ANATOMY OF ENDOCRINE SYSTEM

Introduction, Pituitary gland and Thyroid gland

Prepared by
Dr. Payal Jain

Endocrine System

I. Introduction

A. Considered to be part of animals communication system

1. Nervous system uses physical structures for communication
2. Endocrine system uses body fluids to transport messages (hormones)

II. Hormones

A. Classically, hormones are defined as chemical substances produced by ductless glands and secreted into the blood supply to affect a tissue distant from the gland, but now it is understood that hormones can be produced by single cells as well.

1. epicrine

a. hormones pass through gap junctions of adjacent cells without entering extracellular fluid

2. paracrine

a. hormones diffuse through interstitial fluid (e.g. prostaglandins)

3. endocrine

a. hormones are delivered via the bloodstream (e.g. growth hormone

Comparison of the endocrine and nervous systems - 1

	Endocrine	Nervous
Cells involved	Gland	Sense receptor
Message	Chemical (Hormone)	Electrical(Impulse)
Carried by	Blood	Nerve cell
Message sent to	Cells throughout the body	A specific cell or tissue
Received by	Target organ	Effector (muscle or gland)

Comparison of the endocrine and nervous systems -- 2

	Endocrine	Nervous
Speed of transmission	Usually slow	Rapid
Effects	Can be widespread	Localised usually
Duration	long-lasting (hours)	Usually brief (seconds)

Different endocrine glands with cell arrangement

Organ	Division	Cell arrangement/morphology	Hormone
Hypophysis	**Adenohypophysis**		
	Pars distalis	Cells in cords around large-bore capillaries:	
		Acidophils	Growth hormone, prolactin
		Basophils	ACTH, TSH, FSH, LH
	Pars intermedia	Mostly basophilic cells around cystic cavities	ACTH, POMC
	Pars tuberalis	Narrow sleeve of basophilc cells around infundibulum	LH
	Neurohypophysis		
	Pars nervosa	Nerve fibers and supporting cells (pituicytes)	Oxytocin and vasopressin (produced in hypothalamus)
	Infundibulum	Nerve fibers (traveling from hypothalamus to pars nervosa)	
Pancreas	Islet of Langerhans	Irregularly arranged cells with many capillaries	Insulin, glucagon

Thyroid		Follicles: Simple cuboidal to columnar epithelium in spherical shells around colloid	Principal cells: T3 and T4 Parafollicular cell: Thyrocalcitonin
Parathyroid		Densely packed cords of polygonal cells (chief cells and oxyphilic cells)	PTH
Adrenal	**Cortex**		
	Zona glomerulosa	Columnar cells in rounded clusters	Aldosterone
	Zona fasiculata	Large, pale-staining polygonal cells in columns	Glucocorticoids (Cortisone)
	Zona reticularis	Round cells in irregular cords	Gonadocorticoids (DHEA)
	Medulla	Chromaffin cells= large round cells with centrally located nucleus with prominent nucleus, often cytoplasmic granules. Note large veins in center of medulla.	Norepinephrine and epinephrine

