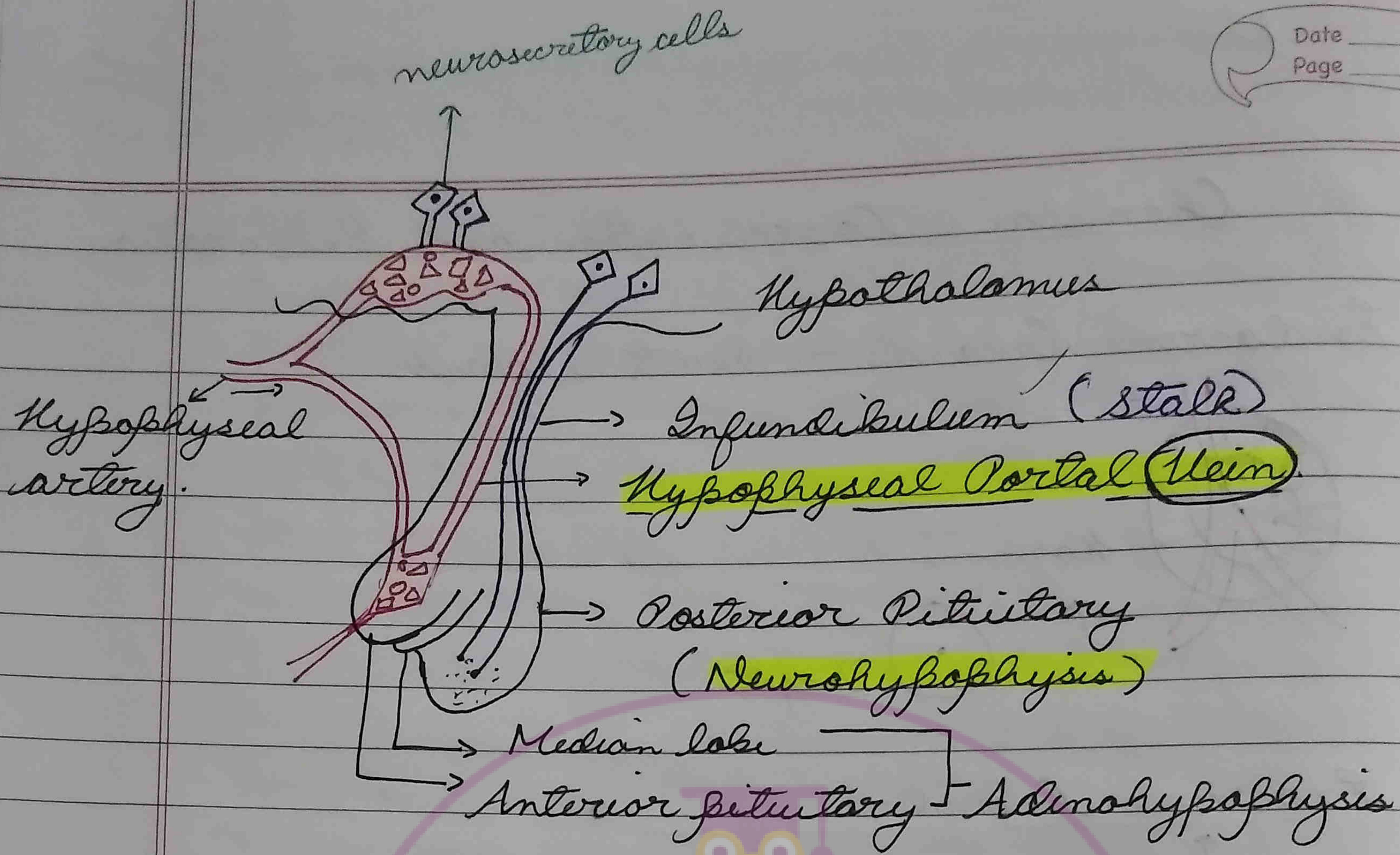
Hormone →

- Chemical messenger ✓
- Non-nutrient substance (cannot be taken diet)
- Secreted in traces ✓ (i.e. produced in the body)
- Hormone word means excite
- It was discovered by Baylis and Starling.
- First hormone to be discovered was Secretin.

Endocrine Glands

(i) Hypothalamus

- present on the floor of diencephalon.
- Neurosecretory cells → neurons which secrete hormones.



• Poured into hypophysial portal vein
↓
Adenohypophysis.

1. GnRH (Growth Hormone Releasing hormone) → stimulates anterior pituitary to release GH (Growth Hormone)
2. GHIH (Growth hormone inhibiting hormone) / Somatostatin → Inhibits the secretion of GH
3. TRH (Thyrotrophin releasing hormone) → stimulates anterior pituitary to release TSH (Thyroid stimulating hormone).
4. GnRH (Gonadotrophin Releasing Hormone) → stimulates anterior pituitary to release Gonadotrophins (FSH and LH)
5. CRH (Corticotrophin Releasing Hormone) → stimulates production of ACTH.

- Prolactin misused by dairy farmers.
 - ↳ synthetically produced oxytocin
- ★ Dopamine inhibits prolactin secretion.

6 PRL (Prolactin Releasing Hormone) → stimulates production of prolactin from pituitary.

7★ PRL / Dopamine → Inhibits prolactin secretion.

• Posterior Pituitary

Secreted by

Paraventricular nuclei

Supraoptic nuclei

Oxytocin

Vasopressin / ADH

contraction of uterine muscles during childbirth.

Absorption of water from kidney tubules (DCT and collecting duct)

Ejection of milk
Pitocin (synthetic)

• Diabetes insipidus → caused due to insufficient production of ADH.
lastilese
- Copious amounts of dilute urine are produced. (urast)

• Pituitary gland (Hypophysis) →

- Master gland of the body.
- Pea sized gland.
- Located in Sella Turcica, a cavity in sphenoid bone.

★ Very IMP: Infundibulum + pars nervosa are called neurohypophysis

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- Basophil: remaining few hormones
- Acidophil: GH and Prolactin

Hypophyses

Adenohypophyses

Neurohypophyses
(pars nervosa)

Pars anterior / Pars media
distalis (less developed)

- Hormones secreted by pituitary are called tropic hormone.

Tropic Hormones → Hormones that stimulate other glands secrete hormones.

TSH → stimulates thyroid gland.

FSH → stimulates testis and ovaries to produce gametes.

LH → stimulates testis and ovary.

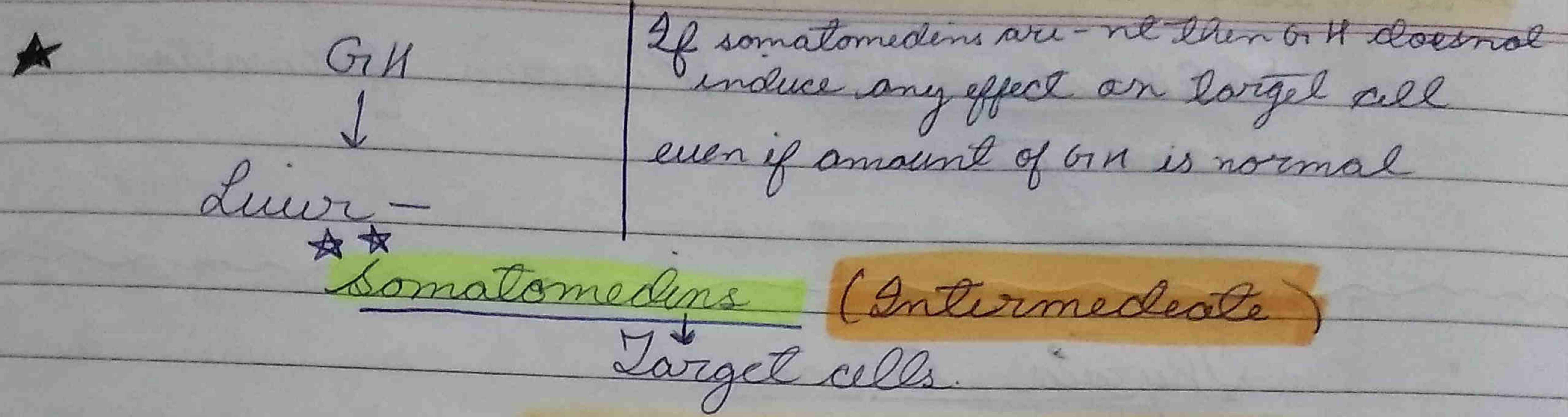
ACTH (Adrenocorticotropic hormone) → stimulates adrenal cortex (only and not adrenal medulla)

- Non-Tropic Hormones → acts on the gland directly.

