The Body Works?
Part 2

Part of the UVic
Retirees Association (UVRA)
Elder Academy Program

Presenters: David Docherty, Ph.D., with Chris Pengilly, M.D., Mike Bassett, M.D. and Dr. Helen Martendale. Ph.D., O.D.

Presentations: in two parts

1. The anatomy and function of four new selected systems
2. Things that can go wrong and the medical interventions commonly

Reminder: Slide presentations available:
https://onlineacademiccommunity.uvic.ca/elderacademy

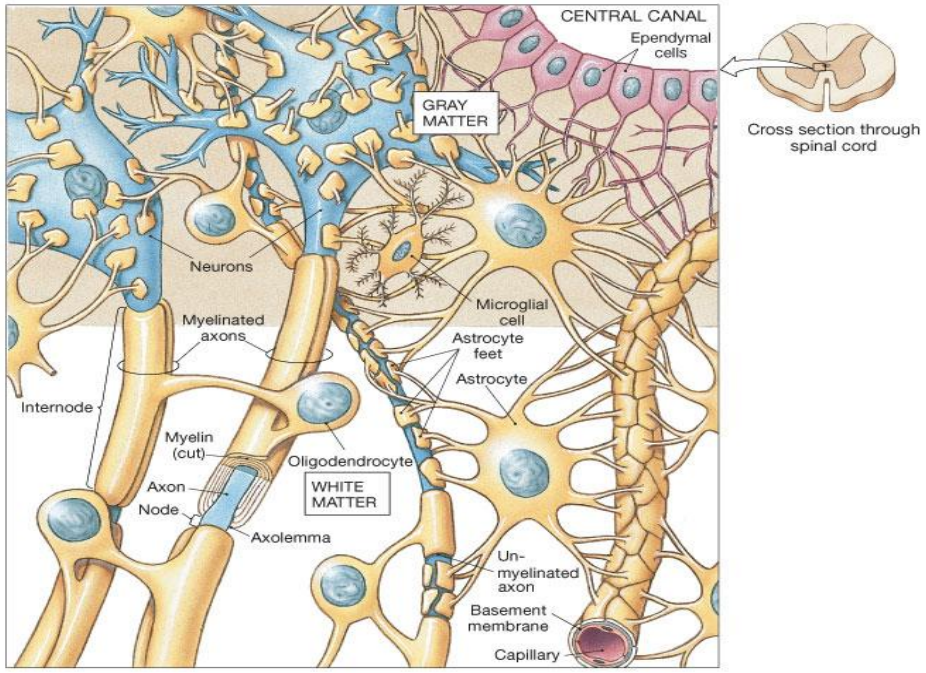
4 New Systems

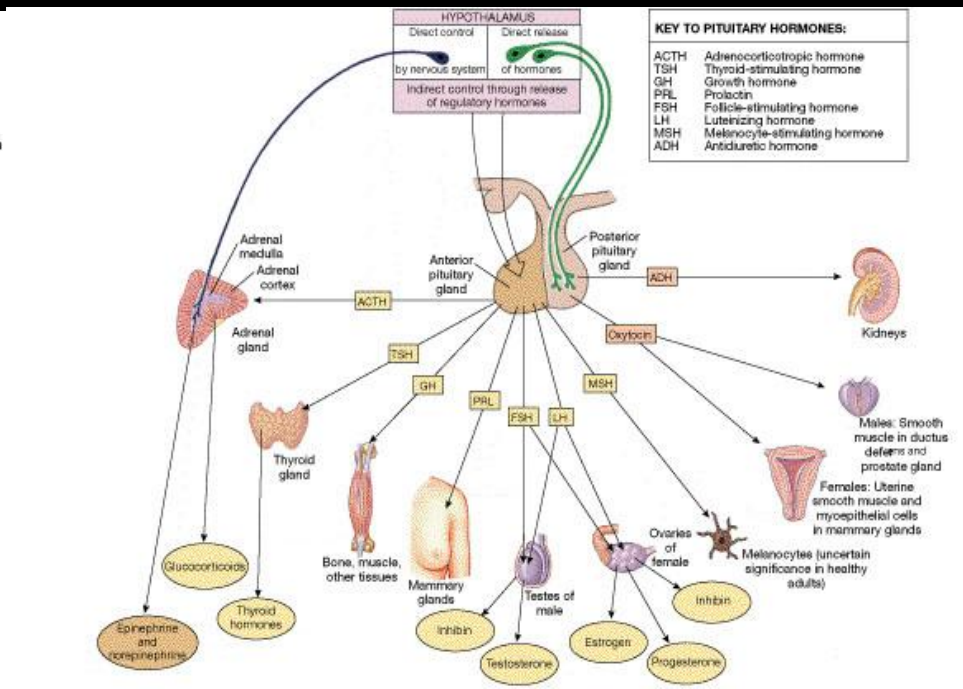
- ~~The Brain-Dr. Mike Bassett~~
- The Endocrine System-Dr. Chris Pengilly
- The Respiratory System-Dr. Chris Pengilly
- The Special Senses (Vision)-Dr Helen Martendale


Medical Issues
and treatments

Nervous and endocrine systems

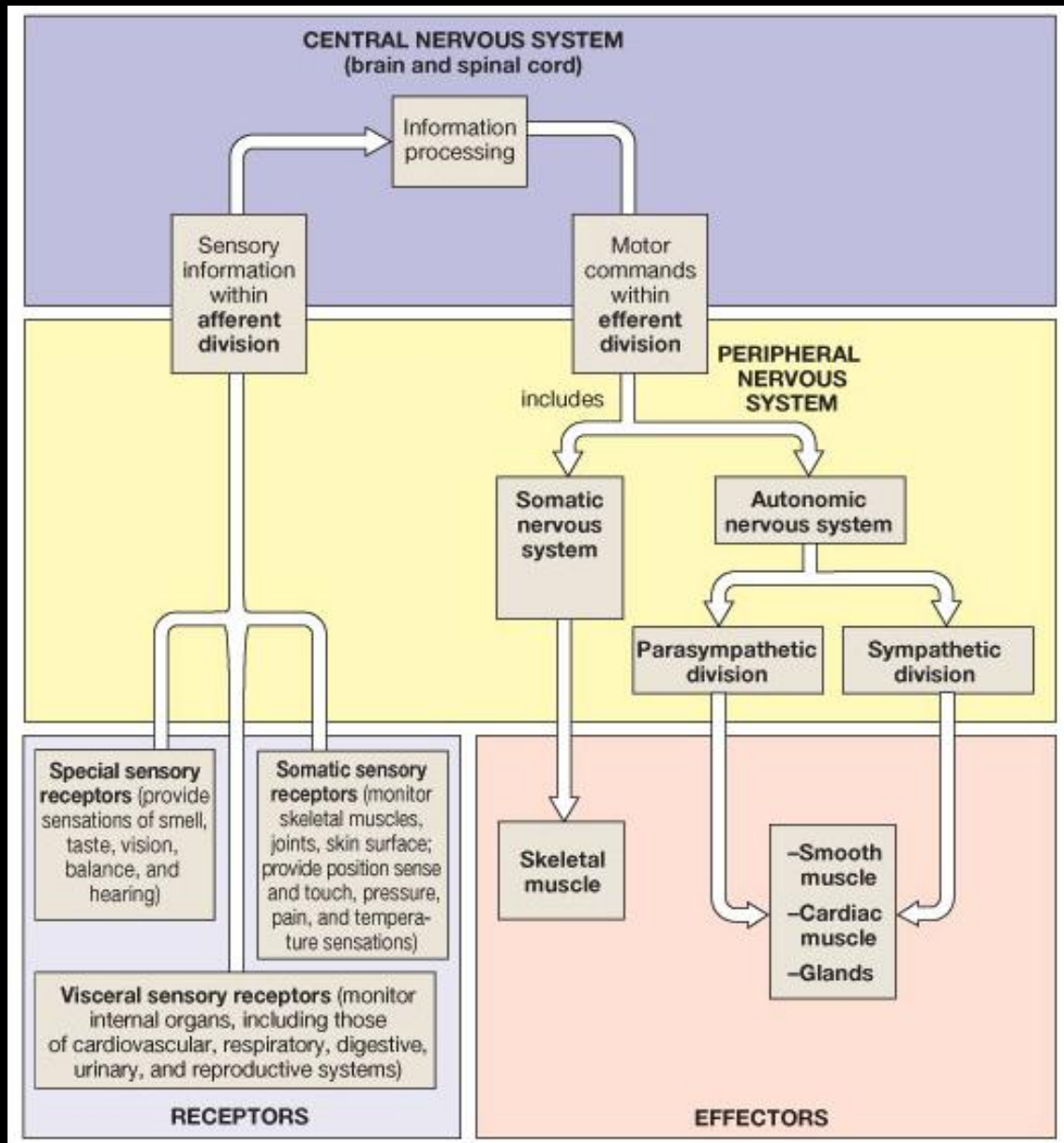
- The cells of the nervous and endocrine systems work together to monitor and adjust the physiological activities under way to attain **homeostasis**.





Quick review of the Nervous System

- This diagram shows the relationship between the CNS and the PNS and the functions and components of the afferent and efferent divisions.



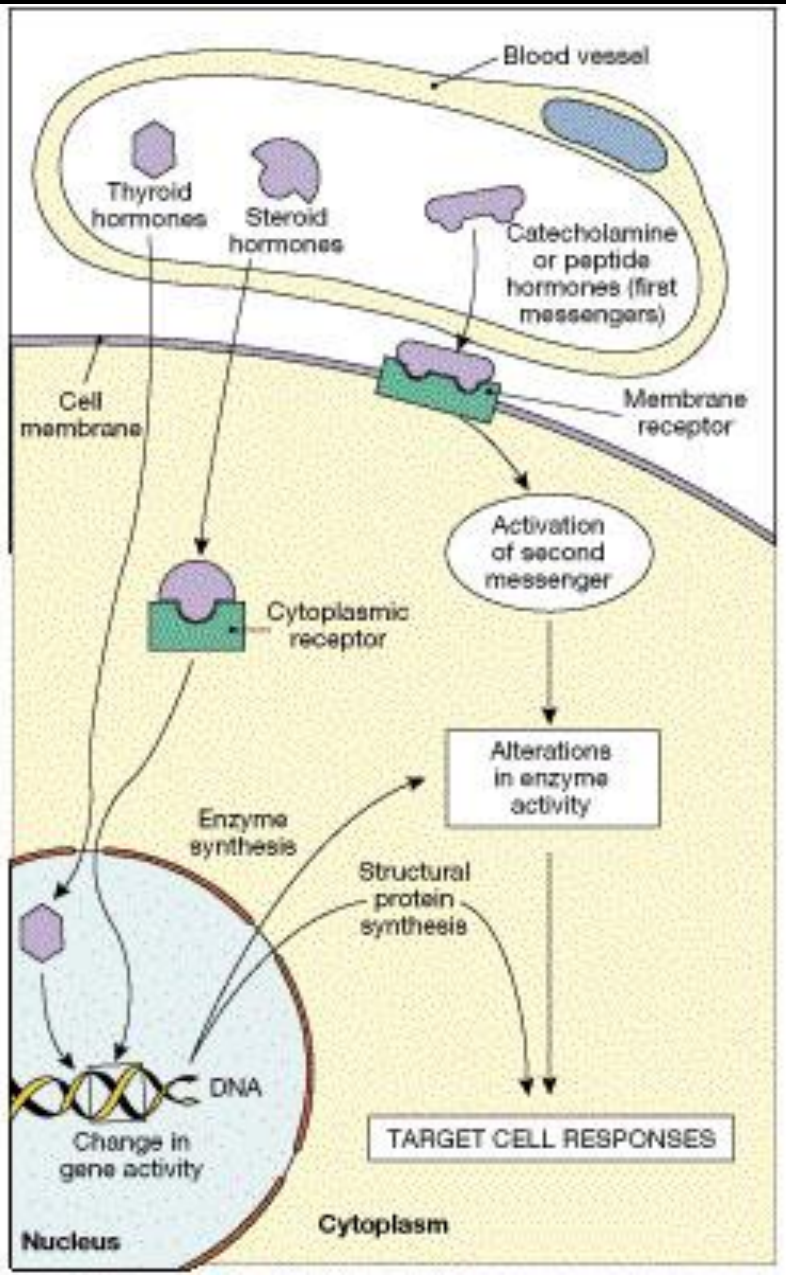
The Endocrine System

- Endocrine glands release hormones into interstitial fluids, lymphoid system, or blood.
- Some organs have endocrine cells (heart and kidneys)

Nervous and endocrine systems

- The cells of the nervous and endocrine systems work together to monitor and adjust the physiological activities under way.
- However:
  - **The nervous system** generally produces ***immediate and short term*** specific responses
  - **The endocrine system** alters metabolic activities of many different tissues and organs simultaneously and ***may take time for the effects to become apparent but then persist for some time after*** (e.g. hormones regulating growth, response to stress).