III. Pituitary Gland (hypophysis cerebri)

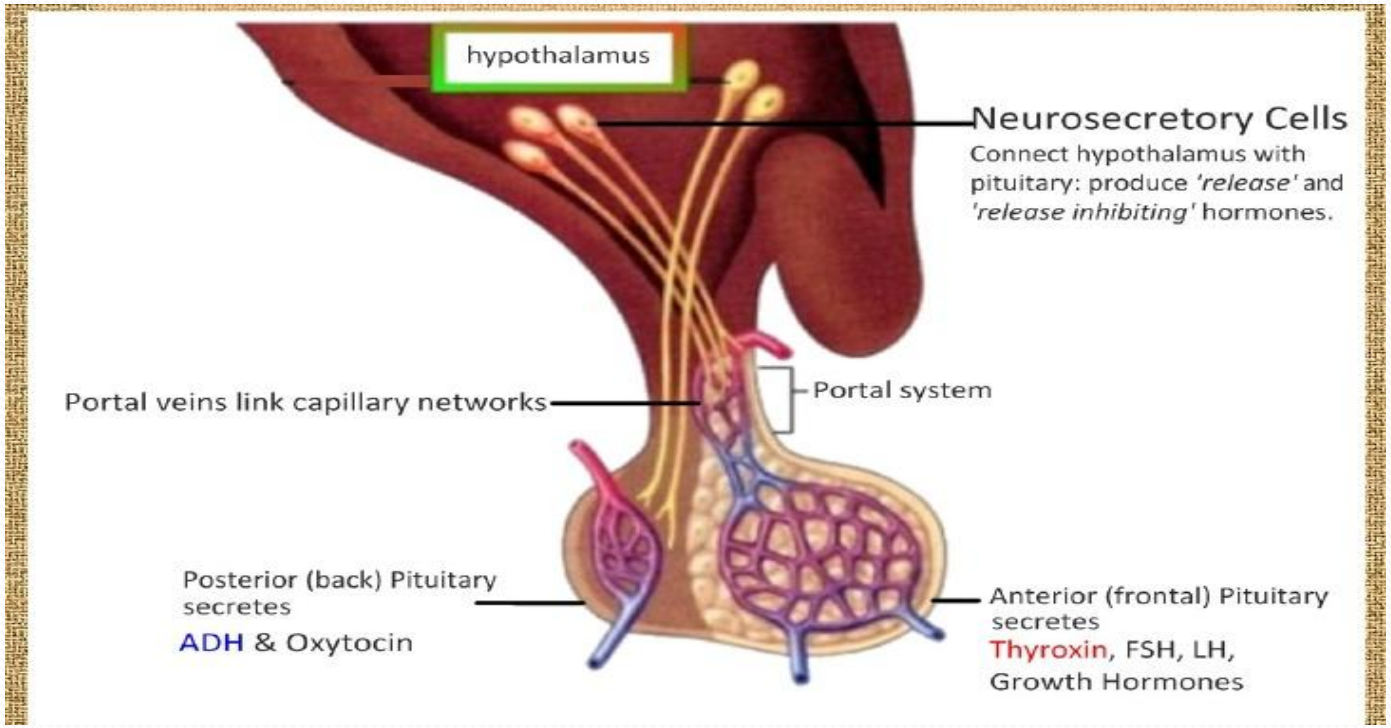
A. Has two distinct parts

1. anterior lobe (adenohypophysis)
2. posterior lobe (neurohypophysis)

B. Located in a bony recess (sella turcica) at the base of the brain

C. Connected to the brain by the hypothalamus and a portal blood supply

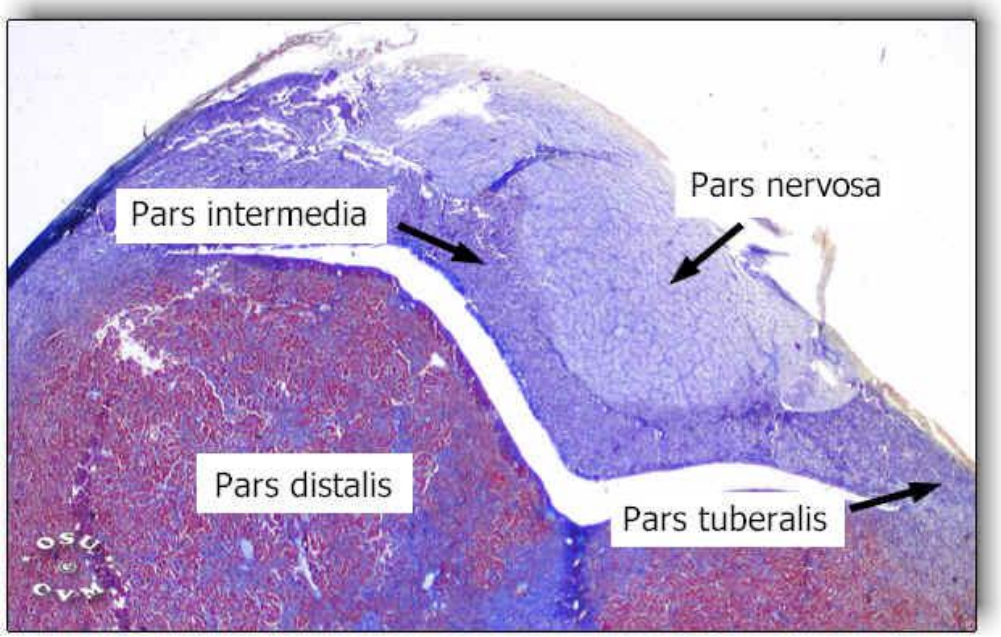
1. vein draining the hypothalamus breaks up into a capillary bed within the anterior pituitary
2. route by which releasing factors from the hypothalamus travel to cause release of hormones from the anterior pituitary