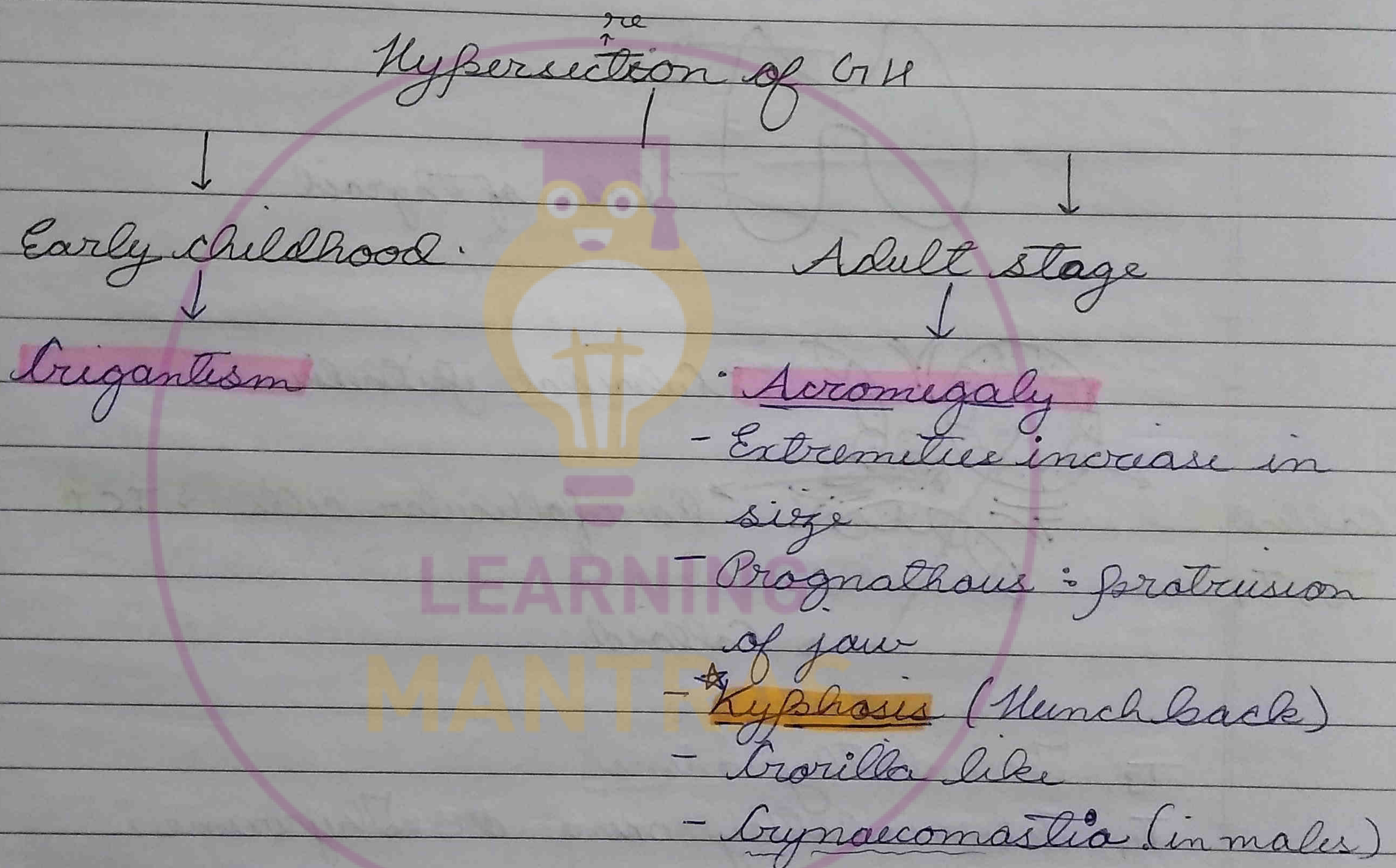
- GH -

- Increases protein synthesis
- Increases blood glucose.

- Prolactin is active for a short time after child birth but remains inhibited for rest of the life cycle. classmate
- GH doesn't directly acts on target cells, it acts ^{Date} _{Page} through intermediate called somatomedins.



• Hyposecretion of GH → Dwarfism.



• Prolactin (PRL):

• Stimulates the mammary glands to secrete milk.

• MSH (Melanocyte Stimulating Hormone)

- Secreted from pars media under stimulus of MRFH (Melanocyte Stimulating Releasing Hormone).

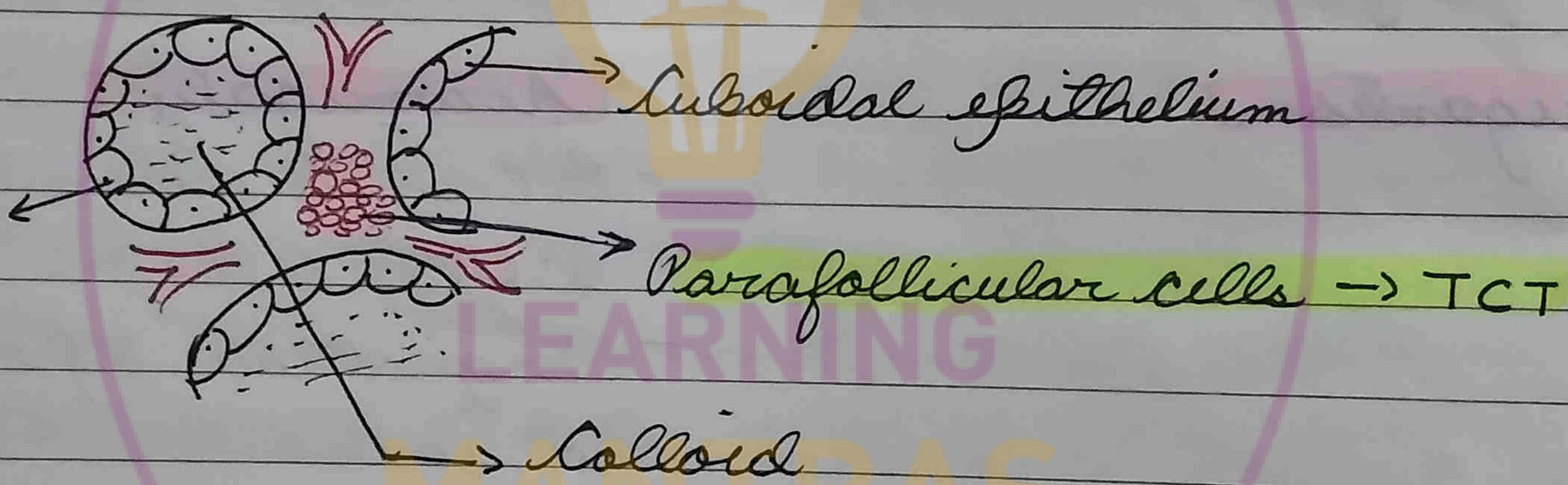
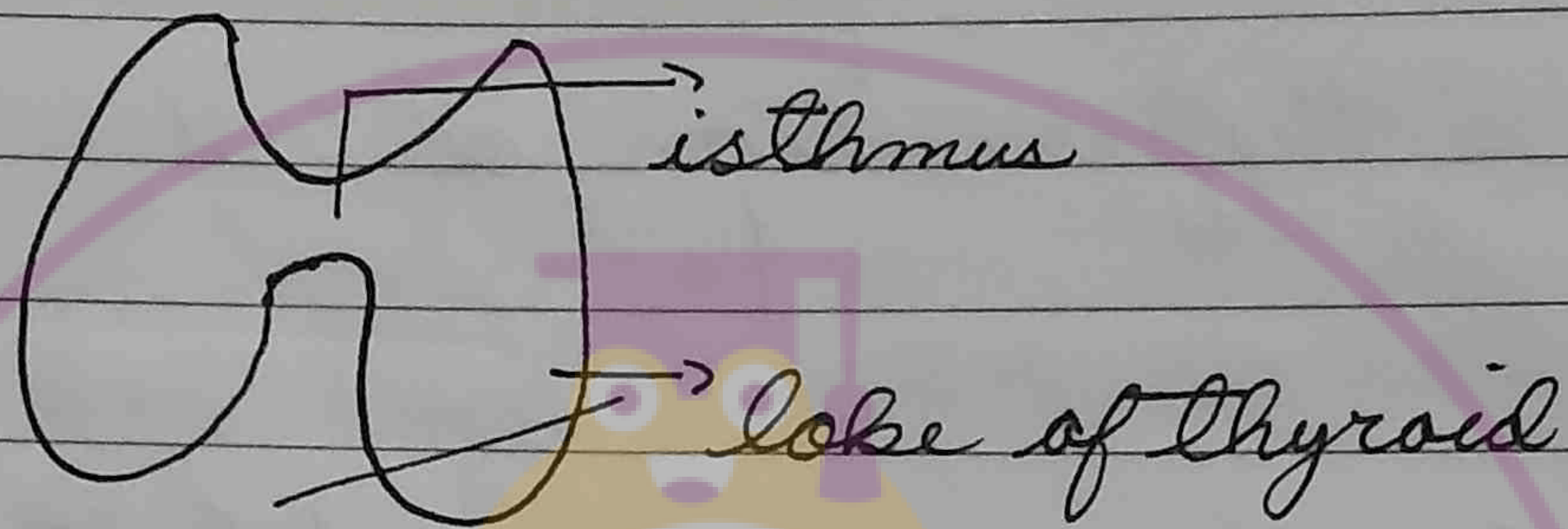
- Inhibited by MIFH (Melanocyte stimulating inhibiting hormone).

- Thyroid gland is butterfly shaped.
- T_3, T_4 secreted by follicular cells.
- ve feedback is present in formation of thyroxine

- MSH stimulates Melanin formation in melanocytes.