Mechanisms of hormone actions



Catecholamines (AA) and peptides (all pituitary) must bind to cell membrane receptor

Steroid hormones bind to receptor in cytoplasm

Thyroid hormones (AA) go straight to cell nucleus

Endocrine reflexes:

- **Humoral stimuli**
  - From changes in composition of extracellular fluid
- **Hormonal stimuli**
  - Arrival of specific hormones
- **Neural stimuli**
  - Arrival of neurotransmitter

Hormone regulation

The levels of hormones in the blood are tightly controlled by three homeostatic mechanisms:

1. When one hormone stimulates the production of a second, the second suppresses the production of the first (e.g. FSH stimulates production of estrogen which will suppress the production of FSH.

2. Antagonistic pairs of hormones (e.g. insulin causes blood sugar levels to drop when they are high whereas glucagon causes it to rise when it has dropped).

3. Hormone secretion is increased (or decreased) by the same substance that causes it to increase or decrease (e.g. a rising level of calcium in the blood will suppress the production of PTH whereas a low level will stimulate production and release).

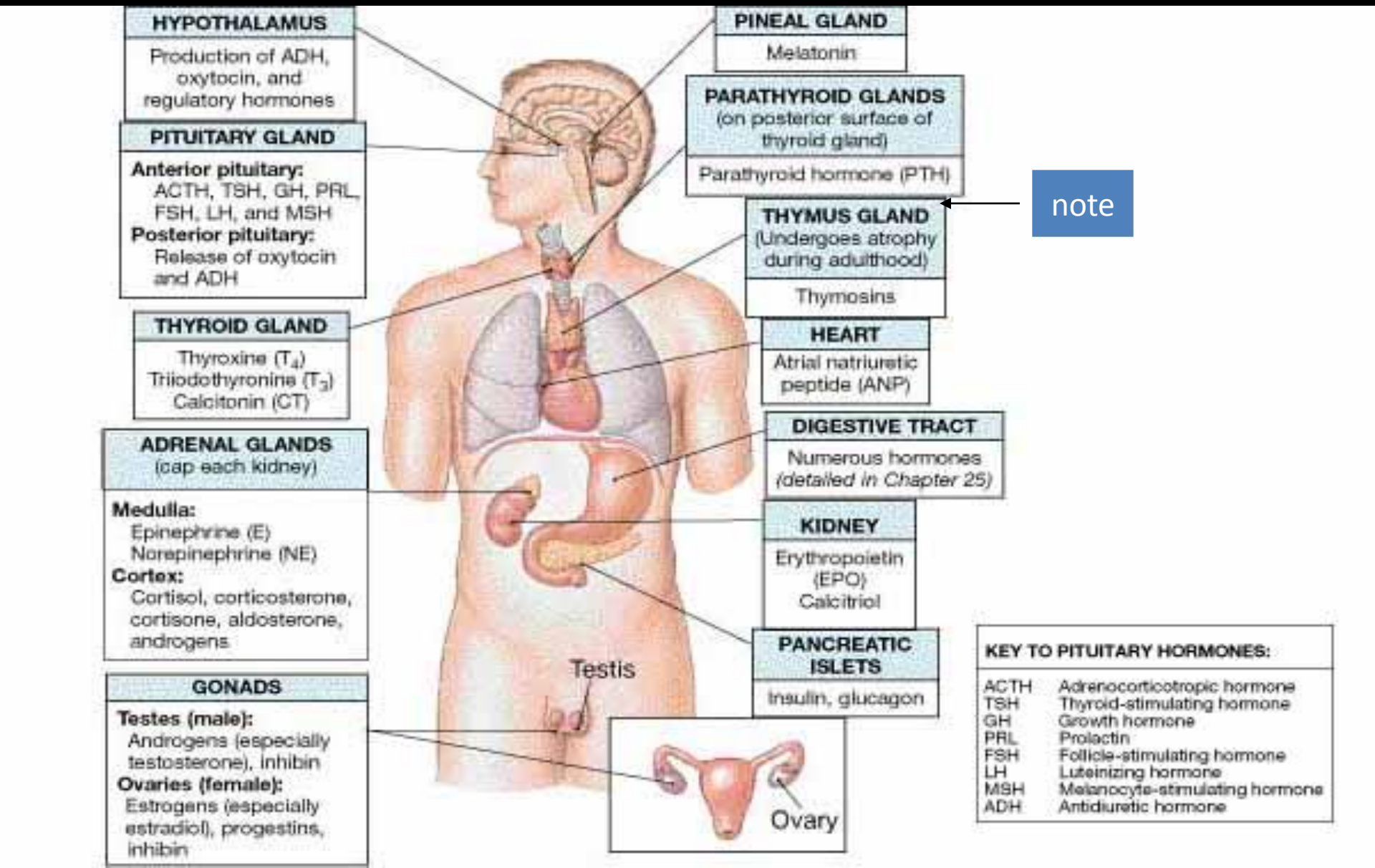
Endocrine reflexes

- Endocrine reflexes are usually controlled by some form of negative feedback loop:

  e.g. Control of calcium in the extracellular fluid (parathyroid hormone)

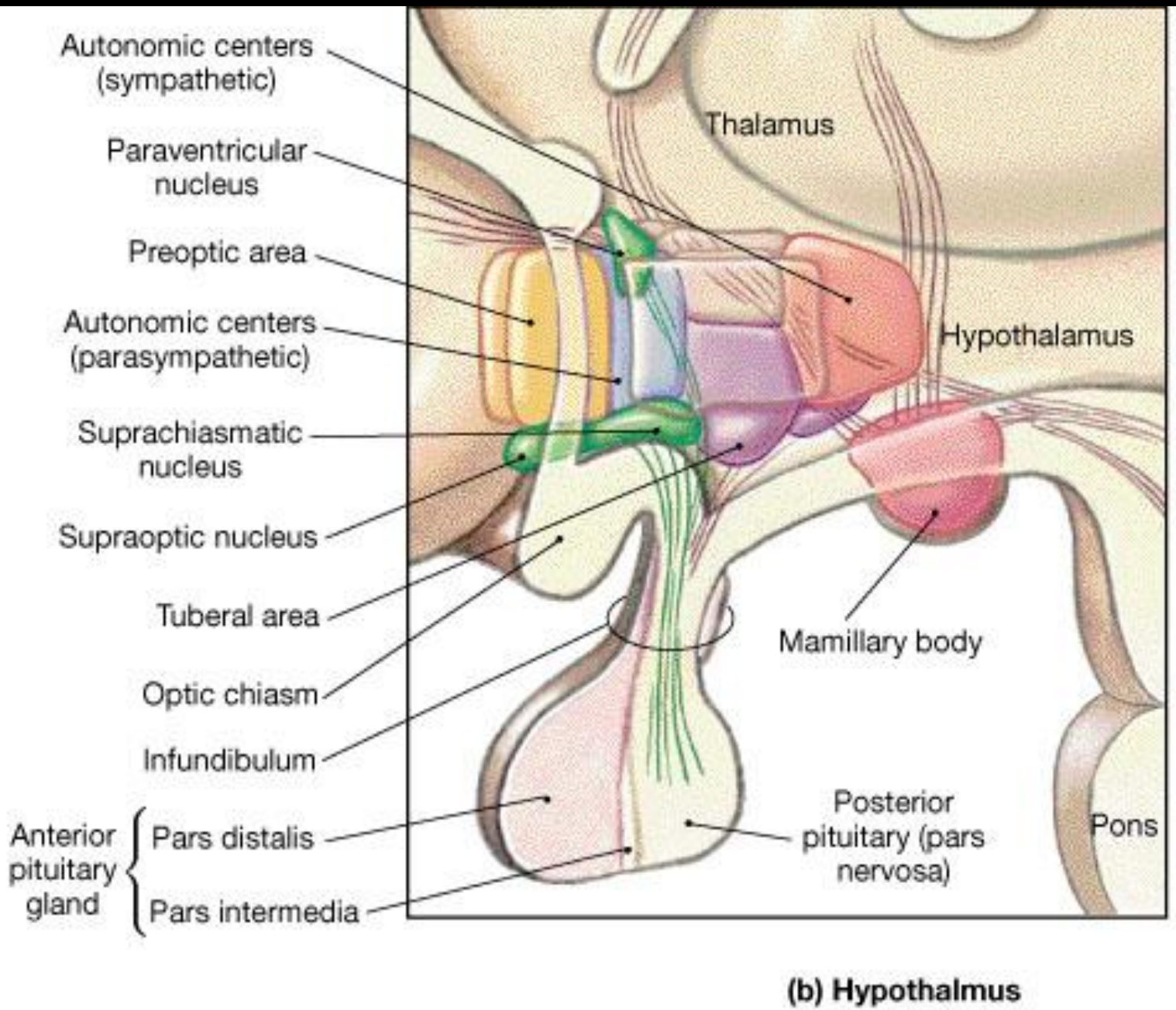
  – When circulating levels of calcium decline, the parathyroid hormone is released
  – The target cells (osteoclasts) elevate blood calcium levels
  – As the level of calcium increases in the blood the stimulation of the parathyroid declines and the release of parathyroid hormone decreases

The Endocrine System (Wow!)

