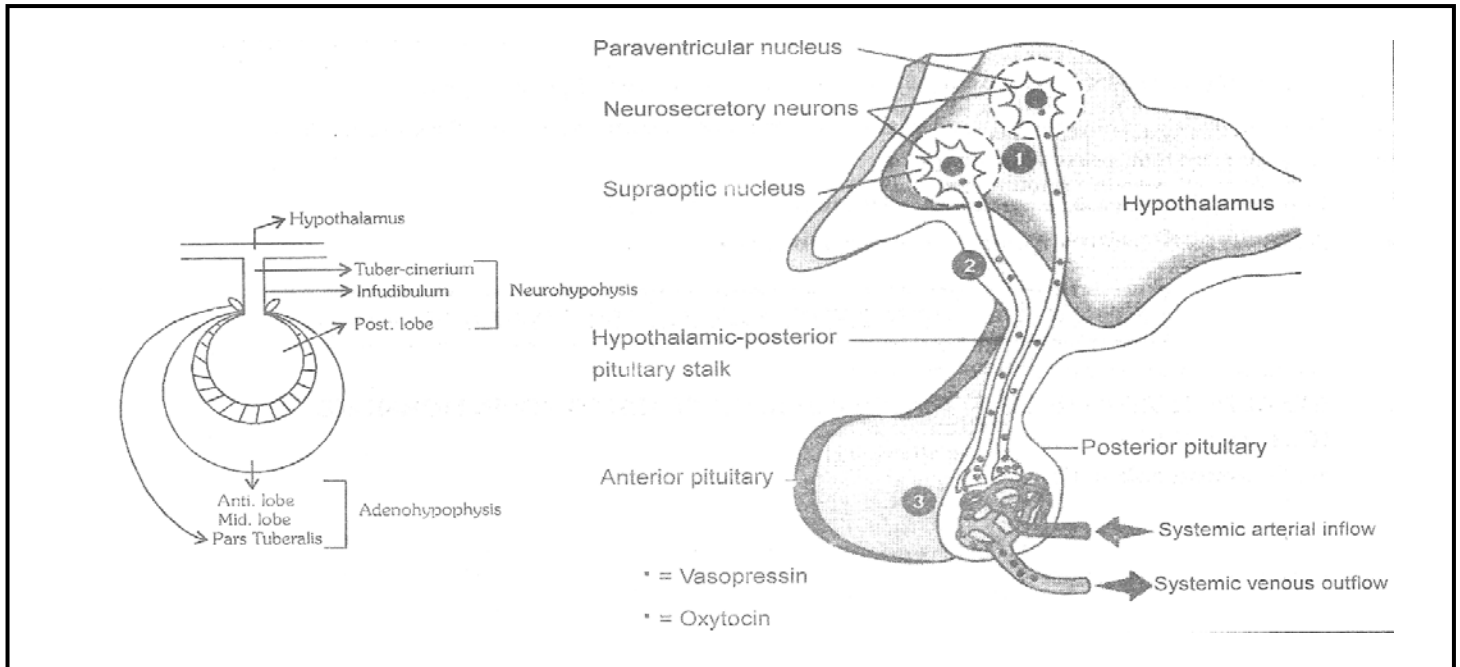


PITUITARY GLAND



- ☞ On the basis of development pituitary gland is completely **Ectodermal**.
- ☞ It is situated in the **sella-turcica** of sphenoid bone.
- ☞ This gland is attached to the hypothalamus through a stalk which is called as **infundibulum**.
- ☞ The upper terminal end of infundibulum which is attached to the hypothalamus is called as **tubercinerium/Median eminence**.
- ☞ The lower terminal end of infundibulum is bulging type which is called as **posterior lobe or pars nervosa**.
- ☞ Tubercinerium , infundibulum & pars are collectively called as **Neurohypophysis**.
- ☞ A small & fine tube is developed in the foetus which is called as **gut**. This gut is developed into **alimentary canal**. Anterior part of gut is called as **stomodaeum** (developed from ectoderm).
- ☞ A small projection is developed from dorsal **surface of stomodaeum** (the anterior part of gut) this part is separated from stomodaeum and form the **Rathke's pouch**.
- ☞ Upper surface of Rathke's pouch is developed into **mid-lobe** which is also known as **pars intermedia**.
- ☞ The **upper margin** of **R.pouch**, which surrounds the infundibulum & forms a collar like structure called as **parstuberalis**.
- ☞ **Remaining part** of R.pouch . is developed into anterior lobe which is also called as pars distalis.
- ☞ **Pars distalis, pars tuberalis & pars intermedia** are collectively called as **adenohypophysis**.
- ☞ Neurohypophysis + Adenohypophysis is called as **hypophysis cerebri** or **pituitary body**.
- ☞ A remaining & vestigial cavity of **R.pouch** is found in the anterior lobe which is called as **Hypophysis recess**.
- ☞ **Superior branch** of **hypophyseal artery** supplies blood to the **hypothalamus**.
- ☞ **Inferior branch** of **hypophyseal** artery blood to the **pituitary gland**.
- ☞ **Hypophyseal portal vein** collects the blood from hypothalamus and supplies to the **pituitary gland**.
- ☞ Branch of hypophyseal artery & hypophyseal portal vein form a network of blood capillaries which is called as **circle of Willis**.