Thyroid Gland

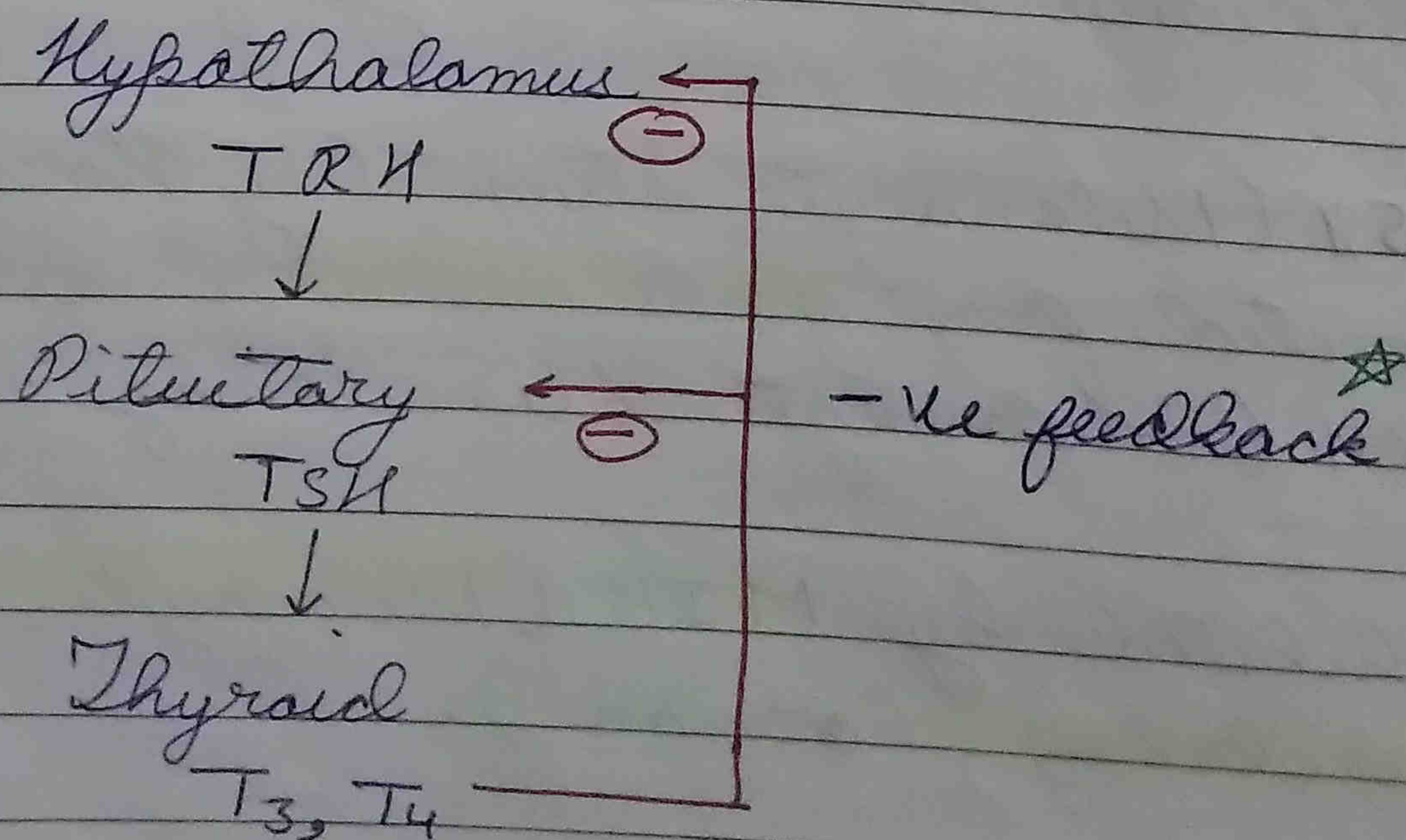
- Largest endocrine gland.
- Located over trachea.



T_3 Triiodothyronine

T_4 Tetraiodothyronine or Thyroxine.

Formed by iodination of Tyrosine.



T_4 is released in larger amount but T_3 has higher potency.

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• Functions of T_3, T_4

- Regulates BMR.
- **Calorigenic hormone** (stimulates production of heat).
- Important for physical and mental growth.
- For normal menstrual cycle.
- Necessary for metamorphosis in amphibians.
(Tadpole \rightarrow frog).

• Hyposecretion of T_3, T_4

- **Cretinism** \rightarrow Hypothyroidism in **children**.

- Low IQ
- Mentally and physically retarded.
- Protuberant belly, thick tongue
- Deaf-mutism.

- **Myxedema** \rightarrow Hypothyroidism in **adults**.

- Puffy appearance
- Low BMR
- Gain of weight (obesity)
- Lethargy
- Failure to conceive.

- **Hashimoto's Thyroiditis**

Autoimmune disease in which the immune cells destroy the thyroid gland.

★ If a tadpole is given thiourea, its metamorphosis will stop.

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- Simple Goitre
- Caused due to nutritional deficiency of iodine.
- Enlargement of gland
- Endemic in hilly areas.

• Hyperthyroidism

- BMR increases
- Lean and thin physique and heat intolerance.

- Graves' Disease -

- Autoimmune disease
- Antibodies are formed which mimic TSH.
- Exophthalmic goitre - Eyeballs protrude out
- In this case Thiourea - blocks is given which helps breakdown thyroxine.

- Hyperthyroidism can also result due to thyroid tumour.

• Thyrocalcitonin (TCT)

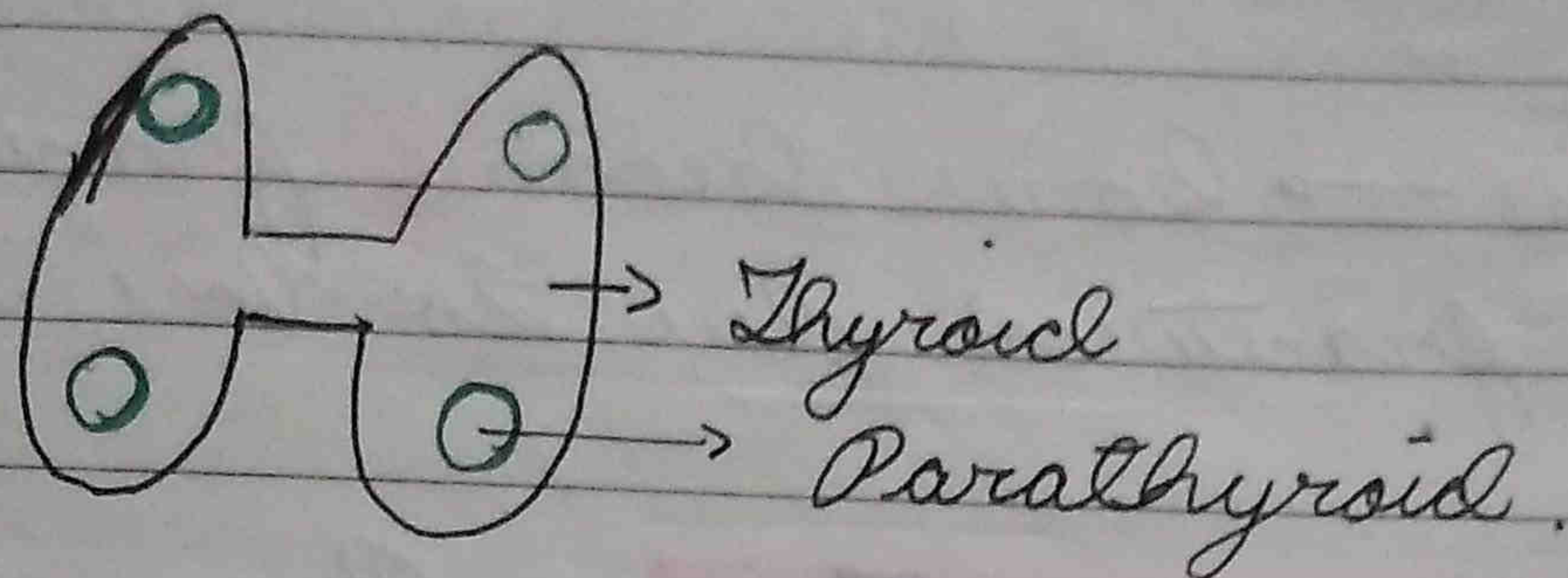
- Peptide hormone having 32 amino acids.
- secreted by parafollicular cells.
- secreted in response to high blood Ca^{2+} .
- removes excess Ca^{2+} (hypocalcaemic hormone)
- Inhibits osteoclasts in the bone.
- Inhibits Ca^{2+} absorption in the gut.
- Increases excretion of Ca^{2+} .

- For calcium absorption vitamin D is required and active form of vitamin D is D_3 .

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Parathyroid Gland



- Located on posterior surface of thyroid.
- Secretes Parathormone / PTH / Collip's hormone.
- Antagonistic to calcitonin (TCT).
- Increases the level of blood Ca^{2+} in blood.
- Increase osteoclast activity (Resorption of bone).
- Increases Ca^{2+} reabsorption from kidney and absorption from gut.
- Vitamin D is converted to $1D_3$ (in kidneys) for absorption of Ca^{2+} .

Hyposecretion of PTH →

- Hypocalcemic Tetany :
- Blood Ca^{2+} is lowered.
- increase in Na^+ and K^+
- spontaneous contraction of muscles
- cramps.

Thymus is also called training school of lymphocytes.