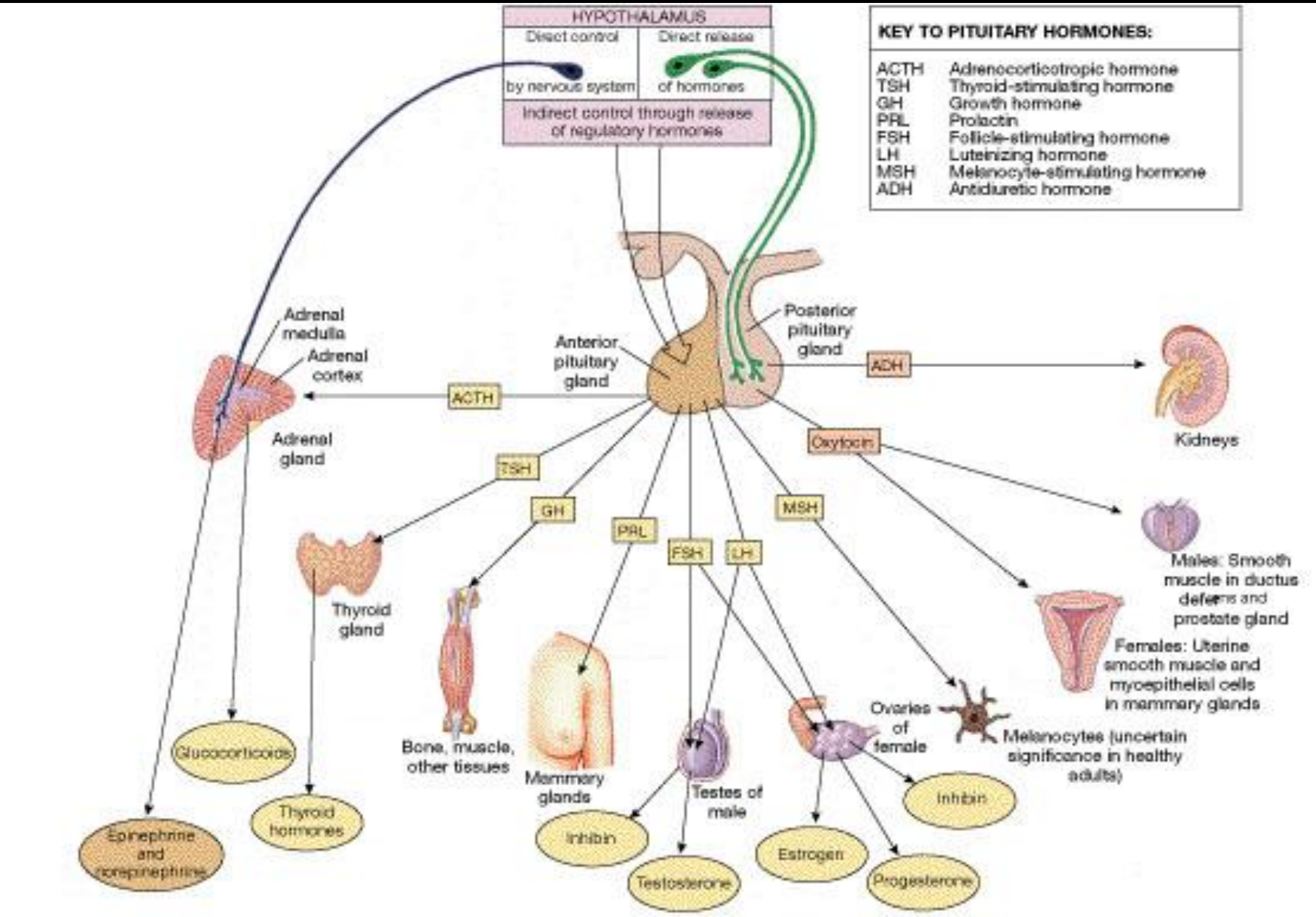


note

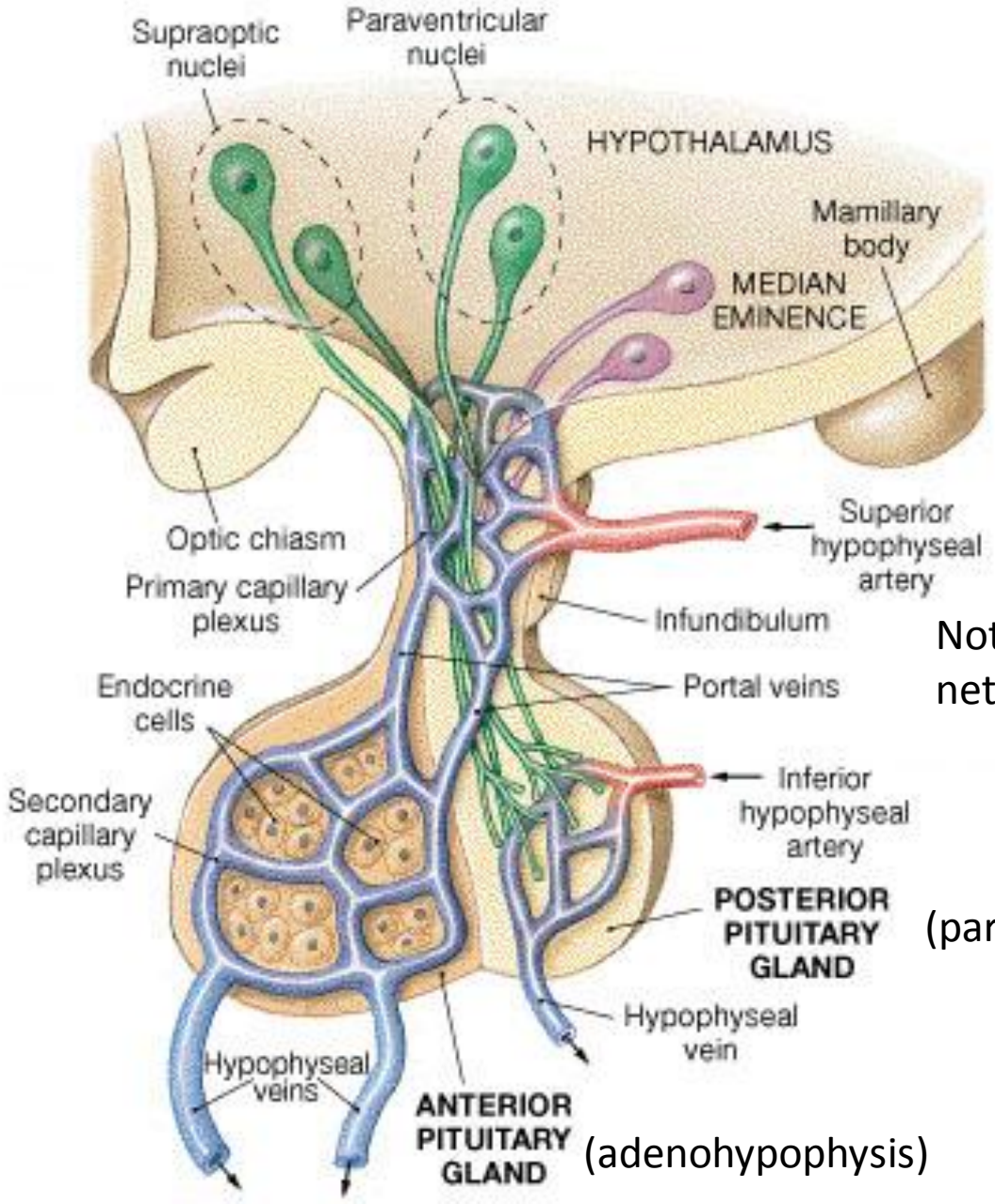
Divisions of the pituitary



Targets of the pituitary gland (the Master Gland)



Hypophyseal portal system



Note: **Two** capillary networks (fenestrated)

(pars nervosa)

(adenohypophysis)

Pituitary Gland

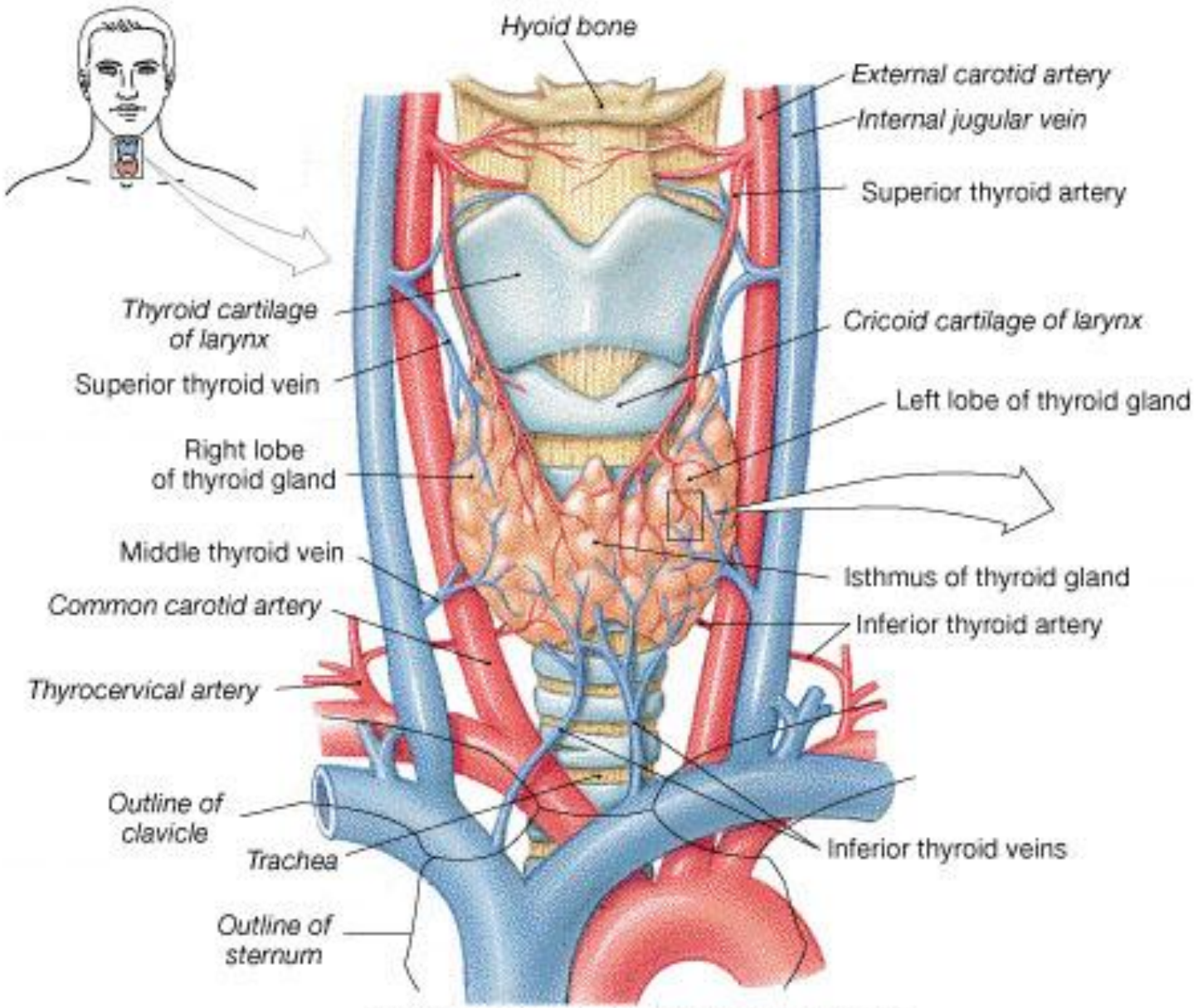
- Pituitary Tumors
- The most frequent type of pituitary disorder is a pituitary gland tumor. These tumors are fairly common in adults. They are not brain tumors and are almost always benign (that is, not cancer). In fact, cancerous tumors of this sort are extremely rare.

The problems caused by pituitary tumors fall into three general categories:

- Hypersecretion: Too much of any hormone in the body is caused by a secretory pituitary tumor.
- Hyposecretion: Too little of any hormone in the body can be caused by a large pituitary tumor, which interferes with the pituitary gland's ability to produce hormones.
- Hyposecretion can also result from surgery or radiation of a tumor.

  Tumor mass effects: As a pituitary tumor grows and presses against the pituitary gland or other areas in the brain, it may cause headaches, vision problems, or other health effects.