- ☞ In human, mid lobe is ill developed or membrane like, while mid lobe is absent in elephant & Whale.
- ☞ Three types of glandular cells are found in Adenohypophysis.
- 1. **Basophils** → They are large cells & found in the peripheral part of gland. They are more in number.
- 2. **Acidophil** → They are small in size & found in the central part of pituitary gland.
- 3. **Neutrophils** → They are smallest in size and are found in scattered form. They are minimum in number.
- ☞ **STH & LTH** are secreted by acidophils.
- ☞ Remaining hormone of adenohypophysis are secreted by **basophils**.
- ☞ All hormone of pituitary gland are **protein Hormone**.

HORMONES SECRETED BY ADENOHYPHYSIS

All these hormones are of proteinaceous nature.

1. **GROWTH HORMONE OR SOMATOTROPIC OR SOMATOTROPIN HORMONE**
[G.H. or S.T.H.] :-
By Somatotroph cells

Functions : Major effect {

- On growth
- On metabolism

Effect on Growth :-

- (1) **On bone :** It increases the longitudinal length of bone.
- (2) **On soft tissue :**
 - (i) GH promotes mitosis & increases number of cells in many organs & tissue e.g. liver.
 - (ii) GH stimulates growth of muscle and cartilage due to increase synthesis of collagen, muscle growth

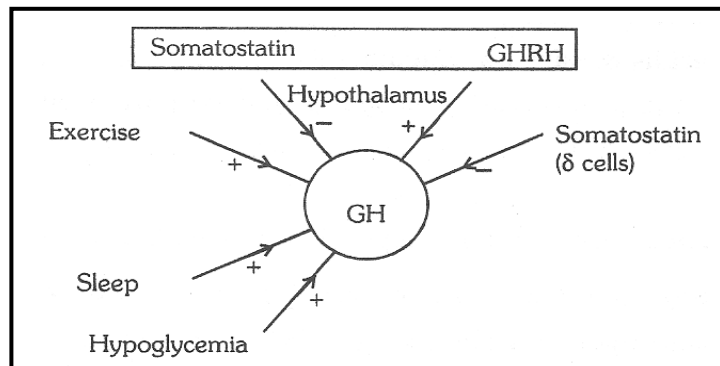
Effect on metabolism -

Fat : Increases lipolysis so that free fatty acid level of plasma rises. Under the influence of growth hormone fat is used for energy in preference to carbohydrate and protein, due to this protein deposition is increased.

Carbohydrate :- Hyperglycemia develops due to decreased uptake of glucose in the cells, so it is also **diabetogenic hormone**.

Protein : GH increases amino acid uptake by the cells of the liver & muscles & helps in protein synthesis.

- ☞ In the presence of thyroxines and insulin, growth hormones become more active and help in body growth. In this way this hormone is important for the growth of body.



Diseases due to hyposecretion or Hypersecretion of somatotropin hormone :-

- (a) **Hyposecretion of STH :-** Due to deficiency of STH in childhood or adolescence, dwarfism is observed.
- ☞ Dwarfism due to the defect of pituitary is called **Ateliosis**.
 - ☞ Clowns of circus are such dwarfs, they are called **midgets**. This midget is physically & mentally normal while sexual maturation is delayed.
- (b) **Hypersecretion of STH :-** Due to Hypersecretion in childhood and adolescence, a higher quantity of aminoacids is supplied to the body cells.
- (i) Epiphyseal cartilage present on the edges of bones does not convert into bone for a long time.
- ✍ Thus the bones of legs & hands become very long and height of that person increases very much. Body becomes imbalanced. this disease is called **Gigantism**.
- (ii) **Acromegaly :-** Due to Hypersecretion of STH in adulthood, jaw bones of the affected person become long, cheek bones buldge out, broad hand , legs & fingers of person becomes gorilla like. These symptoms are observed as a result of acromegaly.

2. THYROTROPHIC [T.T.H. OR T.S.H.] OR THYROID STIMULATING HORMONE :-

- ☞ T.S.H. is secreted by **basophil cells. (Thyrotroph cell)**.
- ☞ It is glycoprotein in nature.
- ☞ T.S.H. stimulates thyroid gland to secrete thyroxine. TSH helps in almost all step of the thyroid hormone synthesis & it causes growth of thyroid gland.
- ☞ Secretion of **TSH** is stimulated by Thyrotrophin releasing factor & inhibited by somatostatin of hypothalamus.