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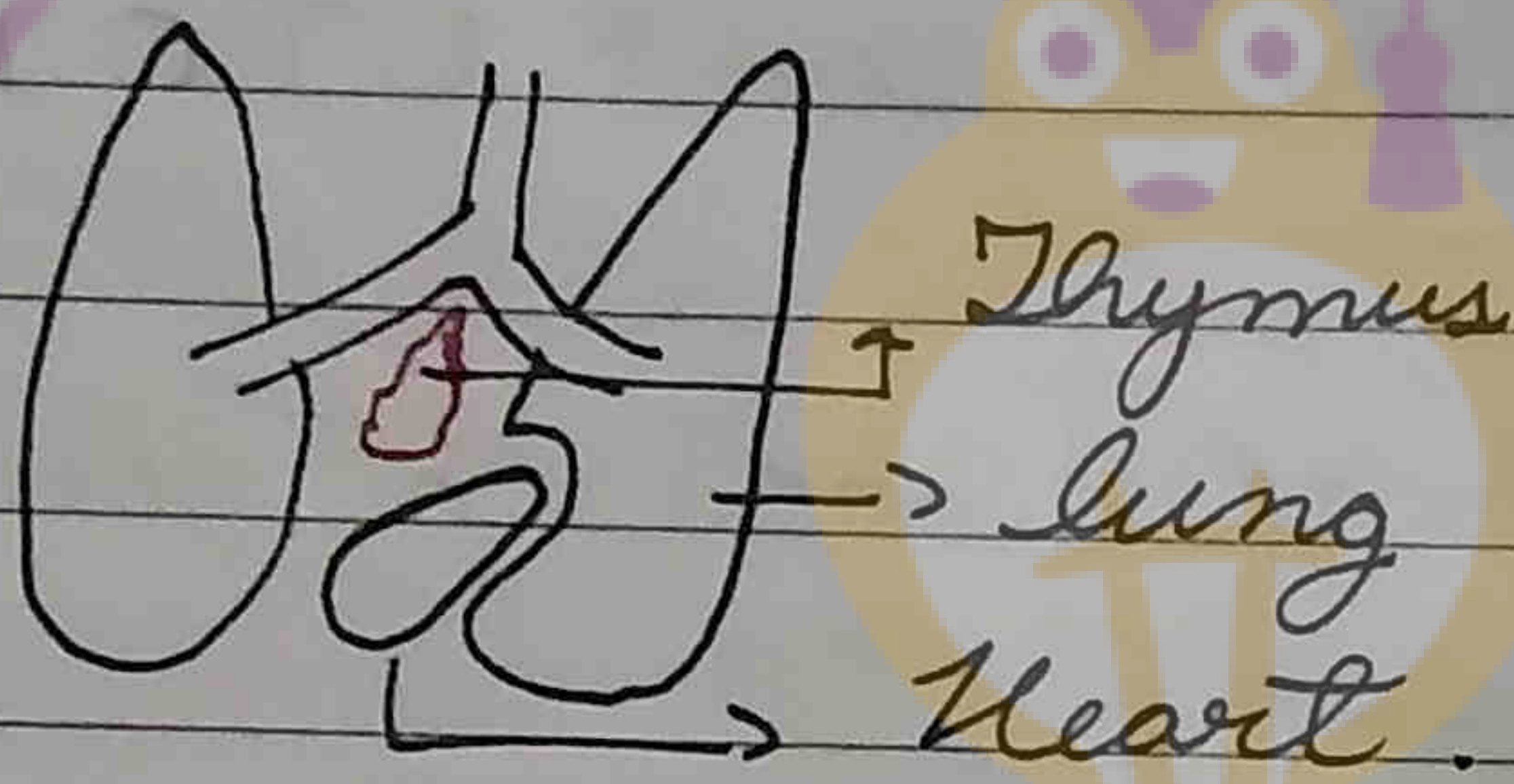
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Hypersecretion of PTH →

Osteoporosis → bones become fragile and easily get fractured due to loss of Ca^{2+} .

★ Osteitis fibrosa cystica → Bony matrix is replaced by fibres.

Thymus



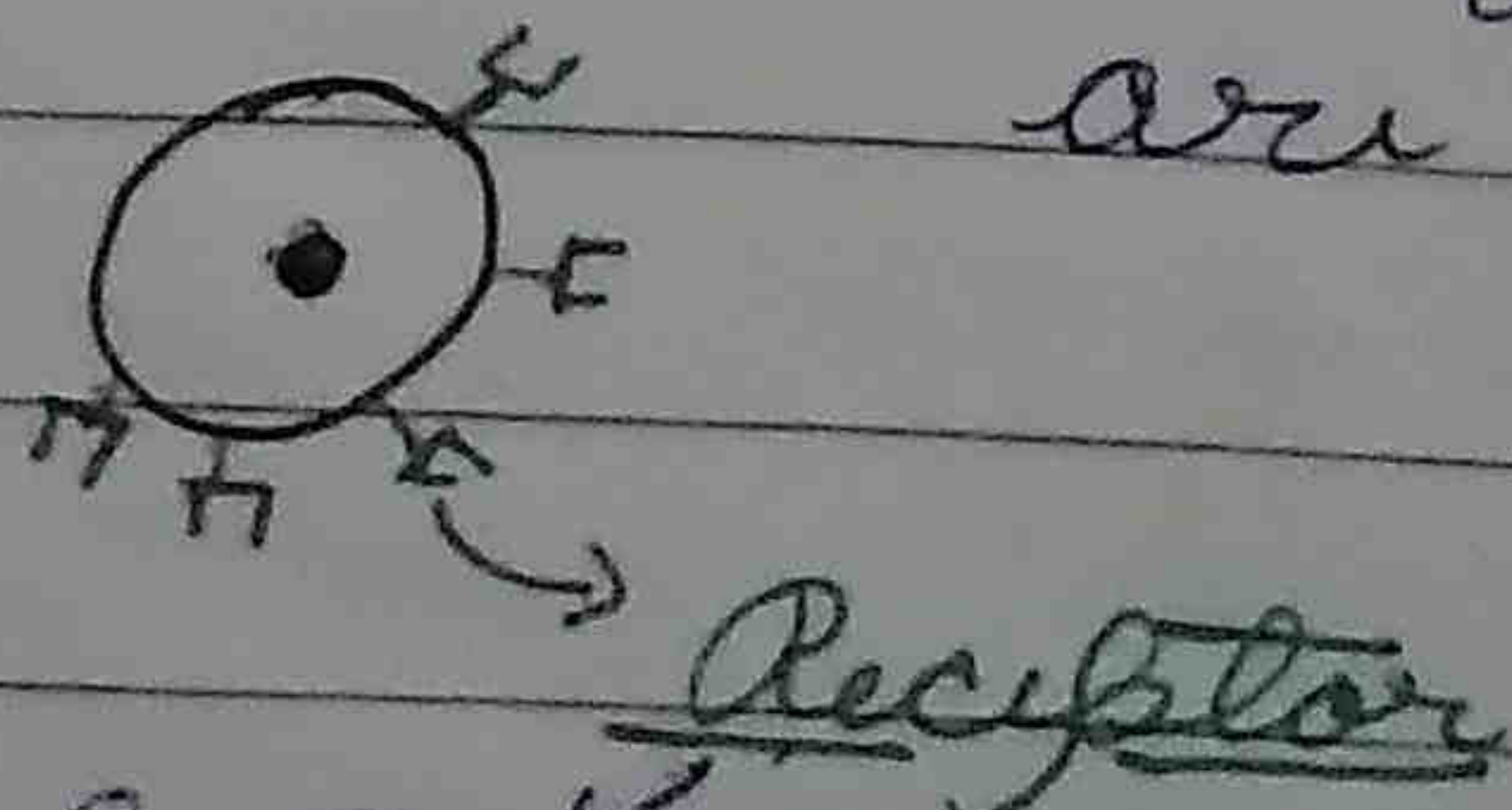
Thymus → well developed in foetal life, upto puberty. Starts to atrophy after puberty.

It is called Throne of Immunity.

Site for maturation of T-lymphocytes which are responsible for cell-mediated immunity.

↓
Helper T-cells stimulate B-cells which provide Humoral Immunity.

- Thymosins → proteinaceous hormones which help in maturation of T-cells. i.e receptors are formed on T-cells



which bind to foreign antigens but never to self antigen.

★ Melatonin is gonad inhibiting hormone, so up till puberty its secretion is high but after puberty its secretion decreases.

present in thymus.
★ Hassall's corpuscles → phagocytes which destroy lymphocytes with wrong receptors over them.

• Pineal Gland
⇒ (Epiphyses cerebri)

- present on the roof of diencephalon or IIIrd ventricle behind anterior choroid plexus.

- Pine - cone shaped gland.

- Secretes Melatonin
(amine hormone)

- Melatonin is secreted only during night when no light falls on retina.

- Regulates circadian rhythm (24-hr cycle)

- Sleep - wake cycle.

★ Regulates breeding cycles in other animals which breed reproduce seasonally.

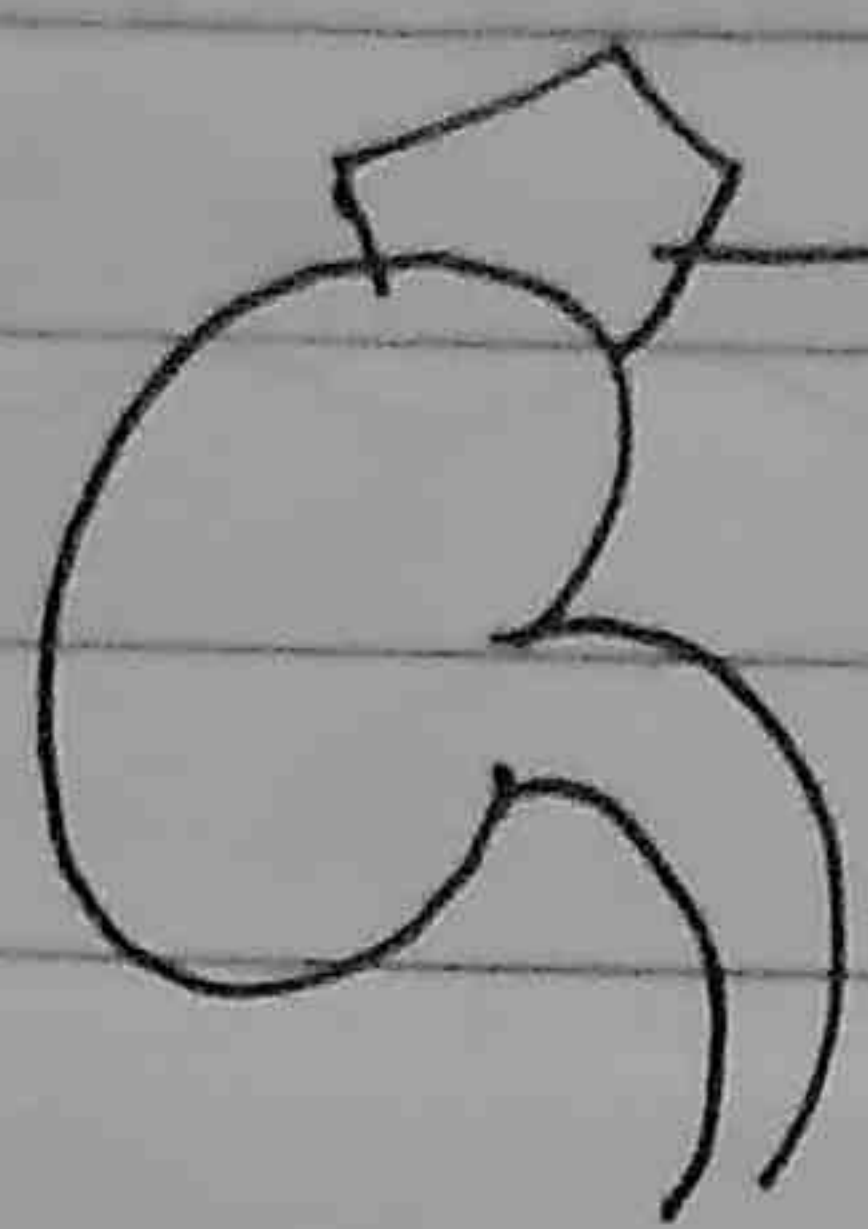
★ Melatonin inhibits gonads in animals undergoing hibernation.