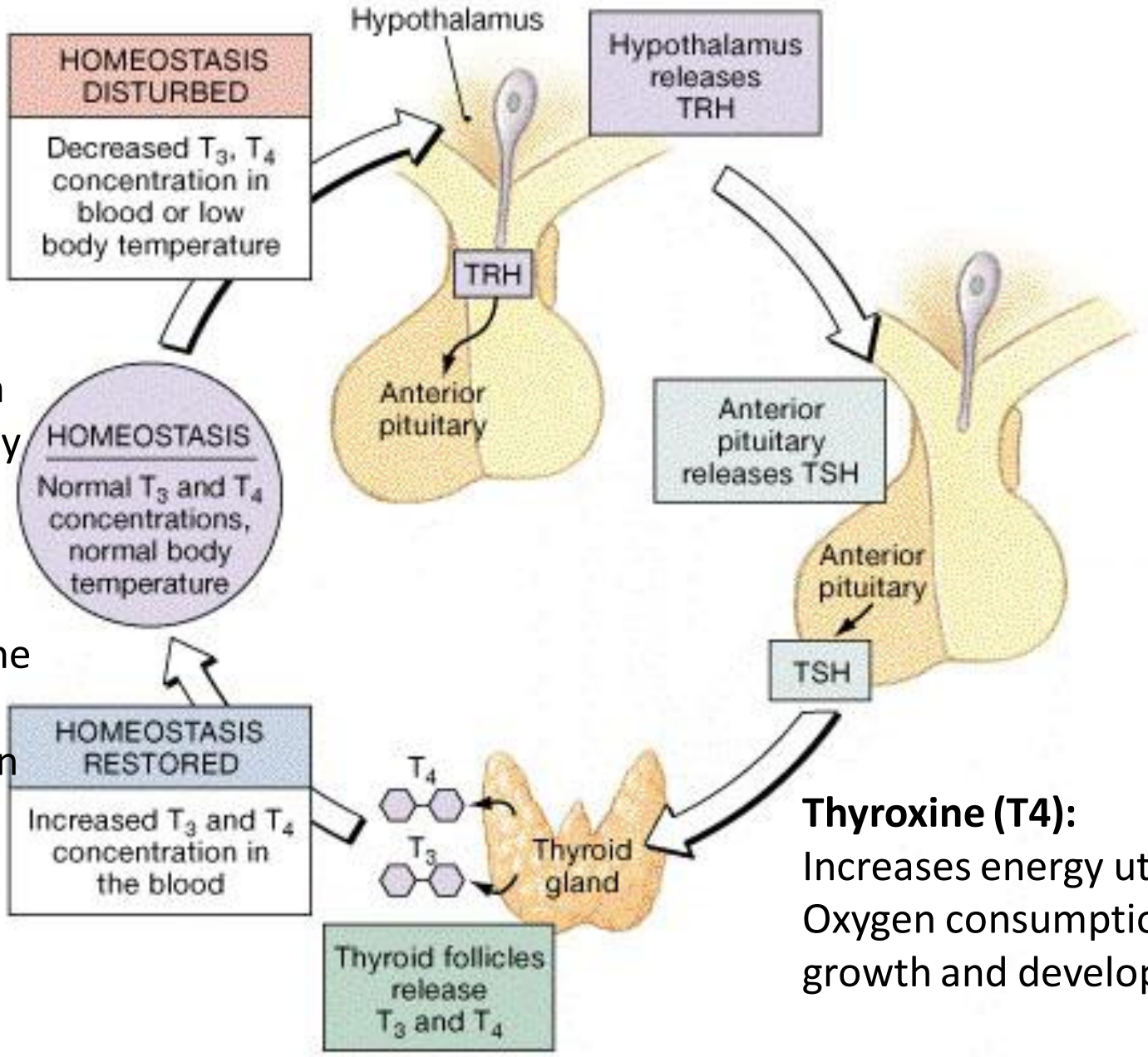
The thyroid gland



(a) Location of thyroid gland, anterior view

Regulation of the thyroid gland by TSH

Calcitonin: decreases calcium concentration in the blood by storing it in bone and increasing excretion in the kidney (works in conjunction with the parathyroid)



Thyroxine (T4):
Increases energy utilization, Oxygen consumption and growth and development

Hypothyroidism

- Hypothyroidism is more common in women, people with other thyroid problems, and those over 60 years old. Hashimoto's disease, an autoimmune disorder, is the most common cause. Other causes include thyroid nodules, thyroiditis, congenital hypothyroidism, surgical removal of part or all of the thyroid, radiation treatment of the thyroid, and some medicines.

Etiology

PRIMARY HYPOTHYROIDISM

- Hashimoto's thyroiditis-most common
  Post partum thyroiditis
- Atrophic hypothyroidism
- Irradiation of thyroid
- Surgical removal
- Late stage invasive fibrous thyroiditis
- Iodine deficiency
- Drug therapy (Lithium, Interferon)
- Infiltrative Diseases: Sarcoidosis, Amyloidosis Scleroderma, Hemochromatosis

Primary Hypothyroidism:
Management

Mathew John, MD, DM, DNB

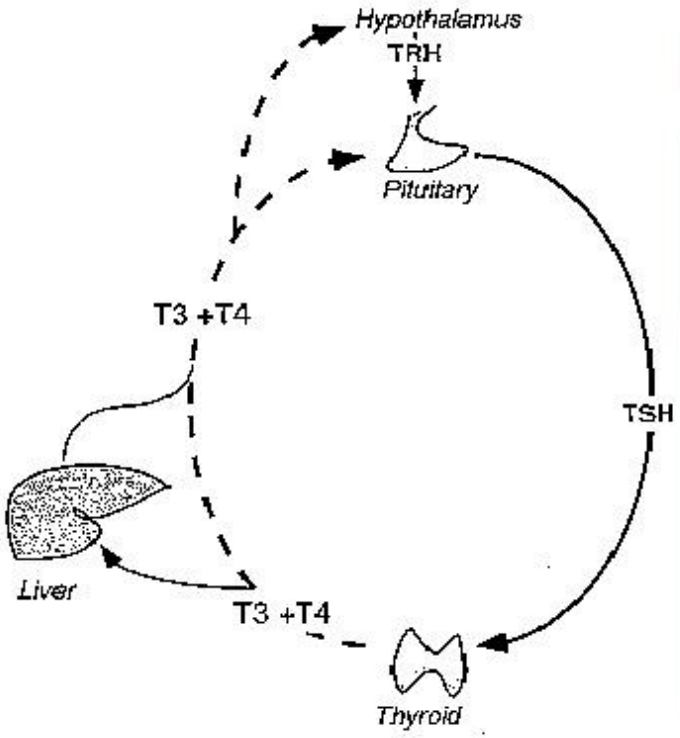
Consultant Endocrinologist

Providence Endocrine & Diabetes Specialty Centre

www.endocrinologydiabetes.com

www.providence.co.in

Diagnosis



Thyroid hormones feedback inhibit TSH

So

If T3, T4 reduces TSH increases

Primary hypothyroidism

Treatment

- Treated with thyroid replacement
- Normal thyroid produces both T4 and T3 , predominantly T4
- T3 is formed in periphery by deiodination of T4
- Commercial preparations are usually only L-thyroxine (T4)

Hyperthyroidism

- If your thyroid is too active, it makes more thyroid hormones than your body needs. This is called hyperthyroidism.
- Hyperthyroidism is more common in women, people with other thyroid problems, and those over 60 years old. Graves' disease, an autoimmune disorder, is the most common cause. Other causes include thyroid nodules, thyroiditis, consuming too much iodine, and taking too much synthetic thyroid hormone.

HYPERTHYROIDISM

Thyroiditis / Graves Disease

- Excessive sweating
- Heat intolerance
- Increased bowel movements
- Tremor (usually fine shaking)
- Nervousness; agitation
- Rapid heart rate
- Weight loss
- Fatigue
- Decreased concentration
- Irregular and scant menstrual flow

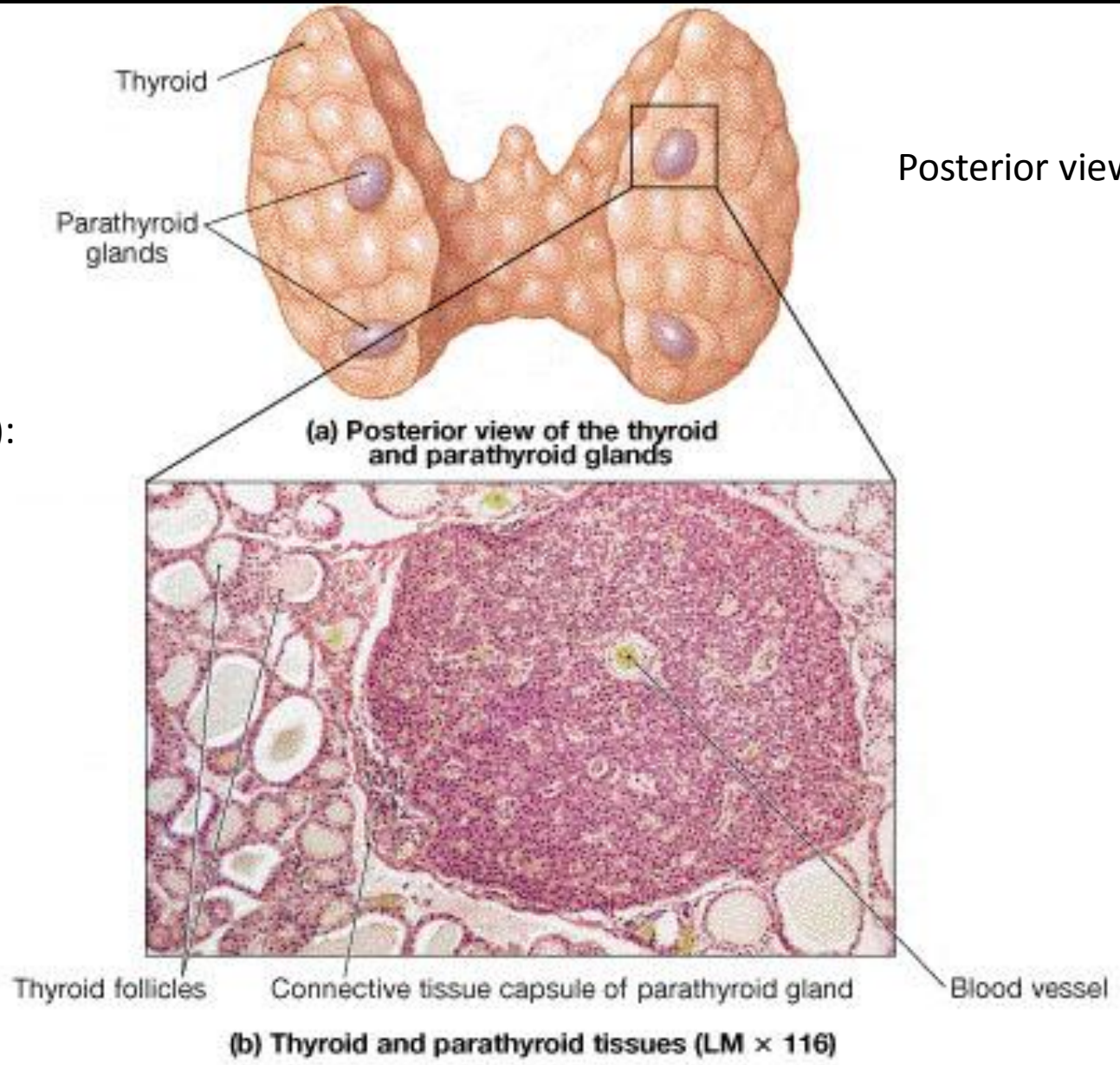
Treatments for Hyperthyroidism

- Medical therapy with antithyroid drugs such as propylthiouracil or methimazole
- Ablation of the thyroid gland with radioactive iodine
- Subtotal thyroidectomy
- Self-limited causes of hyperthyroidism, such as subacute thyroiditis, iodine-induced hyperthyroidism, and exogenous administration of T4, can be treated symptomatically. For more significant cardiovascular symptoms, beta-adrenergic blockade with propranolol can be helpful.

Parathyroid gland

PTH: increases calcium concentration in body fluids (from Chief Cells):

1. Activates osteoclasts
2. Increases Ca^{++} absorption in intestine
3. Conserves Ca^{++} in kidney



Posterior view

Parathyroid Diseases

- Hyperparathyroidism
- Hypoparathyroidism
- Hypercalcemia-more serious than parathyroid cancer!