Adenohypophysis - based on grouping of all regions composed of glandular tissue
This includes the…

pars distalis
pars intermedia
pars tuberalis

Neurohypophysis - based on grouping of all regions composed of neural or neurosecretory tissue
This includes the . . .
median eminence
infundibular stalk
pars nervosa (infundibular process



The Adenohypophysis

Pars distalis: This region of the pituitary gland is organized as cords or clusters of cells supported by a reticular connective tissue. With routine staining two types of cells can be observed: (1) **chromophils** which stain readily and are either red (acidophiles), blue or purple (basophiles) depending on the type of secretory material present, and (2) **chromophobes** which do not take up the stain and thus appear unstained or rather clear. Chromophobes may be chromophils that have lost their secretory granules or chromophils that have not accumulated large numbers of secretory granules. Use of specific antibodies against the protein secretory products has allowed the identification of the different cells.

The cells of the pasr distalis are:

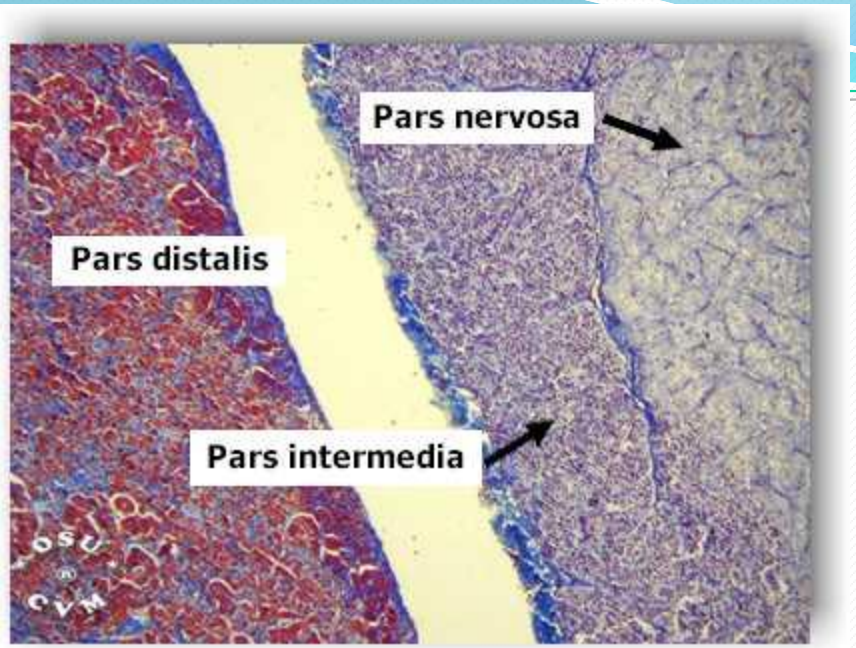
Somatotrophs secrete growth hormone which affects many cells

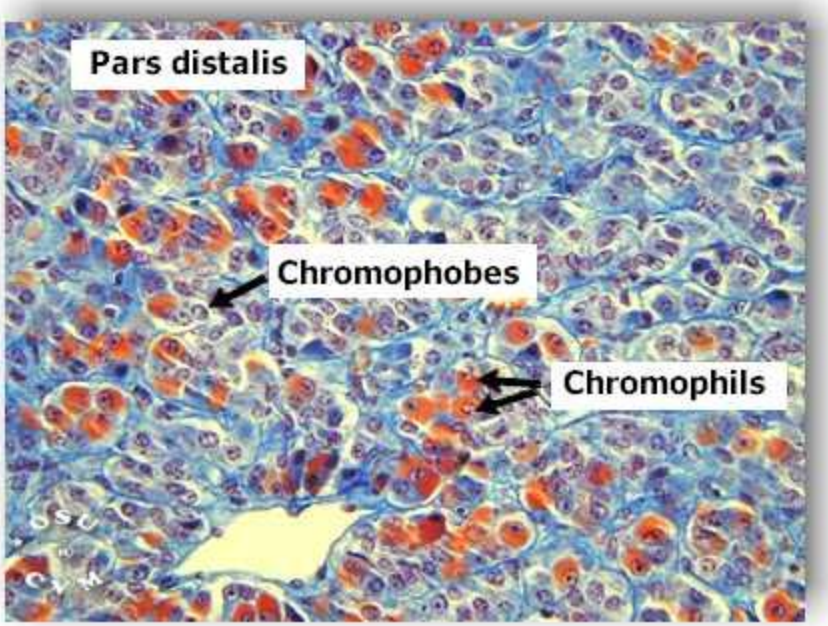
Mammotrophs secrete prolactin which controls milk production during lactation