★ ^{inf} Body temperature (maintains)

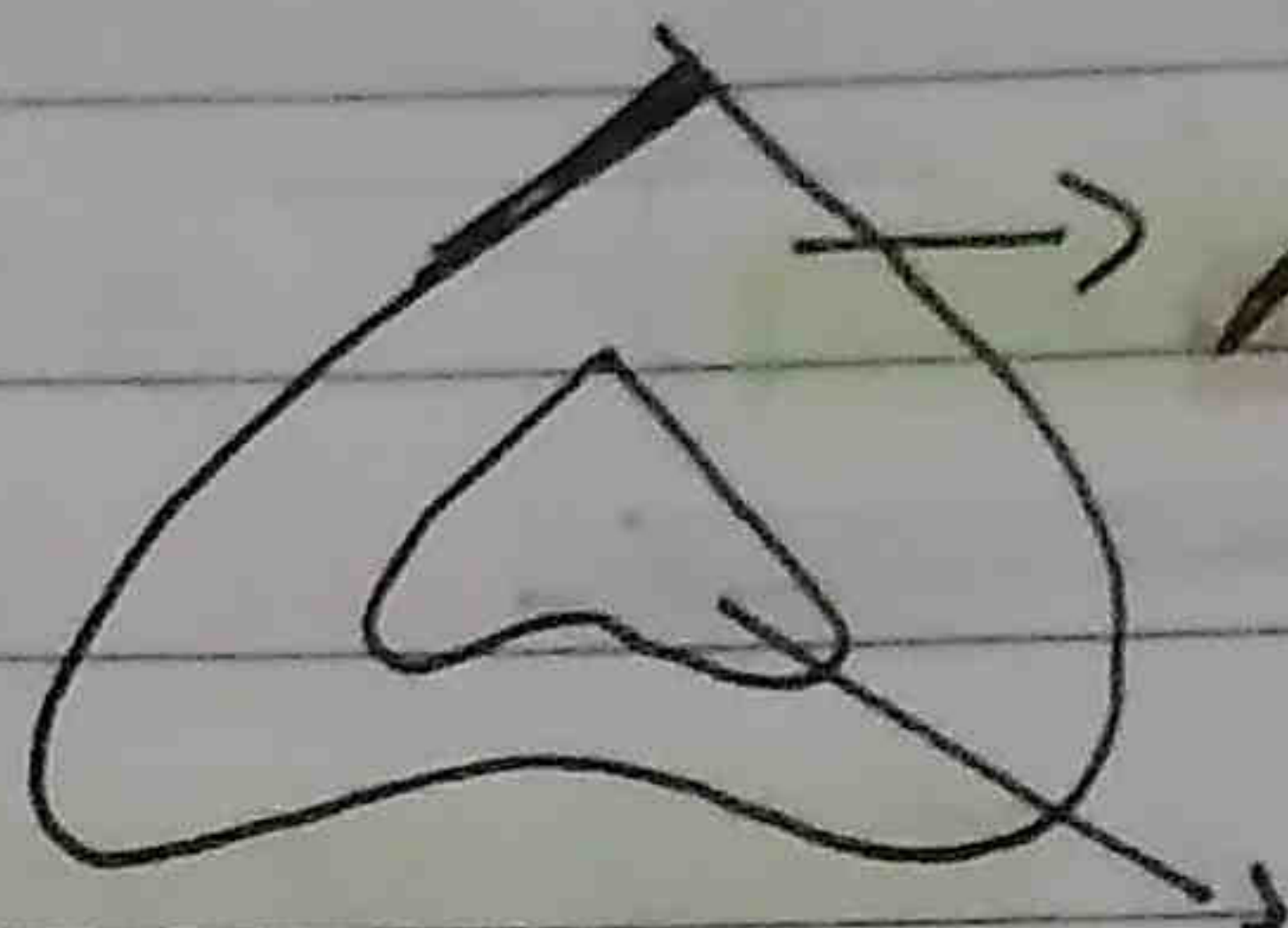
- ★ influences metabolism, pigmentation, menstrual cycle and our defense capability.

- Epinephrine is more potent.

- Adrenal Glands



Supra-renal / Adrenal



Adrenal cortex

(mesodermal)

- Overall: ecto-mesodermal in origin

Adrenal medulla

(ectodermal)

- Hormones from Adrenal Medulla -

- Epinephrine / Adrenaline - 80%

- Norepinephrine / ^{Nor}Adrenaline - 20%

- These are catecholamines

- Also called emergency hormones

Fright, flight, fight

- Role of Epinephrine and Norepinephrine cause

- Vasoconstriction of peripheral blood vessels

- but causes dilation of coronary, hepatic and skeletal blood vessels.

- Blood glucose level rises by glycogenolysis in liver.

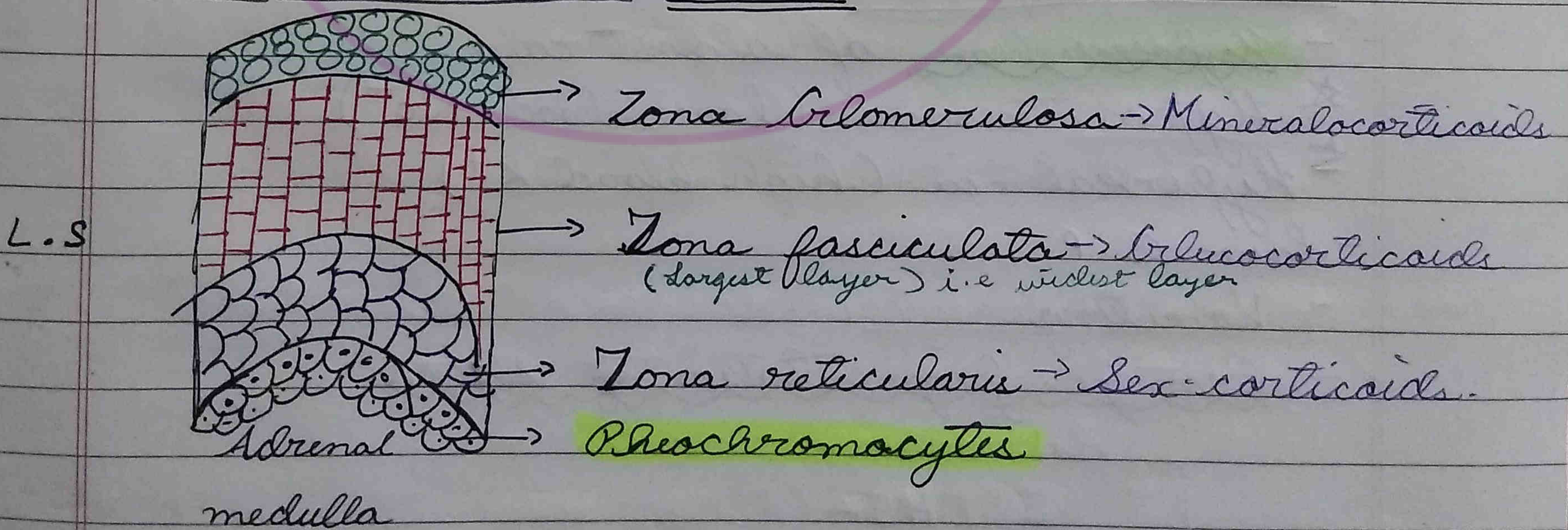
- ★ Cells of adrenal medulla are called pheochromocytus CLASSMATE
- If adrenal medulla is removed, it is not dangerous to life because similar function performed due to sympathetic nervous system. This is not the case with Adrenal cortex.

- Lipolysis (breakdown of fat)
- Peristalsis and gastrointestinal secretions decrease ↓
- BMR increases.
- Heart rate and respiratory rate increases.

★ Adrenal medulla and sympathetic nervous system work together hence called Sympathetic Adrenal System.

- ★ Pheochromocytoma: Tumour of Adrenal medulla.
 - Increased secretion of epinephrine, norepinephrine.
 - BP will be raised.
 - High blood glucose.
 - Lipid storage decreased.

Adrenal Medulla Cortex



- Mineralocorticoids

- Aldosterone - most potent mineralocorticoid.

- It is secreted in response to low BP, low Na^+ in blood.

- Increases sodium reabsorption

- Increases K^+ excretion and phosphate excretion

- It is secreted when RAAS system is activated.

RAAS Renin - kidneys
Angiotensinogen \longrightarrow Angiotensin
Aldosterone \longleftarrow

stimulates secretion of

- Disorders

• Addison's Disease

- Hyposecretion of aldosterone.
- ★ Hyponatremia (low blood Na^+)
- ★ Hyperkalemia (high blood K^+)
- low B.P
- Vomiting
- Bronze pigmentation of skin

• Conn's Disease

- Hypersecretion of aldosterone.
- High Na^+ in blood.
- High BP

- Spontaneous contractions of muscles which cramps and convulsions.