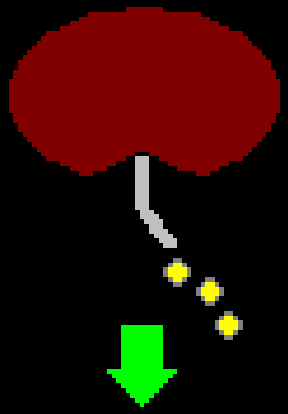
Treatment

- Medications?
  - **Calcimimetics.**
  - **Hormone replacement therapy.**
  - **Bisphosphonates.**
- Surgery
- http://www.endocrineweb.com/conditions/parathyroid/hyperparathyroidism-faqs

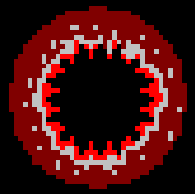
Parathyroid Hormone feedback control

Low concentration of calcium in blood

Release of parathyroid hormone



Vitamin D



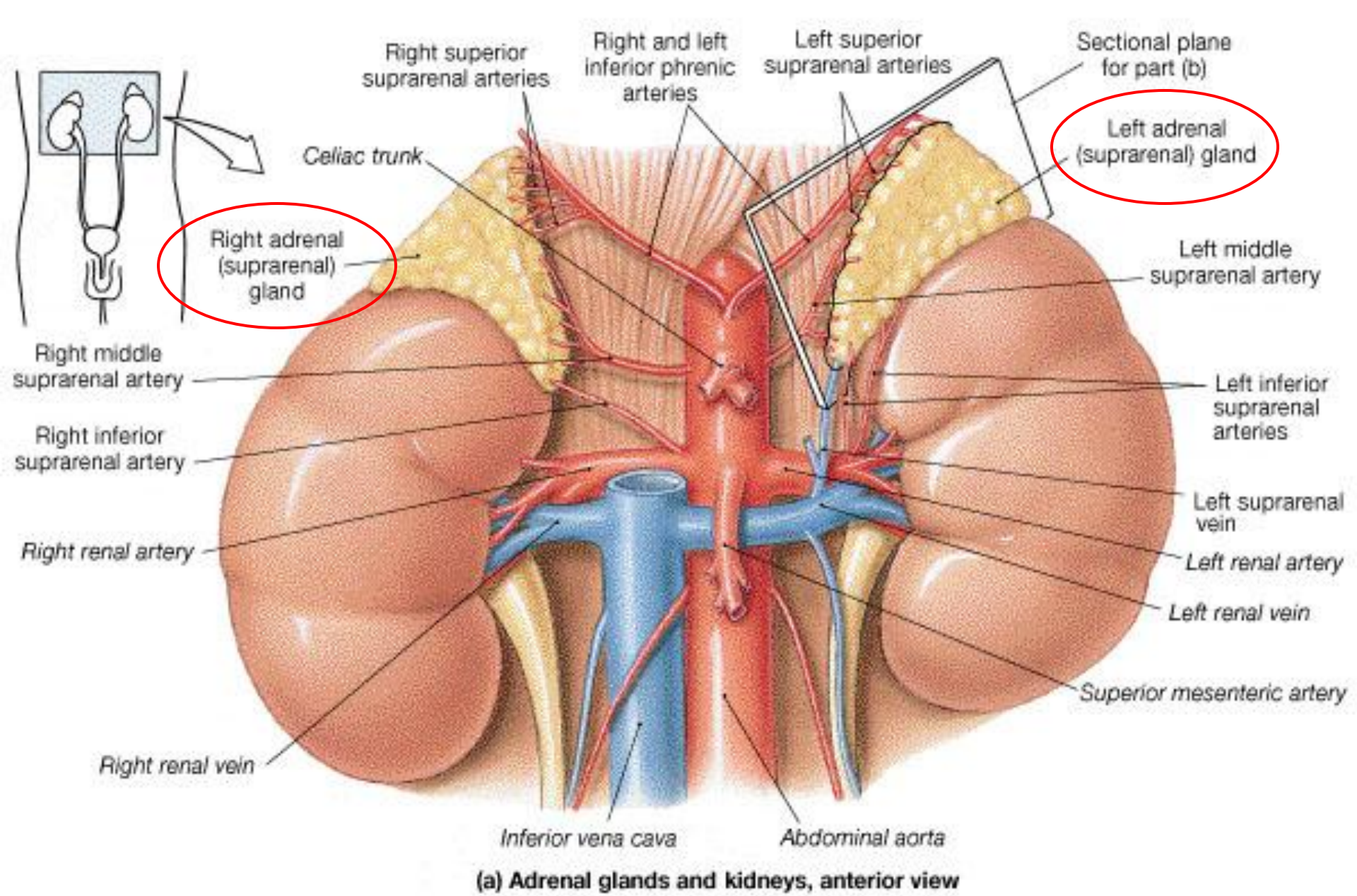
Efflux of calcium from bone

Decreased loss of calcium in urine

Enhanced absorption of calcium from intestine

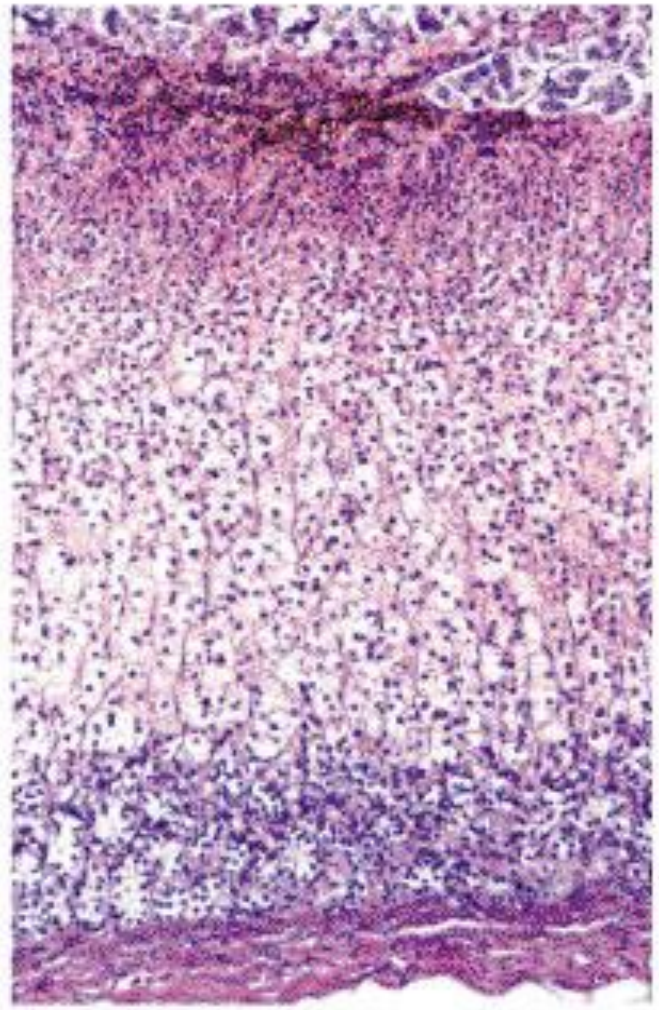
Increased concentration of calcium in blood

The adrenal glands

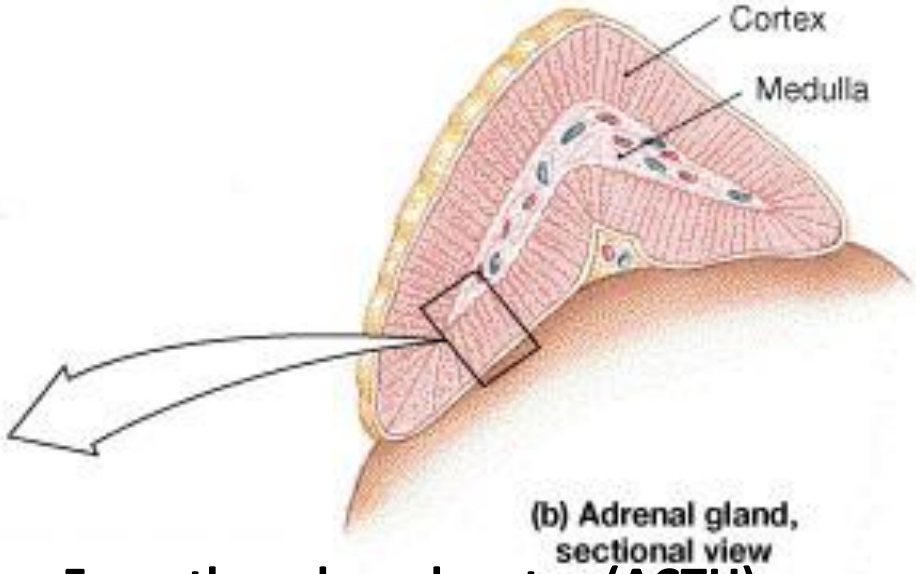


(a) Adrenal glands and kidneys, anterior view

The adrenal cortex and medulla



(c) Adrenal gland (LM × 173)



(b) Adrenal gland, sectional view

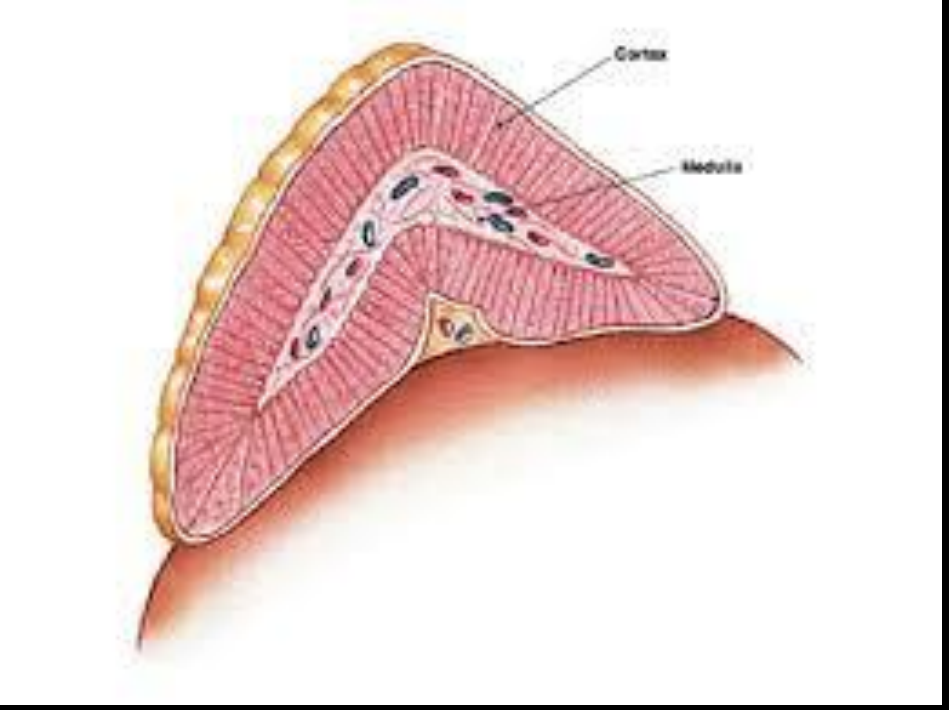
From the adrenal cortex (ACTH):

Mineralocorticoids: (e.g. aldosterone) sodium ions and H_2O reabsorbed

Glucocorticoids: (e.g. cortisol) speed up rate of glucose synthesis and glycogen formation

Androgens: small amounts and uncertain role

ACTH (Adrenocorticotropic hormones)



- The cells of the medulla are the body's main source of the catecholamines, adrenaline and noradrenaline. Approximately 20% noradrenaline (norepinephrine) and 80% adrenaline (epinephrine) are secreted here.

The adrenal medulla is driven by the symapathetic nervous system via preganglionic fibres originating in the thoracic spinal cord from vertebrae T5–T11. Unlike other sympathetic ganglia, however, the adrenal medulla lacks distinct synapses and releases its secretions directly into the blood.