Corticotrophs secrete ACTH which controls secretion of cortisol by cells in the adrenal cortex

Thyrotrophs secrete TSH which controls secretion of thyroid gland

Gonadotrophs secrete FSH and LH which control development of follicles and ovulation in the ovary.

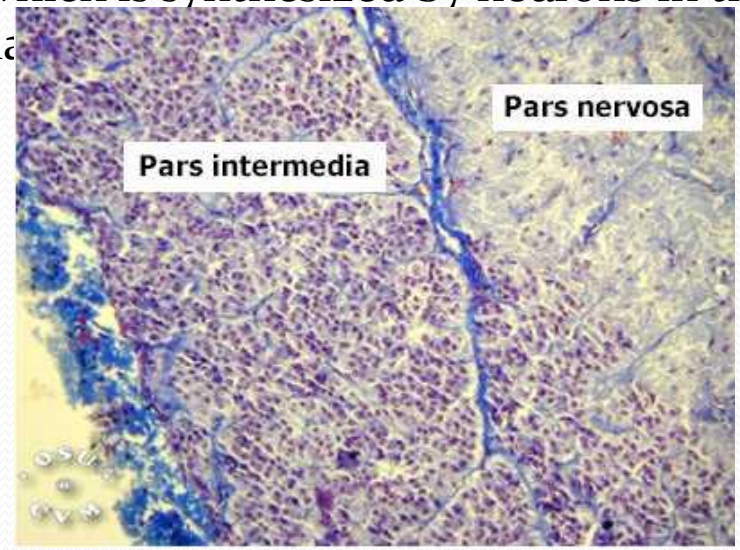

Pars nervosa
Pars distalis
Pars intermedia


Pars distalis
Chromophobes
Chromophils

Pars intermedia: With routine histological staining, the cells in the pars intermedia stain blue-purple and thus are basophilic.
Cells secrete ACTH, MSH, endorphins and lipotrophins.

Pars tuberalis: This region is an extension of the glandular pituitary gland and its cells resemble those of the pars intermedia and pars distalis. The specific function of the cells in the pars tuberalis, however, is not clear.

The Neurohypophysis
Pars nervosa: This region consists of unmyelinated nerve axons (cell bodies are in the hypothalamus) and supportive cells called pituicytes.
Secretes ADH (antidiuretic hormone) which is synthesized by neurons in the supraoptic nucleus of the hypothalamus.
Secretes vasopressin which is synthesized by neurons in the paraventricular nucleus of the hypotha



Adenohypophysis.

The cells in the adenohypophysis secrete two classes of hormones: (1) direct acting and (2) trophic. Direct acting hormones include growth hormone (GH) and prolactin from the pars distalis, and melanocyte stimulating hormone (MSH) from the pars intermedia. Trophic hormones include adrenocorticotrophic hormone (ACTH), thyroid stimulating hormone (TSH), follicle stimulating hormone (FSH) and luteinizing hormone (LH).

Secretion of these hormones is controlled by specific releasing hormones in the hypothalamus. Most of the releasing hormones are stimulatory in their action except for the one for prolactin which is inhibitory and the one for growth hormone which has both inhibitory and stimulatory releasing hormones. Releasing hormones are produced in the median eminence of the hypothalamus and reach the adenohypophysis via a portal system of veins known as the **pituitary portal system.**

Neurohypophysis.