• Glucocorticoids

Cortisol (most potent)

Cortisone

Corticosterone

- Required for metabolism of carbohydrates, fats and proteins.

- Catabolic hormone

- Glycogenolysis

- Gluconeogenesis

} → Rise in blood glucose

★ - Suppresses inflammation

★ - It has antiallergic effect.

★ - Suppresses WBC synthesis ✓

★ - Increases RBC synthesis

★ - Vasoconstriction in case of injury ✓

- Helps in controlling stress ✓

★ ★ - Inhibits growth in large doses (by inhibiting GH)

★ - Increases osteoclast activity (Hypercalcemic)

- Disorders

* Cushing's Syndrome

- Hypersecretion of glucocorticoids (cortisol)
- * Can be due to tumor in adrenal cortex or excess ACTH.
- Hyperglycemia (Rise in blood glucose).
- * Redistribution of body fat
 - ✓ Pendulous belly
 - ✓ Moon faced appearance.
 - ✓ Buffalo hump.
- ✓ Striae : stretch marks on skin.
- ✓ Hirsutism : excessive hair growth.
- ✓ Amenorrhoea : stoppage of menstrual cycle.
- ✓ Delayed wound healing.

• Sex - corticoids

✓ Secreted in response to ACTH.

→ Androgens : masculinizing hormones
e.g. DHEA (Dehydroepiandrosterone)

→ Oestrogens - feminizing
e.g. Estrogen / Estradiol

- Precocious Pseudopuberty

Excess androgens in males before puberty.

• Puberty characteristics without testicular maturity

• More accentuation of male secondary characters if secretions increase ^{prominent} after puberty.

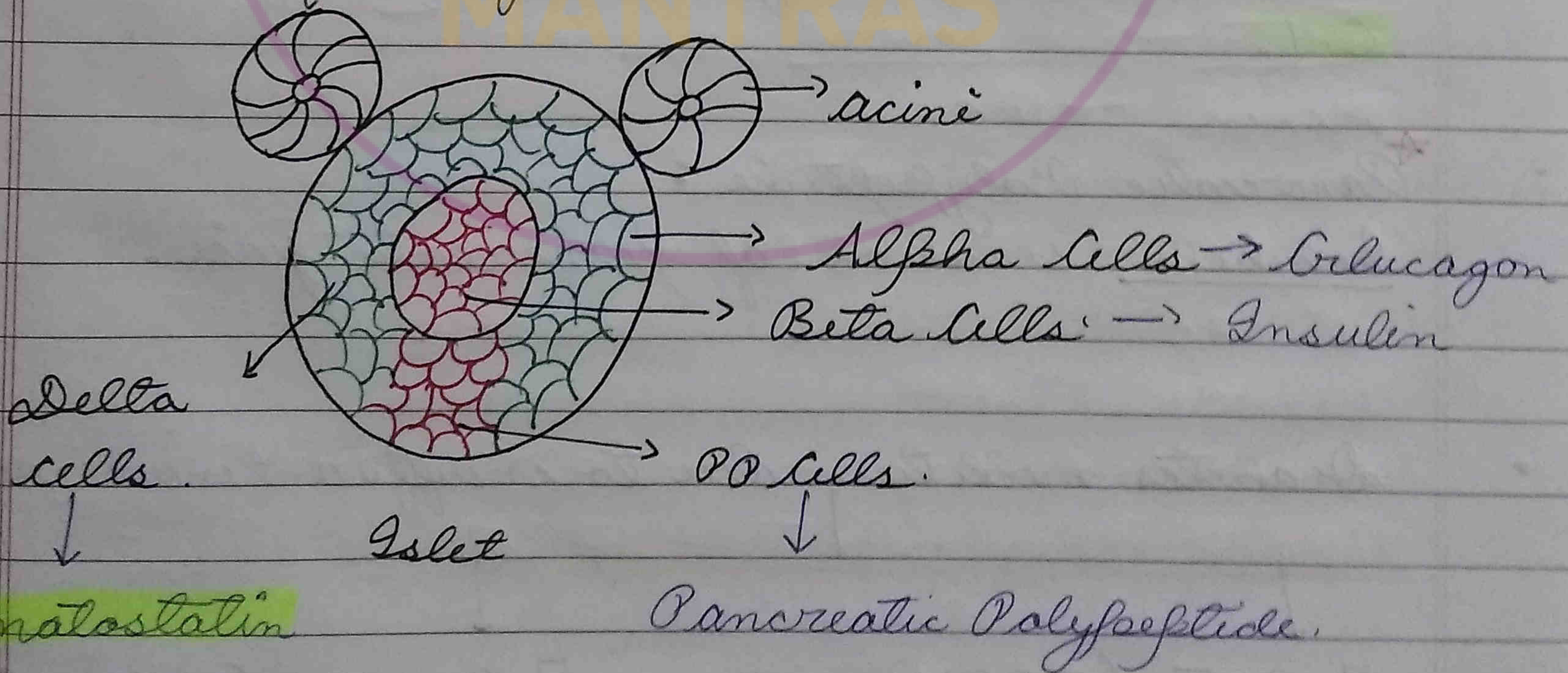
- Adrenal Virilism

• Excess androgens in females.

• Females develop male secondary sexual characters.

• Pancreas

Islet of Langerhans



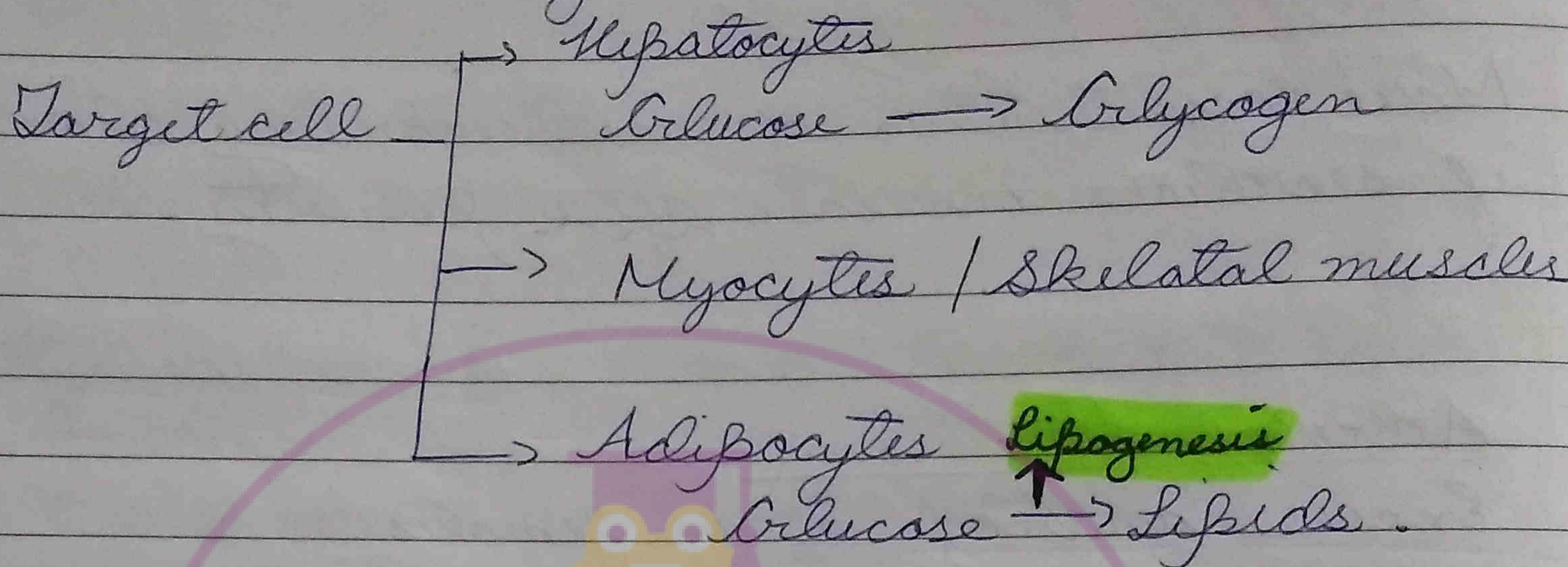
• Glucagon: peptide hormone

- Increases blood glucose level

- Hyperglycemic hormone

Insulin → peptide hormone

It is antagonistic to glucagon and hence lowers blood glucose level.



☆ - Diverts amino acids to the target cells for protein synthesis.

☆ Somatostatin:

Inhibits secretion of insulin, glucagon and GH.

☆ Pancreatic Polypeptide:

Inhibits secretion of pancreatic juice.

Diabetes mellitus: due to insufficient insulin secretion

Type-I (IDDM)

Autoimmune disease in which antibodies develop against Beta cells.

Type-II (NIDDM)

- Insulin secretion is normal.
- Resistance against insulin in target cells.

- Testis is heterocrine as it produces hormones and sperms.
- Testosterone increases muscle growth, RBC synthesis and anabolic.