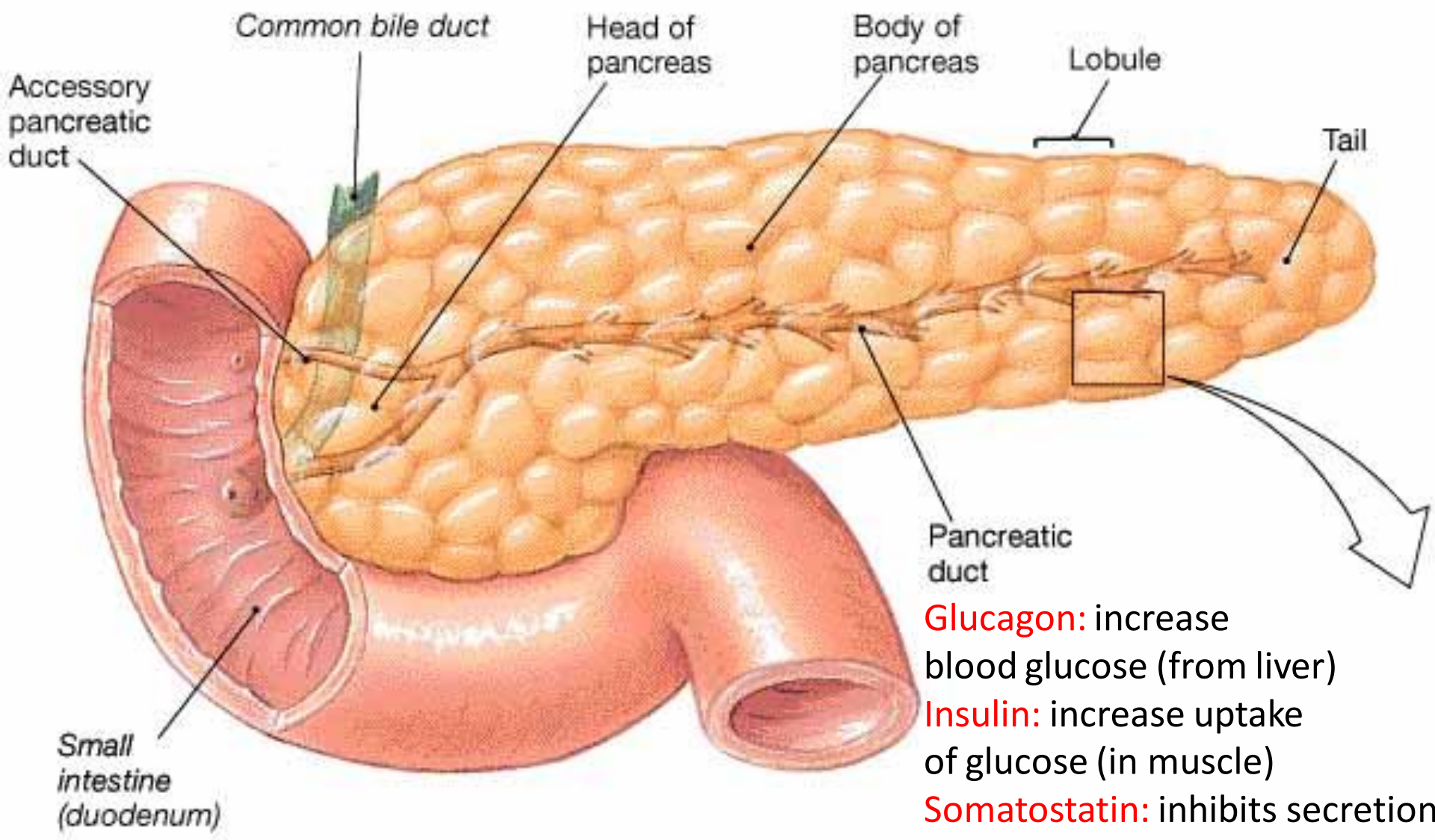
Adrenal Gland Disorders: Addison's Disease

- Your adrenal glands are just above your kidneys. The outside layer of these glands makes hormones that help your body respond to stress and regulate your blood pressure and water and salt balance. Addison disease happens if the adrenal glands don't make enough of these hormones.
- A problem with your immune system usually causes Addison disease. The immune system mistakenly attacks your own tissues, damaging your adrenal glands. Other causes include infections and cancer.

Adrenal Gland Disorders: Cushing’s disease

Cushing's syndrome is a hormonal disorder. The cause is long-term exposure to too much cortisol, a hormone that your adrenal gland makes. Sometimes, taking synthetic hormone medicine to treat an inflammatory disease leads to Cushing's. Some kinds of tumors produce a hormone that can cause your body to make too much cortisol.

The pancreas (endocrine function)



(a) Pancreas, anterior view

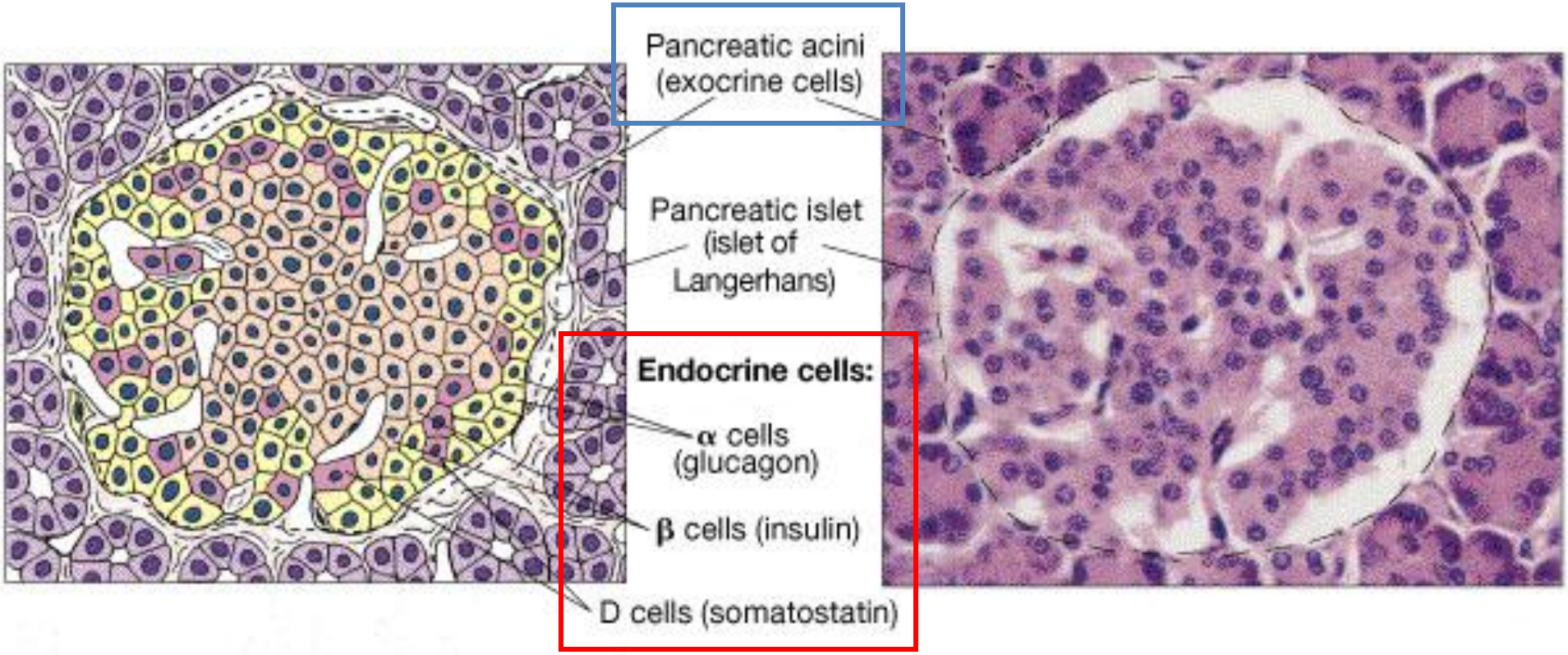
Glucagon: increase blood glucose (from liver)

Insulin: increase uptake of glucose (in muscle)

Somatostatin: inhibits secretion of insulin and glucagon

Islet of Langerhans (Pancreatic islets)

N.B. Pancreas functions as both an **endocrine** (only 1% of cell population) and **exocrine gland** (digestive enzymes)



(b) Pancreatic islet (LM × 400)

The Endocrine System

D. Age-related dysfunctions

3. Diabetes mellitus

a. Essential problem = glucose does enter body cells; blood become hyperglycemia

b. Type I (insulin-dependent) = deficient secretion of insulin by islet cells

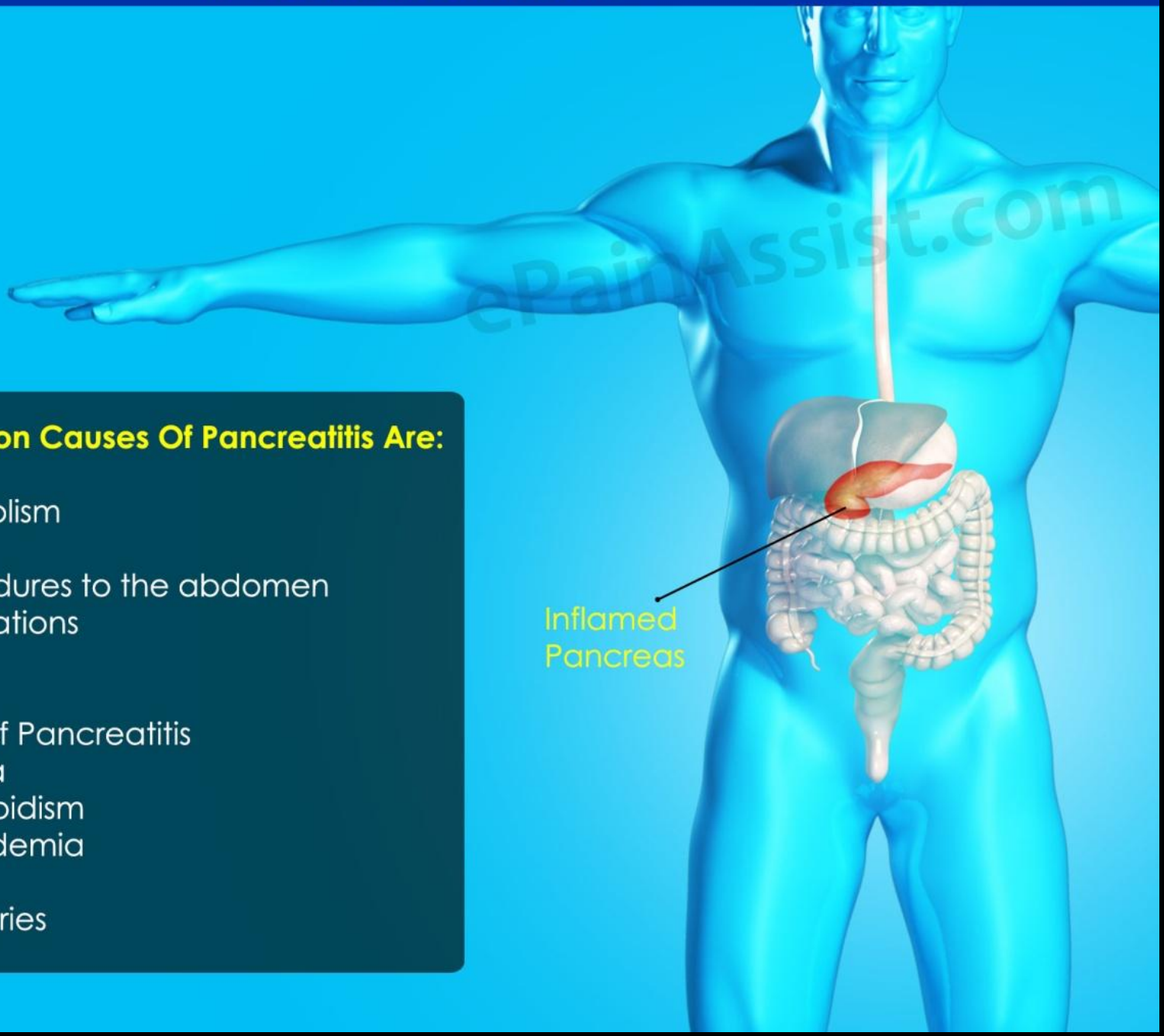
c. Type II (noninsulin-dependent) = decreased sensitivity of target cells to insulin (insulin resistance)

d. Clinical features

i. Ketosis as a result of excessive lipid use for energy production

ii. Skin ulcers, glaucoma, cataracts, poor peripheral circulation, retinopathy, neuropathy

Pancreatitis



Some Of The Common Causes Of Pancreatitis Are:

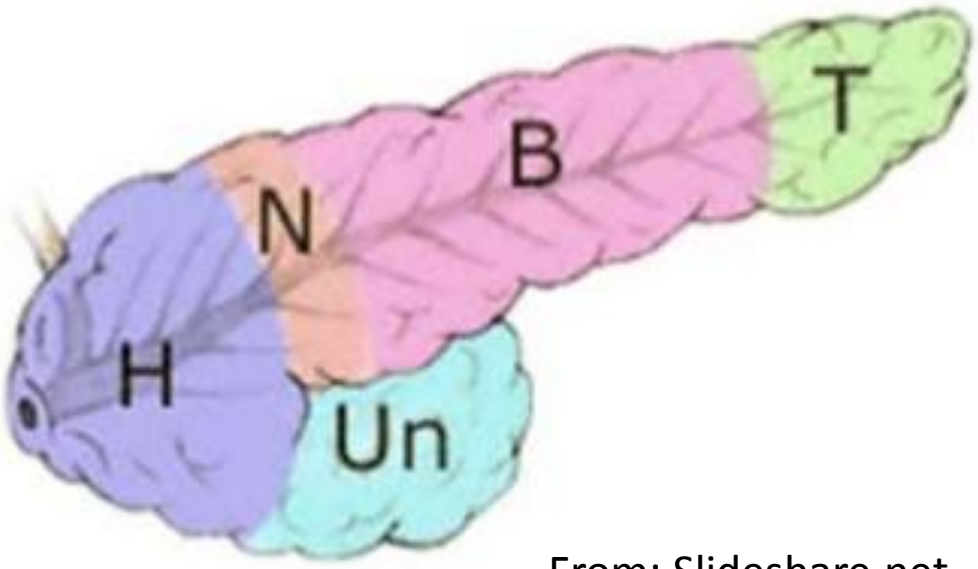
1.) Chronic alcoholism
2.) Gallstones
3.) Surgical procedures to the abdomen
4.) Certain medications
5.) Smoking
6.) Cystic fibrosis
7.) Family history of Pancreatitis
8.) Hypercalcemia
9.) Hyperparathyroidism
10.) Hypertriglyceridemia
11.) Infections
12.) Abdominal injuries

Malignant Pancreatic Tumours

Location of Pancreas Cancer

- 60 to 70 percent of exocrine pancreatic cancers are localized to the head
- 20 to 25 percent are in the body/tail and
- the remainder involve the whole organ

H = Head
N = Neck
B = Body
T = Tail
Un = Uncinate

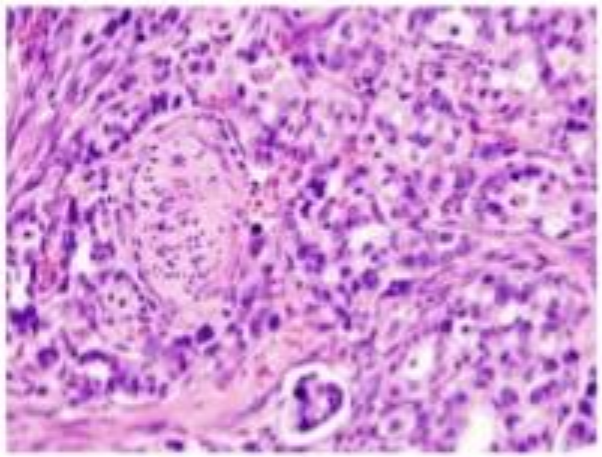


From: Slideshare.net

Pathology

Ductal **adenocarcinoma** accounts for about 85% of all neoplasms. And more than 95% of all pancreatic cancers arise from the exocrine (digestive enzymes) elements.

Cancers that arise from the endocrine cells (neuroendocrine, islet cells) account for 5% or less

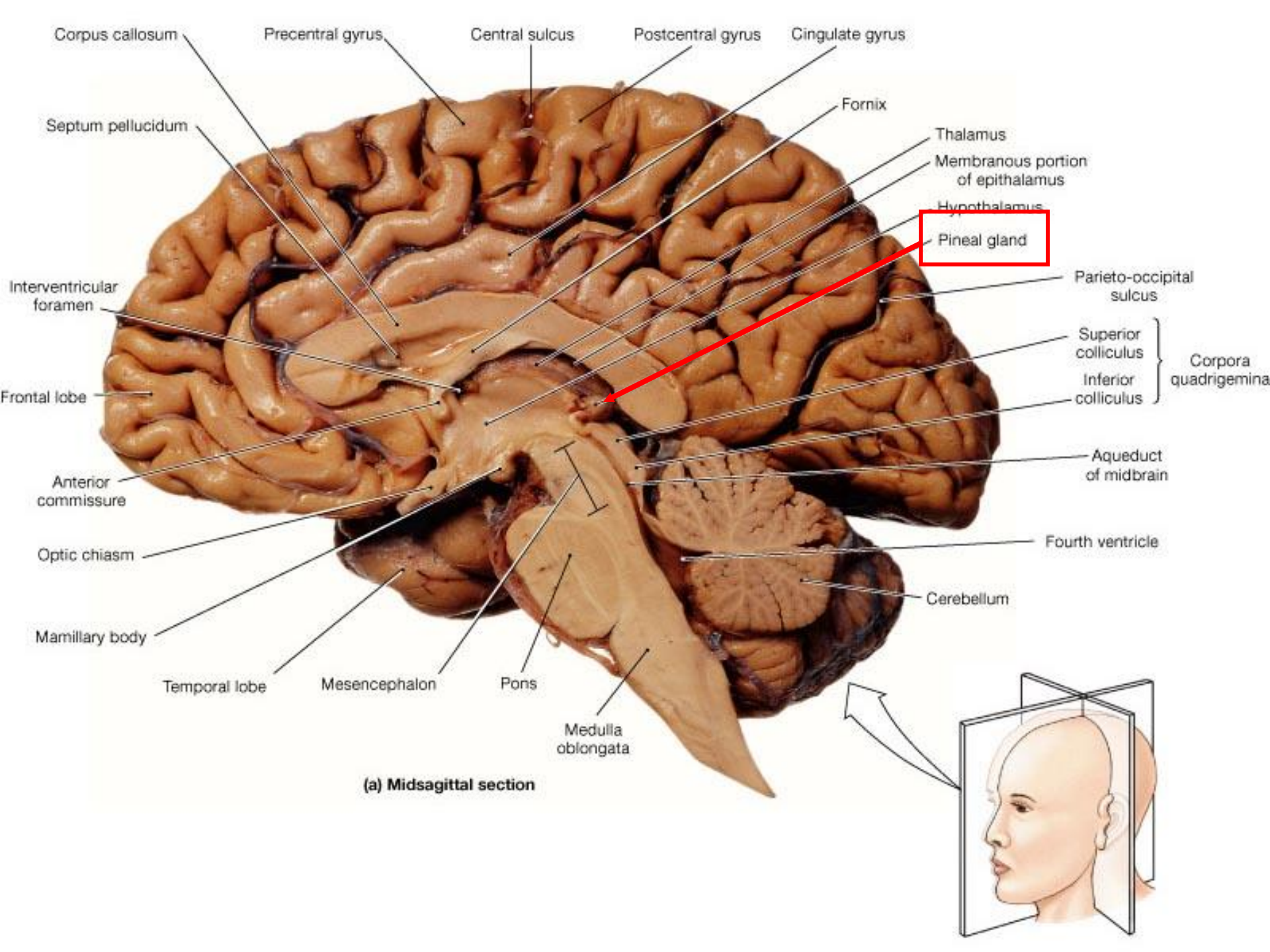


Survival

Surgery offers the only cure but only 10-20% are candidates for resection and even in this group the 5 year survival is only 20% and the median 13 to 20 months

Locally advanced the survival is 8 to 14 months

Up to 60% already have metastases and a median survival of only 4 to 6 months


Corpus callosum
Precentral gyrus
Central sulcus
Postcentral gyrus
Cingulate gyrus
Septum pellucidum
Fornix
Thalamus
Membranous portion of epithalamus
Hypothalamus
Pineal gland
Parieto-occipital sulcus
Interventricular foramen
Superior colliculus
Inferior colliculus
Corpora quadrigemina
Frontal lobe
Aqueduct of midbrain
Anterior commissure
Optic chiasm
Fourth ventricle
Cerebellum
Mamillary body
Temporal lobe
Mesencephalon
Pons
Medulla oblongata
(a) Midsagittal section

Pineal gland:

- Location: in brain and part of epithalamus
- Secretes melatonin
- Melatonin slows maturation of sperm, oocytes and reproductive organs by inhibiting production of hypothalamic releasing factors that stimulate FSH and LH secretion
- Collaterals from the visual pathways enter the pineal gland and affect the rate of melatonin production
- Melatonin production rises at night and decrease during the day which seems to be related to the circadian rhythms

Medical Conditions

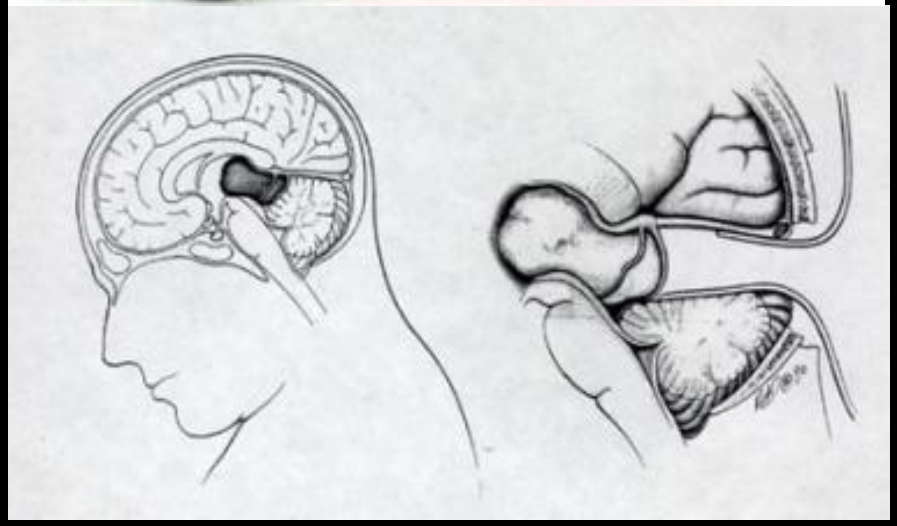
- Depression, peptic ulcers, and sexual dysfunction may be exacerbated by a deficiency of melatonin.
- Stress and dietary habits may lead to deficiencies of both serotonin and melatonin.
- Melatonin inhibits the release of cortisol via the release of vasotocin.
- Abnormal circadian rhythms of cortisol may occur in states of decreased melatonin.
- A circannual rhythm of melatonin has troughs associated with peaks in the incidence of peptic ulcers and psychotic depression.

- Overproduction of melatonin may lead to disorders of the pineal gland as well. They include lower blood pressure, or hypotension, decreased levels of estrogen/progesterone ration and poor function of adrenal and thyroid gland.
- Seasonal affective disorder (SAD) is another symptom of excess secretion of melatonin. This disorder is actually depression caused by short days or minimal sunlight during the winter months.

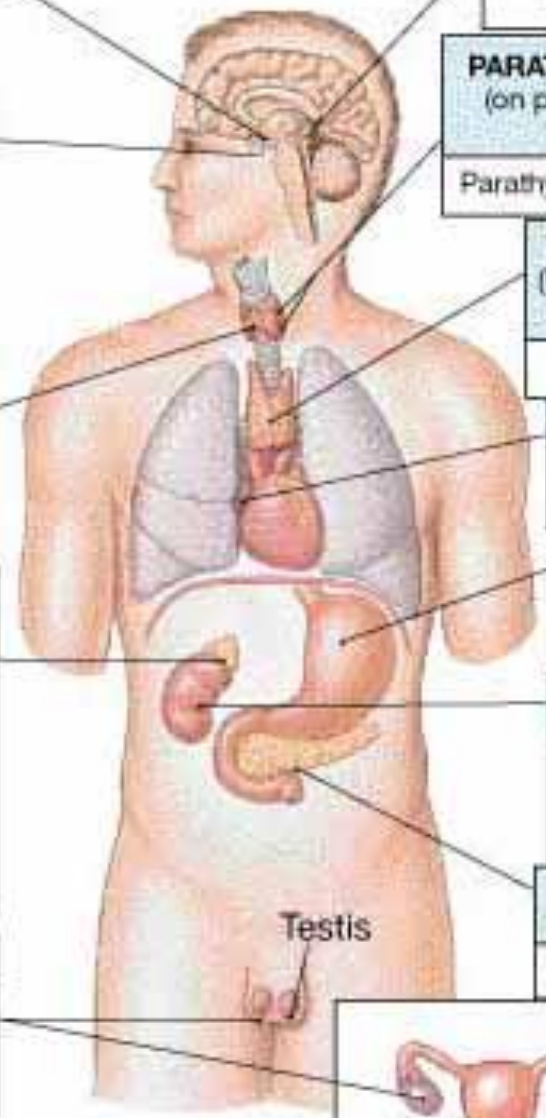
- Apart from abnormal production of melatonin, the pineal gland may be affected by tumors such as gliomas, germ cell tumors and pineal cell tumors.
- Symptoms of these tumors include headaches, seizures, nausea, vomiting, disturbed memory and visual problems.