3. ADSRENO CORTICO TROPHIC HORMONE OR CORTICOTROPINE [ACTH] :-

- ☞ ACTH is secreted by **basophil** (corticotroph) cells.
- ☞ In the ACTH of man, **valine** and **tyrosine** aminoacids are in more quantity.
- ☞ It accelerates the cortex part of adrenal gland to secretes hormones.

4. FOLLICLE STIMULATING HORMONE [FSH] :-

- ☞ It is also secreted by basophils. (Gonadotroph cell)
- ☞ It is a glycoprotein in nature.
- ☞ This is secreted in male and female both.
- ☞ In males, it stimulates spermatogenesis and normal functioning of seminiferous tubules.
- ☞ In females , it stimulates oogenesis and development of Graafian follicles of ovary.
- ☞ FSH is also known as **Gametokinetic factor**.
- ☞ Estrogen hormone that is secreted by Graafian follicles is also affected by FSH.

5. LUTEINIZING HORMONE [LH OR ICSH] OR INTERSTITIAL CELL STIMULATING HORMONE :-

- ☞ It is also secreted by basophils. (Gonadotroph cell). It is a glycoprotein in nature.
- ☞ it stimulates **ovulation** in female as a result of this corpus luteum is formed.
- ☞ Hormone **progesterone** which is secreted by corpus is also stimulated by L.H.
- ☞ In men **LH** is called **ICSH**. It affects the Leydig's cells or Interstitial cells of testes and stimulates the secretion of male hormone "**Testosterone**".
- ☞ L.H. is also called "**gamete releasing factor**".
- ☞ **FSH** and **LH** both are called **gonadotrophic hormone GTH**.
- ☞ FSH and LH act in combined form so these are called **synergesic** hormone.

- ☞ Gonadotrophic hormones (FSH & LH) are start secreting during puberty. Their secretion is regulated by hypothalamus. It is supposed that there present a biological clock to control all this.

6. LUTEOTROPHIC OR PROLACTIN OR LACTOGENIC OR MAMMOTROPHIN HORMONE (PRL) :

It is secreted by acidophil (Lactroph) cells.

Function of Prolactin hormone.

(1) Lactation (Galactopoiesis) :- Prolactin is responsible for lactation in postpartum (after delivery) women.

- ☞ **Regulation of Prolactin secretion by Hypothalamus :-** Hypothalamus mainly stimulate the production of all pituitary hormone, but it mainly inhibits Prolactin production because normally hypothalamus Prolactin inhibitory hormone (Dopamine) is greater then the releasing hormone.
- ☞ Breast is prepared for lactation by oestrogen (duct growth) and progesterone (lobule growth) but both of these hormone inhibit the actual secretein of milk.
- ☞ Dopamine is catecholamine (Biologically active amine) and neurotransmitter in the hypothalamus. It inhibits lactation.
- ☞ **During pregnancy :-** Prolactin hormone steadily increase until term but due to high level of oestrogen and progesterone (secreted by placenta) lactationis inhibited.
- ☞ **After expulsion of the placenta at parturition, there is an abrupt decline in circulating estrogen and progesterone .**
- ☞ The drop in circulating estrogen initiate lactation.
- ☞ Nursing stimulates Prolactin secretion.
- ☞ Prolactin inhibits the action of GnRH on the pituitary and antagonize the action of gonadotrophin on the ovaries. Ovulation is inhibited and the ovaries gets inactive.
- ☞ Nursing is important and effective method of birth control.

7. HORMONES SECRETED BY MIDDLE LOBE OF PITUITARY GLAND :-

- ☞ The part of adeno7pophysis of pituitary gland, which is very close to neurohypophysis is a very thin portion it is called **pars intermedia** or **middle lobe** of pituitarygland.
- ☞ In man it is in the form of a thin membrane only . It is **inactive** in men.

MELANOCYTE STIMULATING HORMONE [MSH] :-

- ☞ It is secreted by middle lobe. (By corticotroph cell)
- ☞ MSH is also called **Intermedin**.
- ☞ In man, MSH is secreted by anterior lobe, because middle lobe is ill –developed.
- ☞ It stimulates the melanocytes to synthesize melanin in mammals.
- ☞ This hormone is related with change in the colour of skin in **Amphibian** and **Reptiles**. This phenomenon of colour changing is known as **metachrosis**.
- ☞ It darkens the complexion of skin by distributing **melanin** pigment evenly under the skin.
- ☞ Just opposite to it, **melatonin** secreted by **pineal body**, collects the melanin pigments at one place thus fairing the complexion of skin.
- ☞ MSH is found in all the vertebrates, but it is functional in poikilothermic animals e.g. fishes , amphibians , reptiles etc.
- ☞ The importance of MSH in man has not been evaluated.