The cells in the neurohypophysis secrete only direct acting hormones : (1) antidiuretic hormone (ADH) also known as vasopressin secreted by neurons in the supraoptic nucleus in the hypothalamus and (2) oxytocin secreted by neurons in the paraventricular nucleus in the hypothalamus. After synthesis in the hypothalamus, these hormones move down the axons of the hypothalamohypophyseal tract through the infundibular stalk and terminate near blood vessels in the pars nervosa. Accumulations of these hormones bound to specific glycoproteins can be observed along the axons of the hypothalamophypophyseal tract and in the pars nervosa. These "accumulations" often called Herring bodies represent a storage form of the hormone. Release of these hormone stores is determined by impulses in the axons of the hypothalamophypophyseal tract originating in the hypothalamus. Such a mechanism of secretion controlled by nerve impulses is called "neurosecretion".

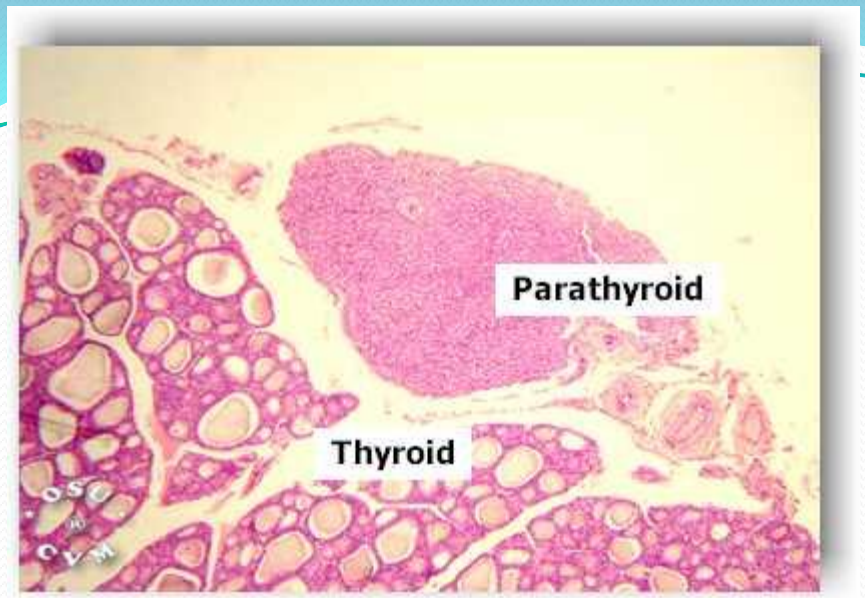
THYROID

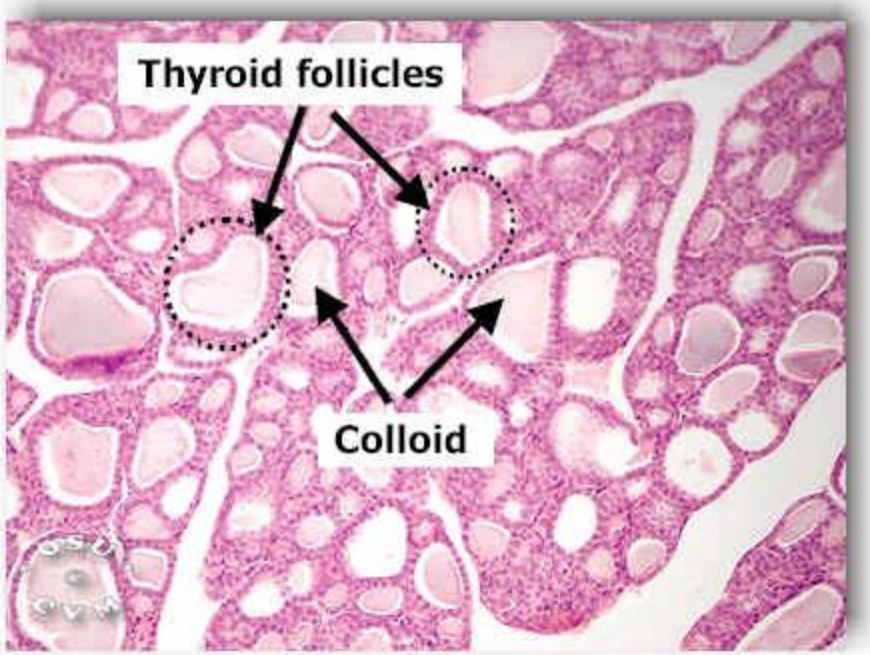
I. Gross Anatomy

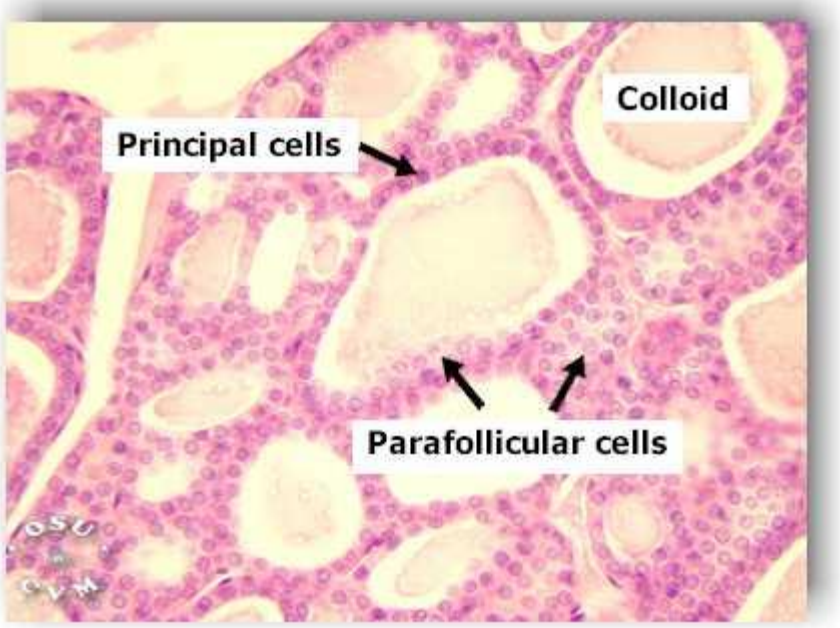
The thyroid gland is located dorsolateral to the trachea, close to the larynx. It has two lobes that are connected by a narrow isthmus.

II. Histology

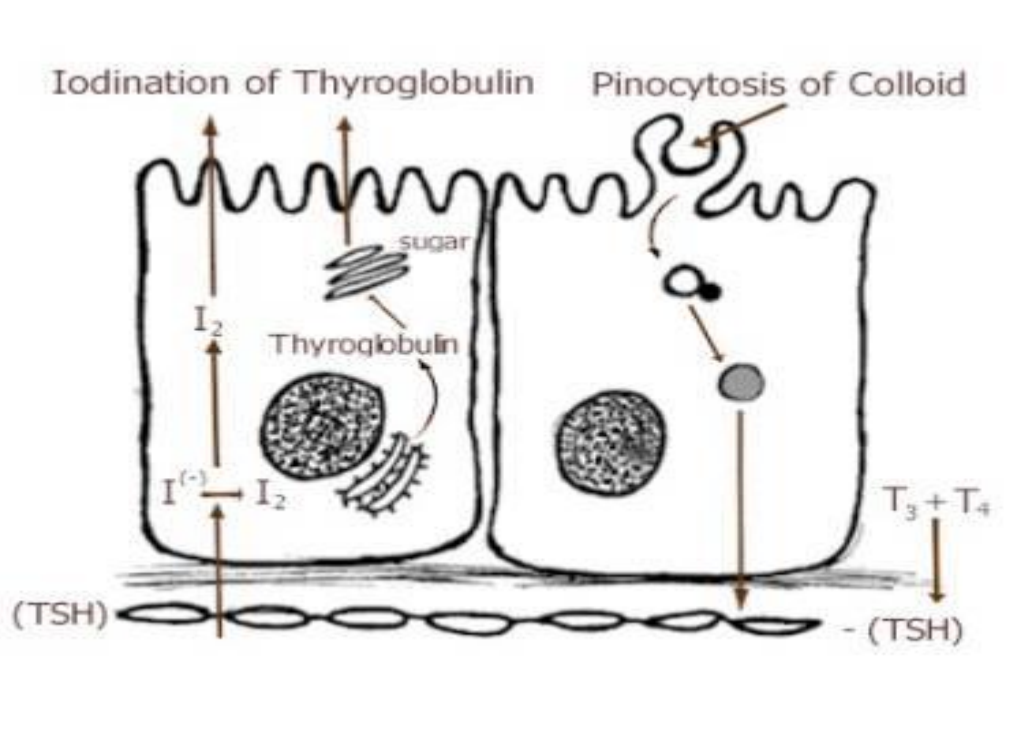
The thyroid gland is composed of follicles and interfollicular connective tissue. The capsule, classified as loose areolar connective tissue, surrounds the mass of thyroid follicles and sends smaller pieces of connective tissue into the gland to surround the individual thyroid follicles. Near the thyroid gland and embedded in the same connective tissue capsule is the **parathyroid** gland. Sometimes patches of lymphocytes can be observed in the thyroid/parathyroid glands.
Thyroid follicles consist of a layer of simple epithelium surrounding a gel-like pinkish material called **colloid**. The **principal cell** is the most numerous cell present in the simple epithelial layer and is responsible for secreting the thyroid hormones as well as thyroglobulin, a glycoprotein. Thyroid hormones are stored extracellularly as part of the thyroglobulin which is the main component of the colloid. The size of follicles and the height of principal cells varies even within one section of the gland. Squamous principal cells indicate a relatively inactive gland whereas cuboidal to columnar cells indicate more activity in removing the hormone from the stored form. In addition to principal cells there is another type of functional cell in the thyroid gland. This is the **parafollicular cell** which may be found as single cells in the epithelial lining of the follicle or in groups in the connective tissue between follicles. They usually appear as large, clear cells since they do not stain well with hematoxylin and eosin. They are sometimes called **parafollicular cells** based on their location and **clear cells (C cells)** based on their appearance of their cytoplasm. Parafollicular cells secrete calcitonin, a hormone that lowers the level of calcium in the blood.