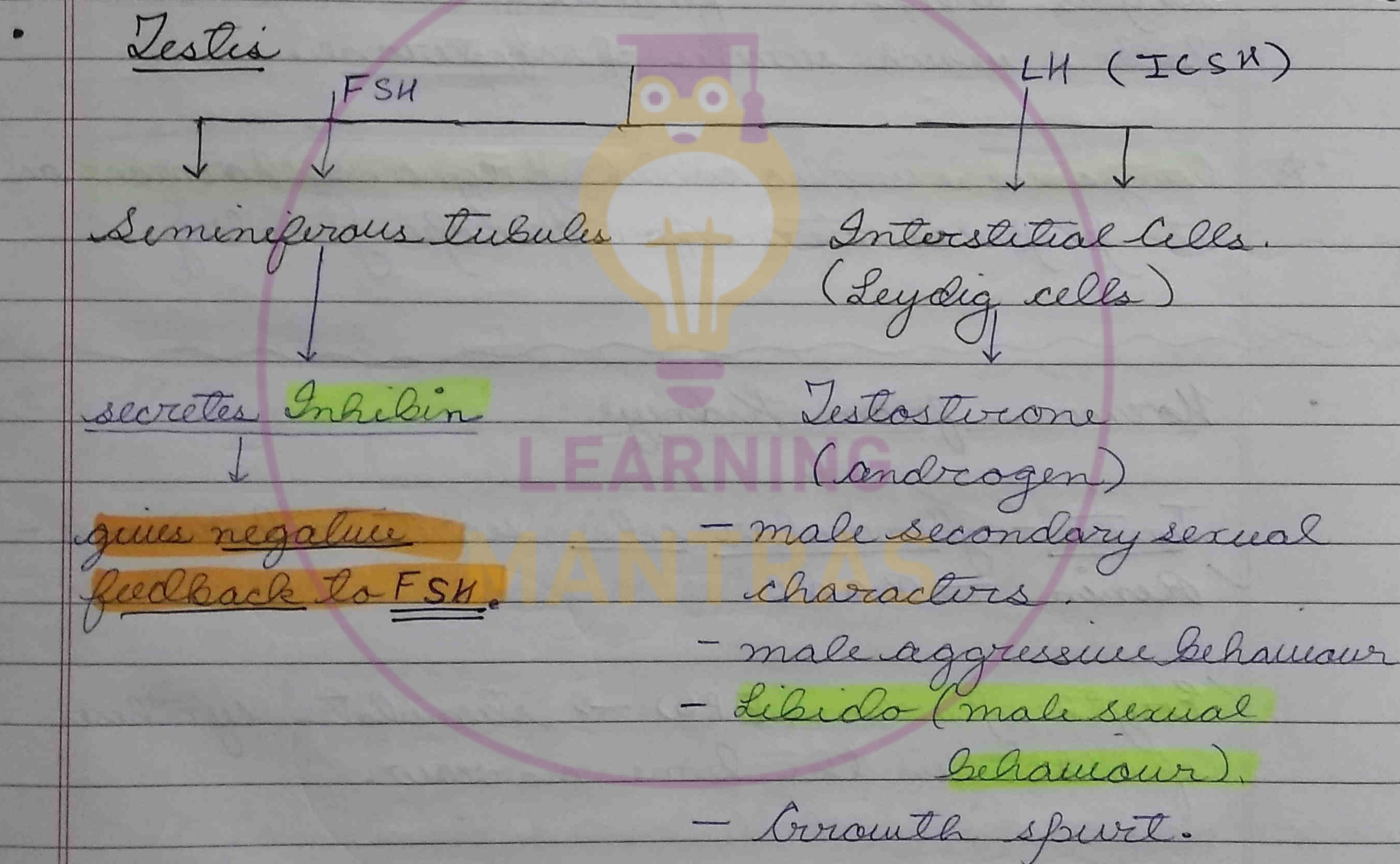
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It is called Insulin dependent diabetes mellitus mostly above age - 40.

below age of 20.

- **Insulinoma**: Tumor of Beta cells. In excess of insulin is secreted which causes hypoglycemia.



- Testosterone gives negative feedback to LH.

- Testosterone is an anabolic steroid.

- Excessive testosterone causes acne and high B.P. and because of inhibitory effect on LH, sperm synthesis is also reduced.

- Ovaries are heterocrine glands.
- Stroma is mesodermal tissue around ovaries

Ovaries

↓
Ovarian follicle

↓
Stroma

↓
Estrogen

- Develops female secondary sexual characters

- Corpus Luteum → formed from ruptured mature follicle which secretes progesterone.

- ☆ Progesterone is also called pregnancy hormone as it prepares uterus for developing embryo.

Hormones from Kidneys

Juxta-glomerular cells secrete 2 hormones -
✓ Renin - RAAS

✓ Erythropoietin (EPO) → stimulates synthesis of RBCs in the bone marrow.

Hormones from Gastro-intestinal Tract

• Gastrin :

- secreted by gastric glands of stomach.
- stimulates secretion of gastric juices.

★ Secretin →, secrete non enzymatic part of pancreatic juice

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- CCK (Cholecystokinin):
 - secreted from duodenal epithelium.
 - stimulates gall bladder to release bile.
 - stimulates pancreas to release pancreatic enzymes.
- ^{secret enzyme} Secretin:
 - secreted by duodenal epithelium.
 - stimulates pancreas to release bicarbonates.
- GIP (Gastric Inhibitory Peptide).
 - Inhibits the secretion of gastric juice.

• Hormone from heart

- ANF (Atrial Natriuretic Factor):
 - secreted by wall of atria if B.P. is high.
 - It opposes RAAS system.
 - It lowers blood Na^+ by increasing urinary excretion of Na^+ .
 - causes vasodilation of blood vessels.

• All the receptors are proteins.

Mechanism of Hormone Action

Hormone (1st Messenger)

Lipid soluble

Water soluble

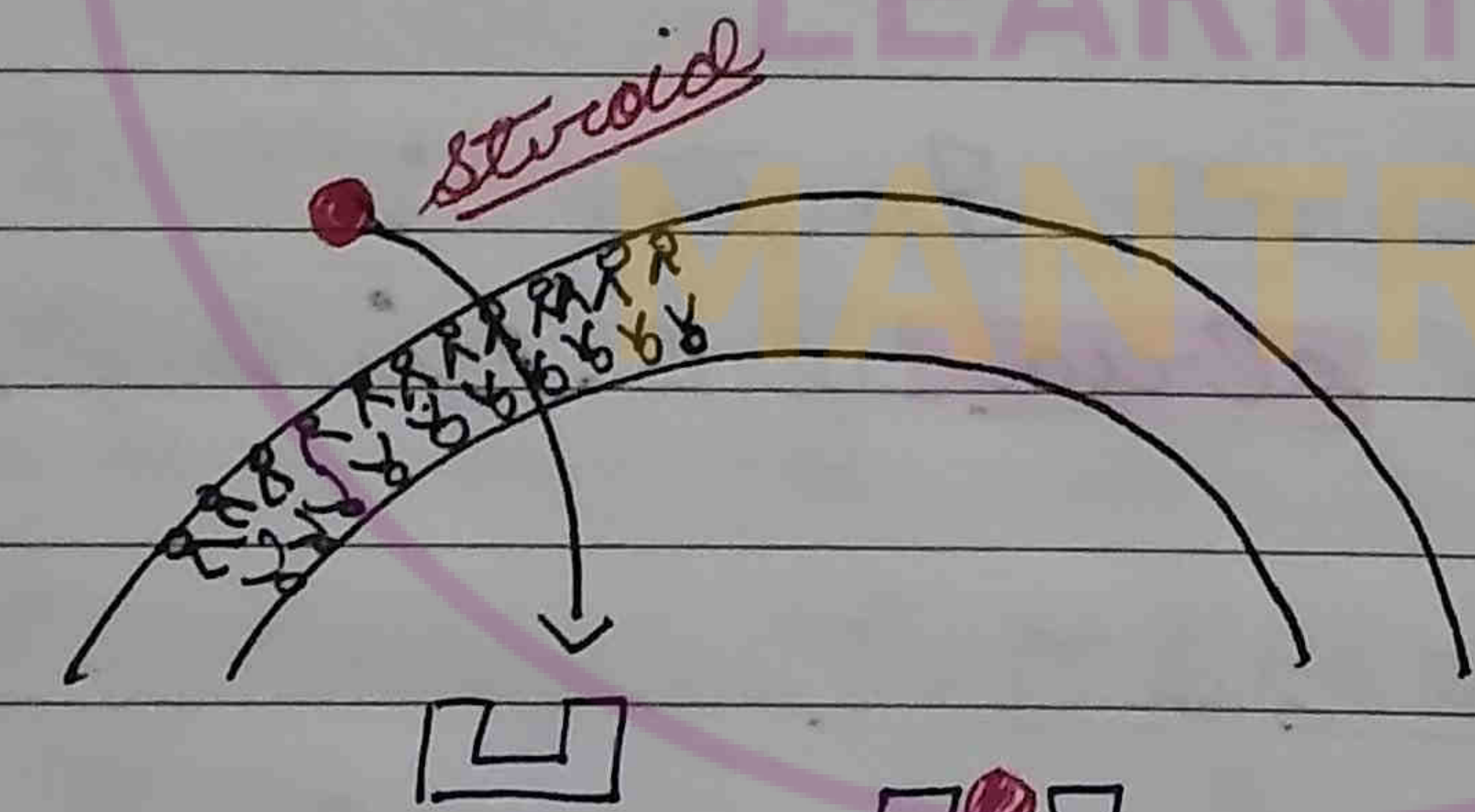
- Iodothyronines :
Thyroxine, T_3

- Steroids :
Corticoids
Gonadal hormones

• Amines : Epinephrine

• Peptides, Proteins :
Insulin, GH, Secretin,
FSH, LH
Thyroid calcitonin (TCT)
Parathyroid hormone (PTH)
Thymosin, Leucagon