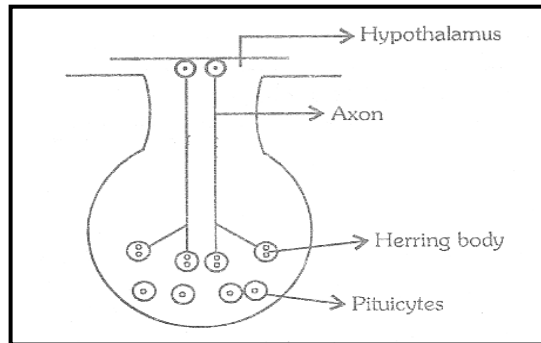
HORMONE RELEASING FACTORS OF HYPOTHALAMUS :-

Hormones secreted by adenohypophysis of pituitary gland are under the control of neuro-secretory cells of hypothalamus. These neuro-secretory cells produce some substances in very small amount which are called releasing factors.

- (1) **Growth hormone releasing factor :- [GHRF] :-** It stimulates the secretion of growth hormone.
- (2) **Thyrotrophin releasing factor :- [TRF] :-** It stimulates the secretion of TSH .
- (3) **GnRH**
 - Follicle stimulating hormone releasing factor :- [FSHRF] :-** It stimulates the secretion of FSH.
 - Luteinising hormone releasing factor :- [LHRF] :-** It stimulates the secretion of LHS.
- (4) **Growth hormone inhibitory factor [GHIF] (Somatostatin) :-** It inhibits the secretion of GH.
- (5) **Prolactin release factor [PRF] :-** It stimulates the secretion of Prolactin.
- (6) **Prolactin inhibitory factor [PIF] (Dopamine) :-** It inhibits the secretion of Prolactin.
- (7) **Melanocyte releasing factor [MRF] :-** It stimulates the secretion of MSH.
- (8) **Melanocyte inhibitory factor [MIF] :-** It inhibits the secretion of MSH.
- (9) **Adrenocorticotrophic releasing hormone (CRH) :-** It stimulates secretion of Adrenal cortex hormone.

POSTERIOR LOBE OR NEUROHYPOPHYSIS :-

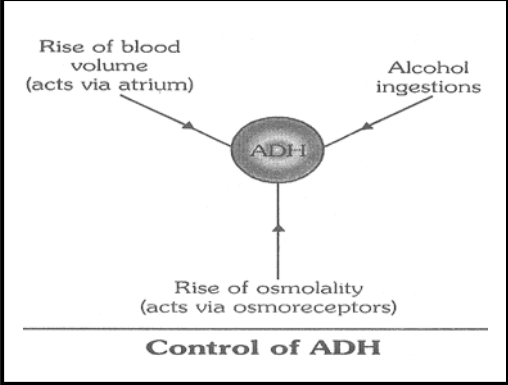
Posterior lobe of pituitary gland is 1/4th part of total gland . It is just like nervous tissue, because in it, the terminal ends of the axons of neurosecretory cells of hypothalamus are swollen. These swollen ends are “**Herring bodies**”. Hormones are released in these bodies.



- ☞ There are some large , branched fatty neuroglial supporting cells in between axons , that are called “**Pituicytes**”.
 - 1. Posterior pituitary hormones are not synthesised in the gland itself but they are synthesized in the **supraoptic nuclei** and **paraventricular nuclei** of hypothalamus.
 - 2. The hormone are then transported from their origin to posterior pituitary through axons of hypothalamohypo-physal tract and stored in association with 2 protein i.e. Neurophysin – I , and Neurophysin –II
- (A) **Vaspressin or Pitressin or Anti Diuretic Hormone [ADH] :-**
Main function of ADH :- Its main function is to increase the reabsorption of water in collecting duct and in distal convoluted part of uriniferous tubules. Due to this , amount of urine is reduced . So it is also called ADH.
- ☞ The hormone increases the blood pressure by constriction of blood vessels of tissues.
 - ☞ Due to **hyopsecretion** of ADH or vasopressin , the amount of urine increases, this process is called **Diuresis**. Patient feels thirsty, Dehydration starts in the body. This disease is called **Diabetes insipidus** (taste less urine, polyuria).

- Due to hyposecretion of ADH, deficiency of water starts in Extra cellular fluid (ECF), Blood pressure , urine becomes dilute and blood becomes thick or concentrate.
- Intake of coffee, tea and excess alcohol etc decrease the secretion of ADH.
- Secretion of ADH is maximum in desert fauna (animals of xerophytic region) e.g. camel.
- Kangaroo – Rat (Dipodomys) also shows Hypersecretion of ADH.