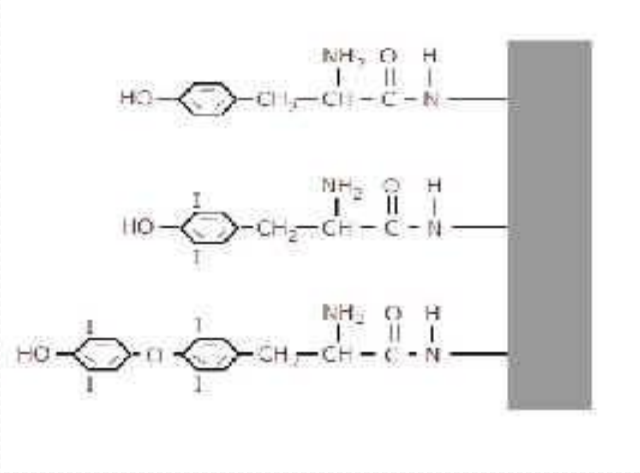

Parathyroid
Thyroid


Thyroid follicles
Colloid


Colloid
Principal cells
Parafollicular cells

Mechanism of Secretion of T_3 and T_4 (thyroxin).





Under the influence of increased TSH from the pituitary gland, principal cells concentrate iodine by active transport. At the same time they synthesize *thyroglobulin* and secrete it into the lumen of the thyroid follicle

The iodination reaction, catalyzed by the enzyme peroxidase, is carried out on the large thyroglobulin molecule at the luminal surface of the principal cell. Various combinations of iodinated and non-iodinated tyrosine are possible. If the two molecules of tyrosine are both fully iodinated, the hormone resulting upon cleavage is T_4 but if one of the tyrosines has only one iodine, then the hormone that results is T_3. In the circulation T_4 is converted to T_3 which appears to be the active form of the hormone.

Under the influence of rising TSH levels, the principal cells take up colloid by pinocytosis, the vesicles fuse with lysosomes which hydrolyze throglobulin releasing T_3 and T_4 (thyroxin) which diffuse into the blood and lymph

V. Parafollicular Cells

Secrete calcitonin which inhibits osteoclasts from resorbing bone resulting in decrease in calcium in the blood

Controlled by the level of calcium in the blood

Thank You