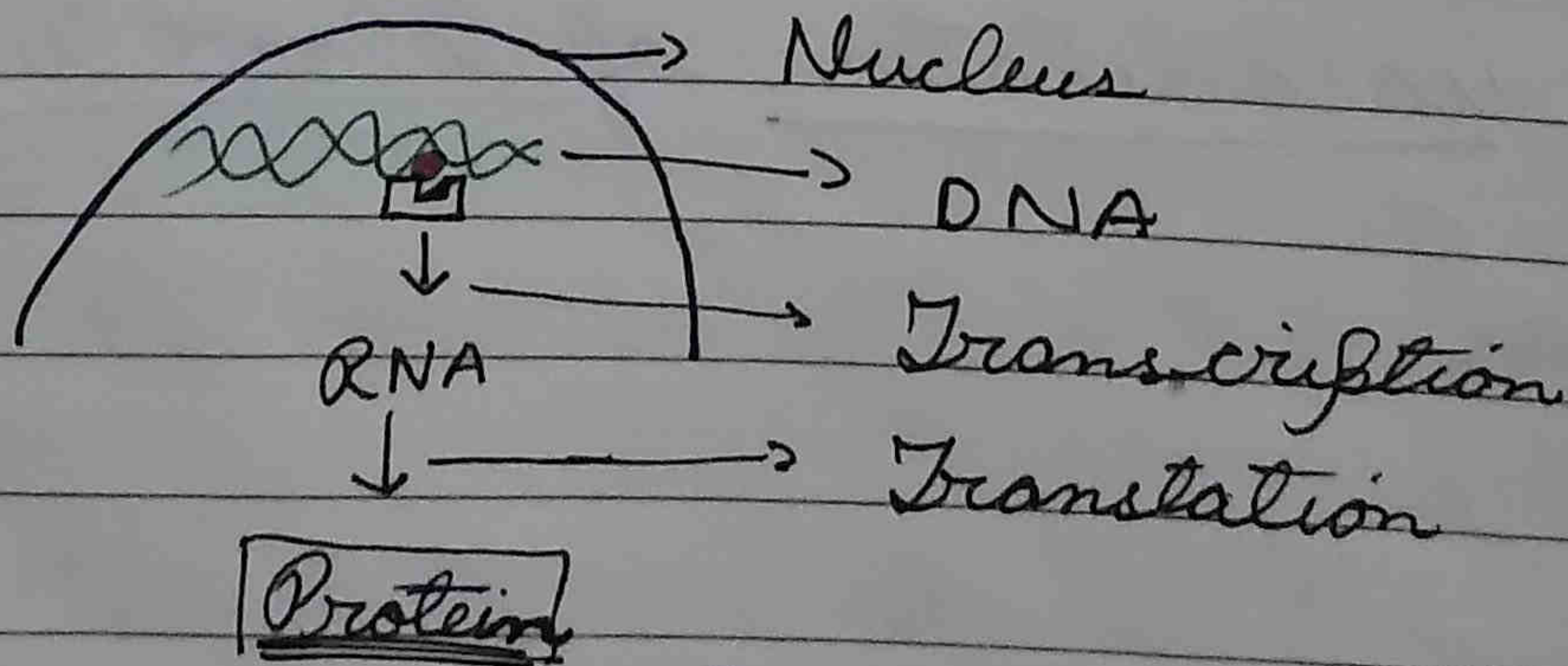
Lipid soluble hormone



Cytoplasmic receptor
(protein)

Hormone-Receptor
Complex

↓ enters nucleus

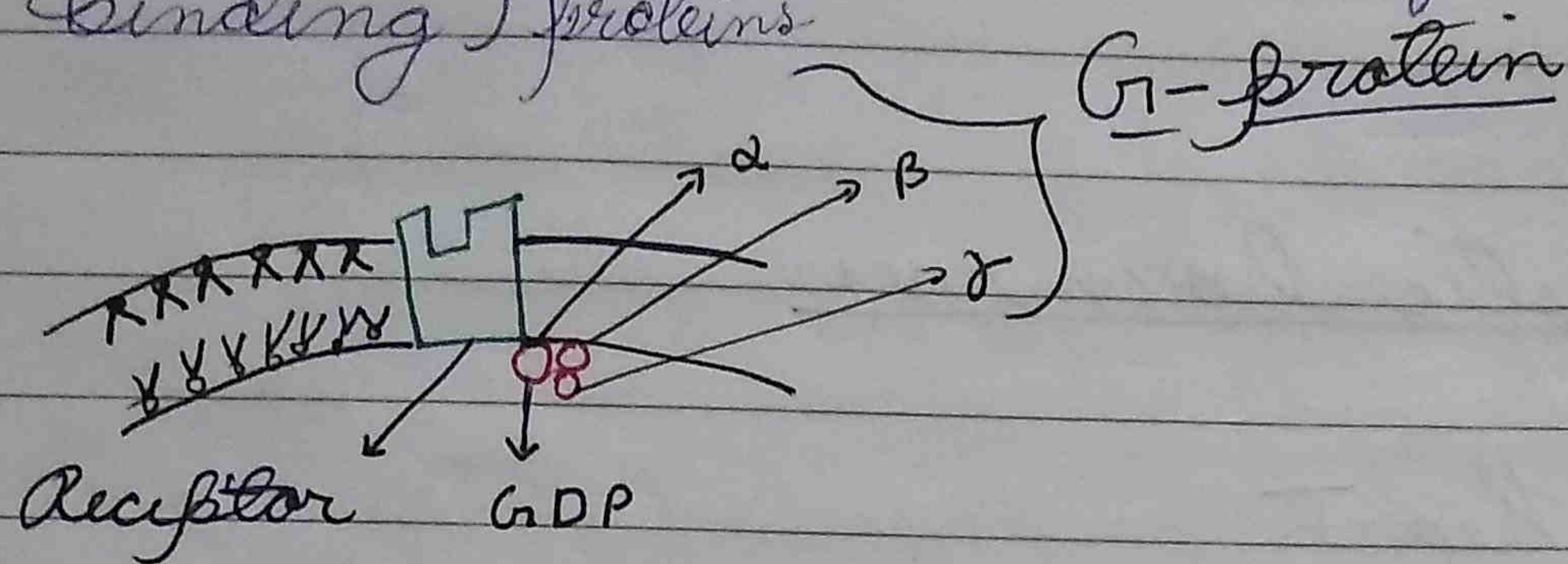


⇒ new enzyme formed

• α unit of G-protein is attached with GDP and when a hormone binds with receptor then this GDP is changed to GTP.

Water Soluble Hormones

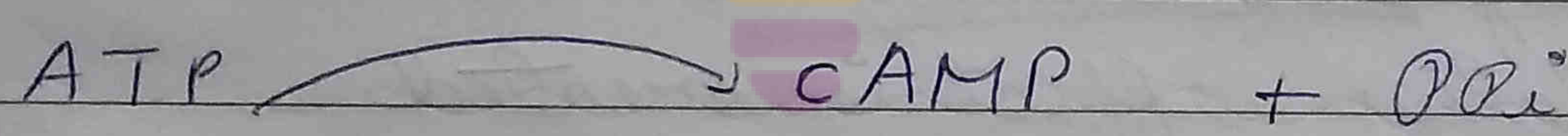
They act with the help of G-proteins (GTP binding) proteins.



Hormone binds to membrane receptors

G-protein activated.

Activates an enzyme (present on membrane) (Adenylyl cyclase)



Cascade mechanism
- Amplification

Because of high turn over rate of enzymes.

Protein kinase (inactive) (already int in cell)

Protein kinase (Active)

Activates Enzyme

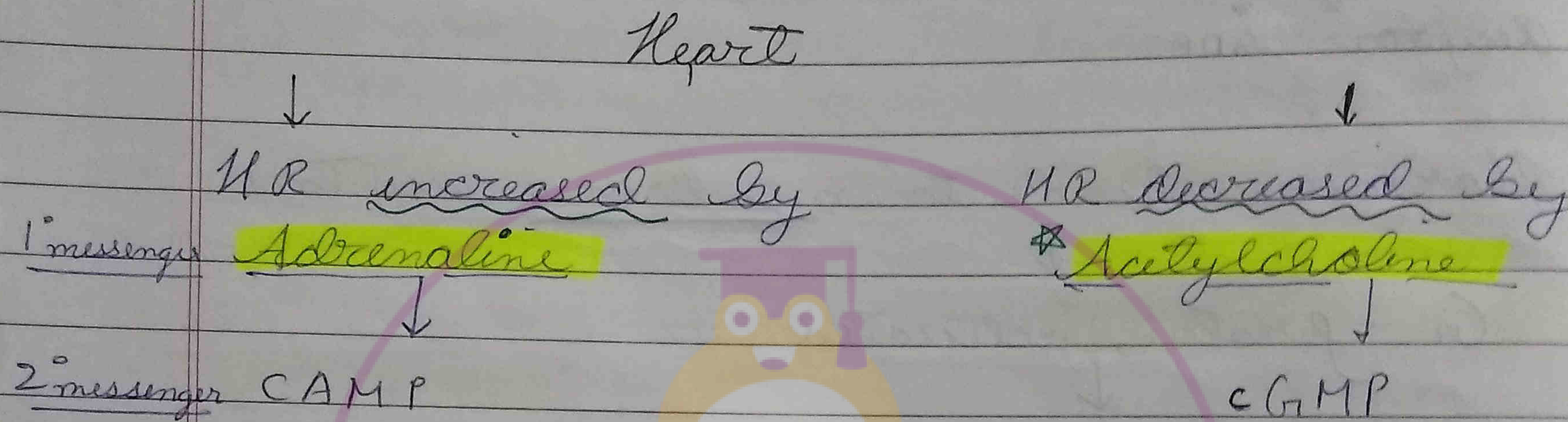
Cell's Response

Secondary Messengers

- ✓ CAMP
- ✓ cGMP
- ✓ Ca^{2+}
- ✓ PIP_2 (Phosphatidyl inositol biphosphate)
- ✓ IP_3 (Inositol triphosphate)

1. DG (Diacyl glycerol)
 1. Insulin acts via Tyrosine kinase activity.

Antagonistic hormones



Synergistic hormones
 Cumulative effect is created

e.g. effect of estrogen, progesterone, prolactin, oxytocin on mammary glands.

* Growth will not take place even when somatomedin are not produced even if ample amount of GH is present.