Kangaroo – Rat never drinks water in its life –time



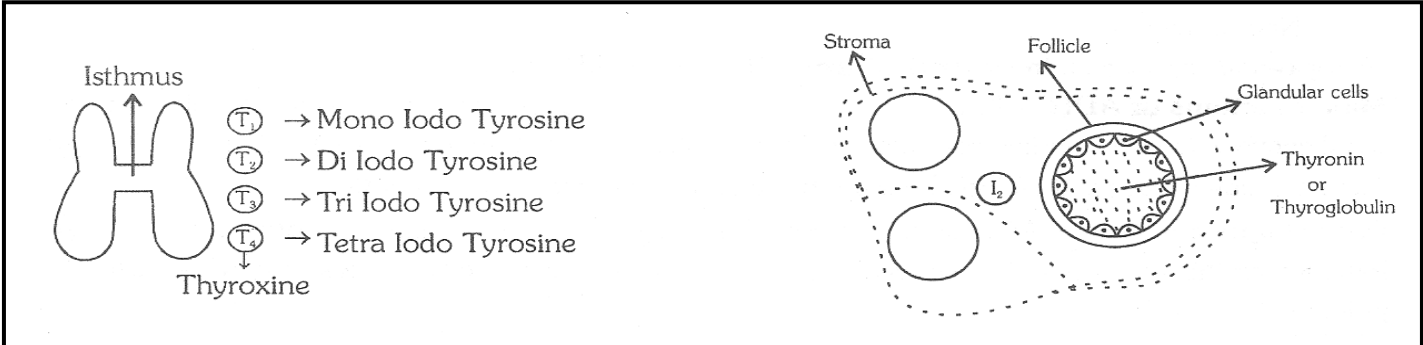
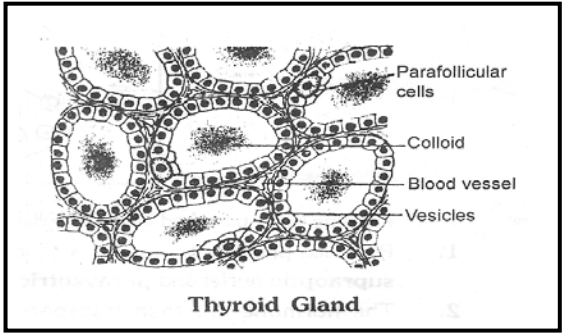
Hypersecretion of ADH causes dilution of blood and increases concentration of urine and thus blood pressure increases.

(B) Oxytocin or Pitocin :- It is the main **partuition hormone**. It stimulates the fast /rapid contractions and expansions of non-striated muscles of the uterine wall at the last moment of gestation period (pregnancy). Due to this uterine constrictions, **labor pains** start just before child birth.

- This hormone is secreted by pituitary glands of mother at the time of parturition.
- This hormone also initiates the contractions in uterine wall muscles during copulation / coitus as a result of that semen of man is swepted out in the fallopian tubes of woman.
- After parturition, this hormone constricts the uterine wall and thus brings back to the normal position.
- Oxytocin hormone contracts the myoepithelial cells present at all the sided of alveoli of mammary glands. Thus it helps in milk ejection so it is also called **milk let down hormone**.
- In female , this hormone related with emotion.
- Even thought, cry or sound of body can bring about release of this hormone in lactating mother.
- This hormone helps during egg laying in birds.
- Injection of oxytocin are initiates cows and buffaloes for instant milk release.

THYROID GLAND

It is the **largest endocrine glands in the body**. This is situated at the latero –ventral side of the joint of trachea and larynx in the neck region of man. The shape of this gland is like letter H. It is **bilobed** in birds and mammals , but it is single lobed in reptiles. Both of its lobes are connecnon-glandular band, formed of a connective tissue. This band is called **isthmus**.



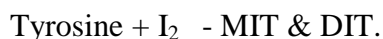
- ☞ It is endodermal in origin.
 - ☞ **Endostyle** of lower vertebrates like **Herdmania** , **Amphioxus** is homologous of thyroid gland.
 - ☞ In human, this gland weighs about 25 gm to 35 gm approximately. (This is some what larger in women as compared to men).
 - ☞ Each lobe of thyroid gland is made up of connectsent so many follicles made up of glandular cells in connective tissue.
 - ☞ These follicles are scattered in loose connective tissue, the stroma. A layer of cuboidal glandular cells is found in the wall of follicles. An iodised colloidal substance **Thyroglobulin** is filled in the cavity of these follicles. **Thyroglobulin** is **glycoprotein** in nature. Parafollicular cells are occasionally found in between basement membrane of the follicle & these cells secrete calcitonin
- Thyroid is the only endocrine gland in the body which stores its hormone its hormone in its inactive state.

Production of Thyroxine :-

Thyroxine contains two phenyl rings linked up by an enter bridge.

Biosynthesis :

- (1) Iodide trapping – when KI taken up by follicular cells.
- (2) Oxidation of Iodide - $KI \rightarrow I_2$.
The oxidation of iodine is promoted by the enzyme **peroxidases**.
- (3) Organification – The binding of iodine with the thyroglobulin molecule is called organification of the thyroglobulin



- (4) Coupling – $\text{MIT} + \text{DIT} \rightarrow T_3$.
 $\text{DIT} + \text{DIT} \rightarrow T_4$

All of these step of thyroxine biosynthesis are stimulated by THS hormone.

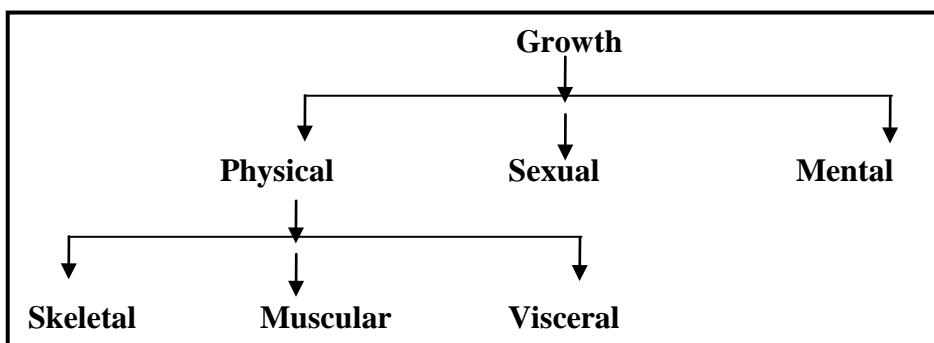
T_1	=	Mono Iodo tyrosine
T_2	=	Di Iodo tyrosine
T_3	=	Tri Iodo tyrosine (20%)
T_4	=	Tetra Iodo tyrosine (80%)

- ☞ Secretion of T_4 is comparatively more then T_3 , and T_3 hormone is four times more effective then T_4 hormone. T_4 changes into T_3 on reachinin the tissues.
- ☞ T_4 is called **thyroxine** in this T- chain of hormones.
- ☞ Thyroxine or Tetra –Iodo – Thyroxine is a derivative of aminoacid.
- ☞ Each thyroglobulin molecule contain an average of T_3 molecule for every 14 molecule of thyroxine (1 : 14 - T_3 : T_4).
- ☞ Thyroid hormones in the form of thyroglobulin are stored in the follicles in an amount sufficient to supply the body with its normal requirements of thyroid hormone for 3 months.

- ☞ **E.C. Kendal** first of all crytallised this thyroxine hormone.
- ☞ **Harrington and Barger** studied the molecular structure of thyroxine.
- ☞ Thyroid gland requires iodine “120 μg ” every day for the production of thyroxine.
- ☞ Normal recommended minimum intake 200 $\mu\text{gm/ day}$, if iodine in take < 50 $\mu\text{gm/ day}$, then thyroid disorder develops.

- ☞ If there is deficiency of iodine in food then thyroid try to absorb more and more iodine from blood and increase its size it is called **simple goiter**.
- ☞ Goitre is found more abundantly in the persons those live on mountain slopes, because iodine (at that place) flows along with water. When most of the people show the symptoms of this disease then it is called **endemic goiter**.
- ☞ Persons who take sea foods, never show the symptoms of goiter.

1. Growth, Development and Metamorphosis :-



- ☞ Thyroxine stimulates the metamorphosis of tadpole larva in amphibians.
- ☞ Due to its deficiency, larval does not show metamorphosis to be an adult.
- ☞ Some amphibian larvae e.g. **Ambystoma** and **Necturus** (Water dog) do not undergo metamorphosis to be an adult, and these larval stages start reproducing without gaining adulthood. This process is called as **Paedogenesis**.

2. METABOLISM :-

General :

- (i) Thyroxine regulates the **Basal metabolic rate (BMR)** in the body.
BMR : The rate of **calorie consumption** that is necessary for life is called basal metabolic rate of body.
 BMR increases → Body Temp. increase → loses weight.
 Over production of heat called as calorogenesis.
 The hormone enhances the oxidative metabolism of body cells as a result of its energy production is also increased in the form of calories so this hormone is also called **calorigenic hormone**.
- (ii) Increases activity of $\text{Na}^+ - \text{K}^+$ AT Pase. It increases the number of mitochondria in all the cells of body i.e. it increases metabolic rate of life. It increases the consumption of oxygen by the cells of body.

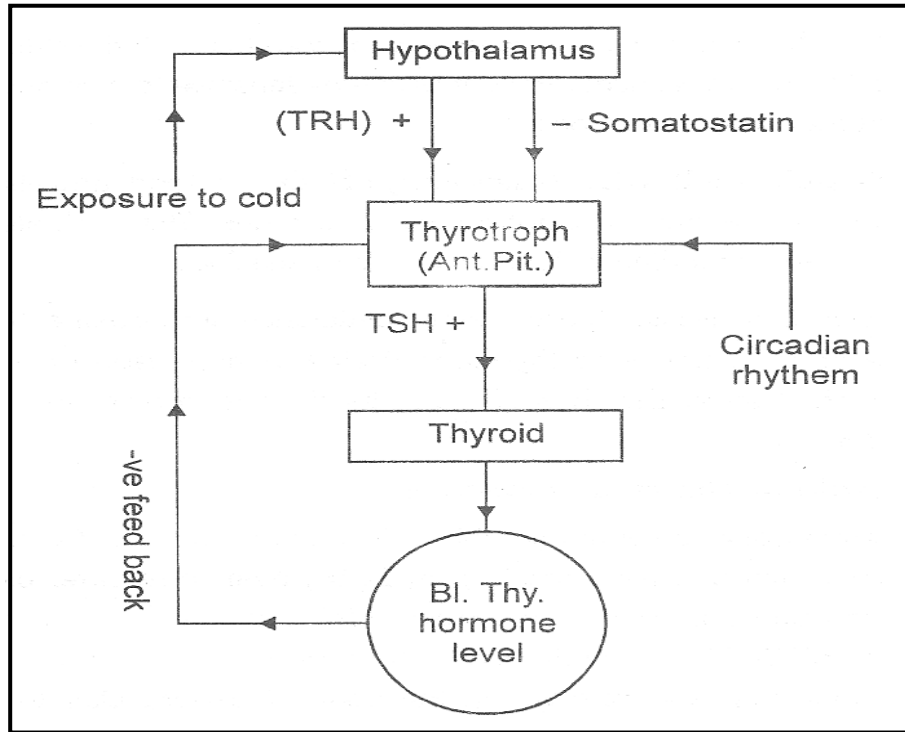
Fat Metabolism :-

- ☞ Enhances enzyme activity both synthesis & predominantly catabolism of cholesterol.
- ☞ **Carbohydrate action** →
- ☞ Blood sugar increases, act as a diabetogenic hormone.
- ☞ **Protein** → both catabolism & anabolism but at optimum concentration of thyroxine, **anabolism** is dominant.

3. ON INDIVIDUAL SYSTEM : Heart.

- ☞ Thyroxine increases – Heart beat increases (Tachycardia) – Increases Cardiac output.
- ☞ Maintain the contraction of myocardium.
- ☞ It regulates the heart –beat because it acts directly on SA-Node.
- ☞ **CNS** – optimum conc. of thyroxine is required for development of the nerve fibre & their myelination.
- ☞ **GIT** –thyroxine increases motility of GIT causes diarrhea. Appetite also increases.
- ☞ **On blood** – Thyroxine stimulate RBC formation.

Regulation of Thyroid Hormone Secretion :-

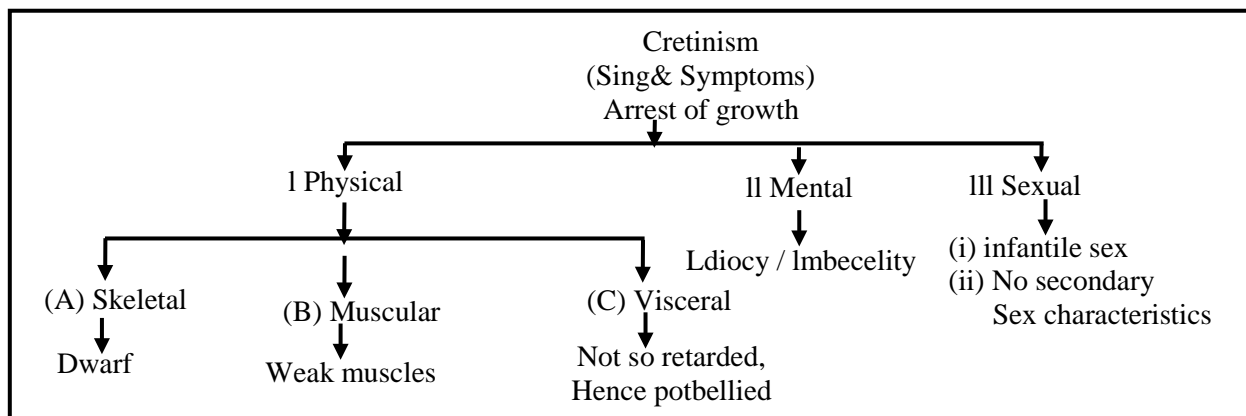


- ☞ The hypothalamus and anterior pituitary gland control rate of thyroid secretion.
- ☞ Anterior pituitary gland secretes TSH.
- ☞ The most important effect of TSH is **proteolysis of thyroglobulin** which cause release of thyroxine into the blood.
- ☞ Anterior pituitary secretion of TSH is controlled by a hypothalamic hormone thyrotroin releasing hormone (TRH).
- ☞ Increase thyroid hormone in the body fluid decreases the secretion of TSH by anterior pituitary.

IRREGULARITIES OF THYROID GLAND AND ITS DISEASES :-

1. Hyposecretion of thyroid or Hypothyroidism :-

- ☞ It may be a genetic disorder or due to deficiency of iodine in food or due to excess iodine excretion in urine.
- ☞ **In childhood**, hypothyroidism causes **Cretinism**, these children are called **cretin**, they may show such symptoms like :- Thick lips, protruding tongue, pot belly, ill developed sex organs & retarded physical & mental growth. The children remain dwarf and become ugly. Their BMR, rate of heart beat and body temperature decreased. They are sterile.



☞ **In adults**, hypothyroidism causes **Myxoedema**. (Gull's disease) The symptoms of this disease are falling of hair, loose and swollen skin, deposition of adipose fat and mucous beneath the skin so body as a whole becomes obese, BMR and blood pressure are reduced. Patient becomes sensitive to cold and shows loss of sexual power. Mental slowing, **bradycardia**, weight gain occurs.

☞ **Simple goitre /Endemic goitre :-** It is due to deficiency of iodine in food, and also known as **Colloid goitre**. Thyroid gland enlarges due to swelling. It is not a genetic disorder. The neck also swells up and looks like a collar. It is cured by extra intake of iodine in food or intake of sea food.

☞ **Hashimoto's disease :-** In this disease, there is acute deficiency of thyroxine. Then the medicines given for the treatment of disease or even hormone thyroxine itself acts as poison or antigen. In its reaction, body produces antibodies, which destroy the thyroid gland itself. It is known also as suicide of thyroid of **Autoimmune thyroiditis**.

2. **Hypersecretion of thyroid or Hyperthyroidism :-**

The gland shows enlargement due to some microbial infections or genetic disorders, and enlarged gland secretes thyroxine in excess amount. As a result of it, BMR, heart beat rate, blood pressure, absorption of glucose in intestine and consumption of oxygen increase. Too much energy is produced in mitochondria, that it is not stopped in the form of ATP but it is released in the form of heat in the body. Thus in place of growth, unnecessary irritation, exhaustion are observed in the body of patient. Due to excess heat/ calorie / energy formation, patient feels extreme hot.

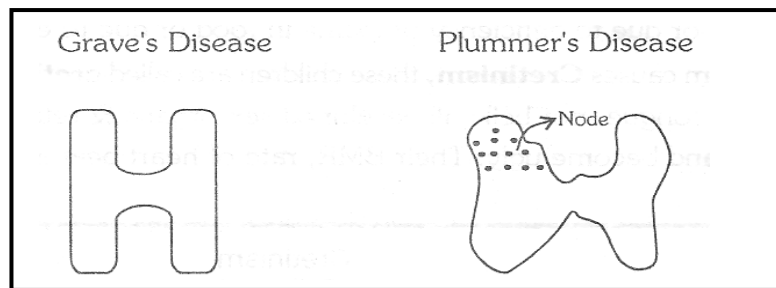
Hyperthyroidism may cause following disorders in the body :-

Exophthalmic Goitre or Grave's disease or Basedow's disease or thyrotoxicosis

In this disease, deposition of mucous beneath the eyeball takes place. As a result of that eyes look enlarged and bulging or protruding outside the eye socket, giving the patient a fearful and staring look. In this disease whole gland shows enlargement in the neck region.

Plummer's disease :- In this disease, thyroid gland does not show even growth but there become small tumours all over the thyroid just like buds. It is also called **Toxic adenoma**.

Thyroid gland shows enlargement (swelling) at the time of Hypersecretion.



Para follicular cells or C-cells :-

These cells are found in the stroma of thyroid gland & basal part of follicle. These cells are of endocrine nature.

They are the remains of ultimobranchial bodies made up of fifth branchial pouches of embryo, i. e. para follicular cells are **endodermal** in origin.

These cells secrete **thyrocalcitonin (Calcitonin) hormone** which lacks iodine. It is a protein.

Thyrocalcitonin reduces the destruction of bones and increases the rate of excretion of Ca^{++} in urine, thus reduces the number of Ca^{++} in extra cellular fluid.

☞ It enhances the deposition of Ca^{++} in bones thus making bones solid and strong.

☞ This hormone is antagonistic to **Collip hormone** or **parathormone**.