Treatment

- Medications?
- Radiotherapy
- Chemotherapy
- Radio-surgery
- Surgical therapy



The Endocrine System: The Thymus



HYPOTHALAMUS
Production of ADH, oxytocin, and regulatory hormones

PITUITARY GLAND
Anterior pituitary:
ACTH, TSH, GH, PRL, FSH, LH, and MSH
Posterior pituitary:
Release of oxytocin and ADH

THYROID GLAND
Thyroxine (T_4)
Triiodothyronine (T_3)
Calcitonin (CT)

ADRENAL GLANDS
(cap each kidney)
Medulla:
Epinephrine (E)
Norepinephrine (NE)
Cortex:
Cortisol, corticosterone, cortisone, aldosterone, androgens

GONADS
Testes (male):
Androgens (especially testosterone), inhibin
Ovaries (female):
Estrogens (especially estradiol), progestins, inhibin

PINEAL GLAND
Melatonin

PARATHYROID GLANDS
(on posterior surface of thyroid gland)
Parathyroid hormone (PTH)

THYMUS GLAND
(Undergoes atrophy during adulthood)
Thymosins

NB

HEART
Atrial natriuretic peptide (ANP)

DIGESTIVE TRACT
Numerous hormones *(detailed in Chapter 25)*

KIDNEY
Erythropoietin (EPO)
Calcitriol

PANCREATIC ISLETS
Insulin, glucagon

KEY TO PITUITARY HORMONES:

ACTH	Adrenocorticotropic hormone
TSH	Thyroid-stimulating hormone
GH	Growth hormone
PRL	Prolactin
FSH	Follicle-stimulating hormone
LH	Luteinizing hormone
MSH	Melanocyte-stimulating hormone
ADH	Antidiuretic hormone

The Thymus:

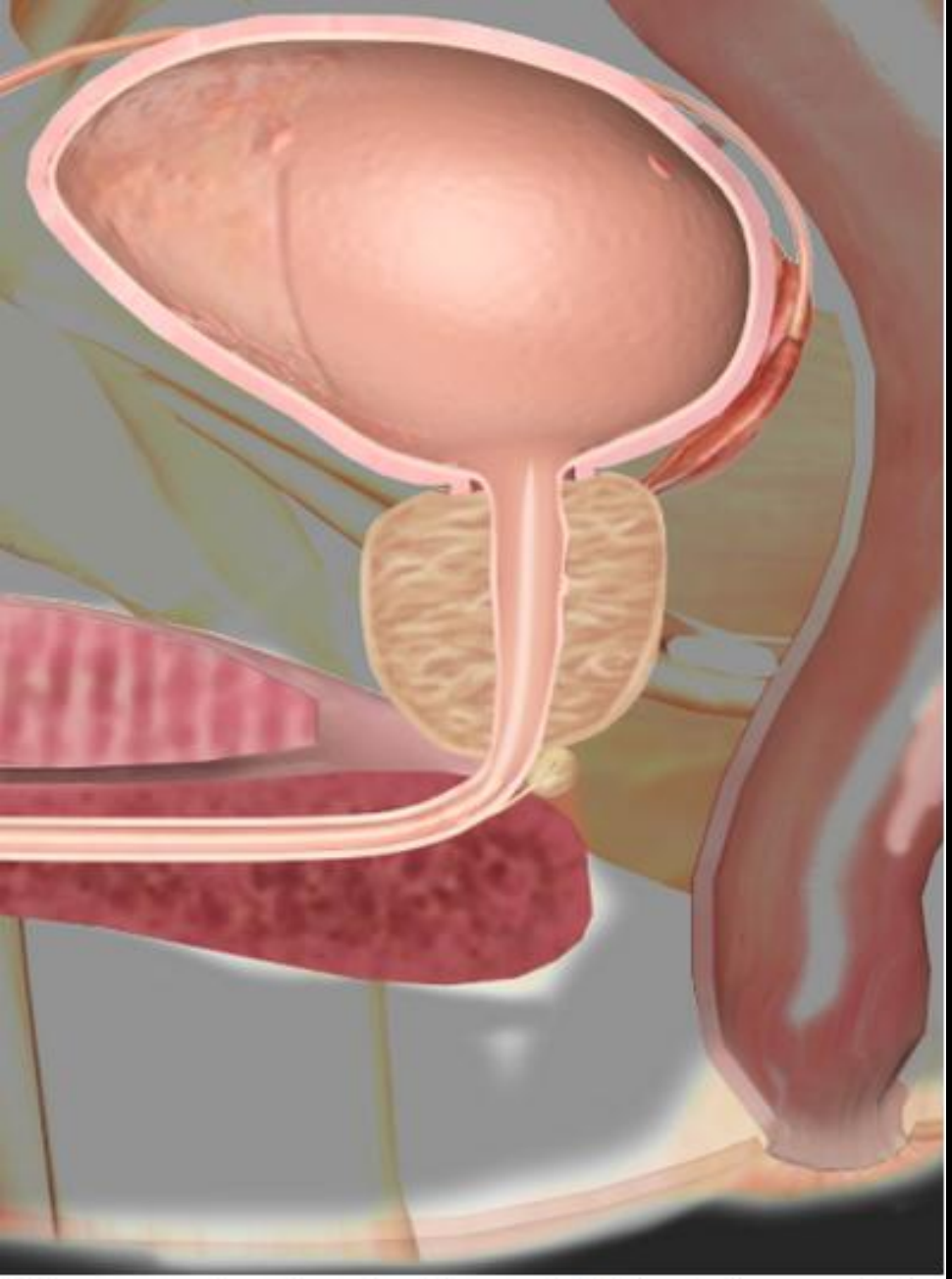
- Location: inside thoracic cavity just posterior to the sternum.
- In infants and young children the thymus is relatively large
- The thymus continues to enlarge up to puberty after which it diminishes in size
- By 50 the thymus may diminish from 40 to 12 grams
- The thymus produces several hormones that are important to the development and maintenance of normal immunological defenses (collectively referred to as Thymosin)
- The relative decrease in size and secretion from the thymus in the elderly is one reason they may be more susceptible to disease.

The kidneys:

- Produce three hormones primarily involved with the regulation of blood pressure and blood volume
  - Renin (from drop in BP) →angiotensinogen (from liver) → angiotensin I (in blood) → angiotensin II (lung capillaries →aldosterone →water retention
  - Erythropoietin (EPO)→stimulates the production of RBC (in response to ↓ in BP or O_2 in kidney)
  - Calcitriol→stimulation of calcium and phosphate absorption in the digestive tract (activated by PTH)

The heart:

- Produces two hormones in response to high BP:
  - Atrial natriuretic peptide (ANP) and brain natriuretic peptide (BNP) →suppress the release of ADH and aldosterone→ stimulates water and sodium loss



This cross-section shows how the prostate (at center) surrounds the urethra as it exits the urinary bladder.

- The prostate gland (really an *exocrine* gland)
- Function: Secretes prostatic fluid that nourishes and protects sperm and may prevent urinary tract infections.

Prostate Cancer…more men die with it than of it

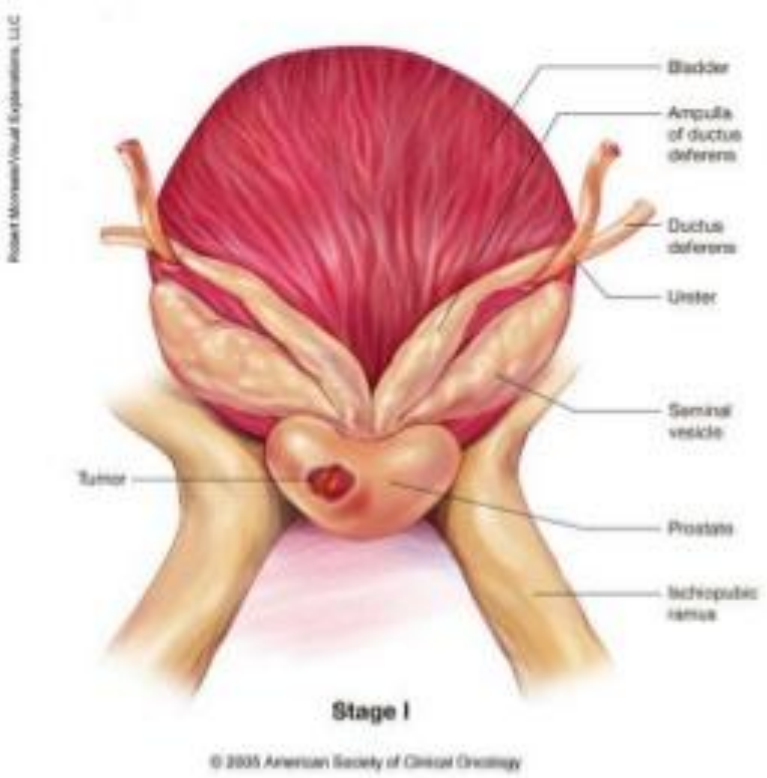
- 80% found at autopsy
- 16% diagnosed during their lifetime
- 3% will die of it

From: Slideshare.net

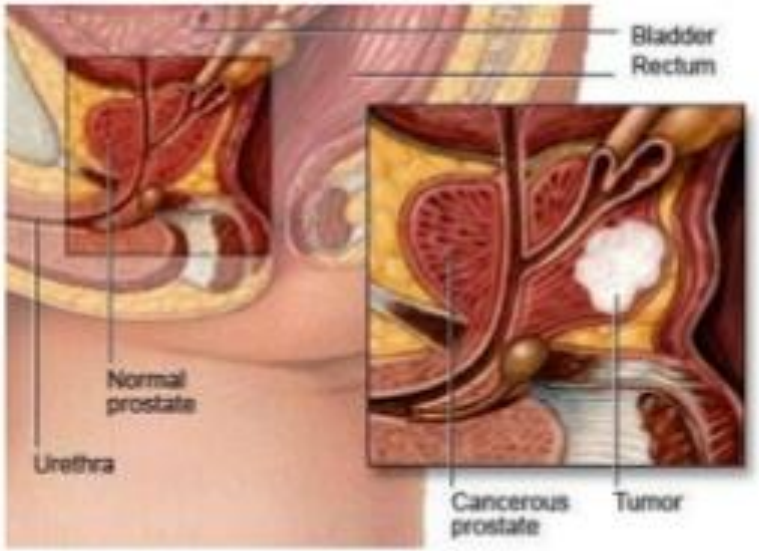
National Cancer Institute
U.S. National Institutes of Health | www.cancer.gov

Risk Factors for Prostate Cancer

Age
Family History
Hormones
Race
Dietary Fat
Multivitamin use
Dairy and Calcium Intake
Cadmium Exposure (-)
Dioxin Exposure (-)



Should you screen for prostate cancer?



National Cancer Institute

at the National Institutes of Health

NCI Home | Cancer Topics | Clinical Trials | Cancer Statistics

Prostate Cancer Screening (PDQ®)

Patient Version | Health Professional Version

Last Modified: 03/01/2013

Prostate Cancer Screening (PDQ®)

- Summary of Evidence

Summary of Evidence

The evidence is insufficient to determine whether screening for prostate cancer with prostate-specific antigen (PSA) or digital rectal exam (DRE) reduces mortality from prostate cancer.

CA A Cancer Journal for Clinicians

Article

Cancer screening in the United States, 2013†

A review of current american cancer society guidelines, current issues in cancer screening, and new guidance on cervical cancer screening and lung cancer screening

Men who have at least a 10-y life expectancy should have an opportunity to make an informed decision with their health care provider about whether to be screened for prostate cancer. Asymptomatic men who have less than a 10-year life expectancy based on age and health status should not be offered prostate cancer screening.

Treating prostate cancer

Surgery?

Radiation?

Or Watchful Waiting?


Questions?

The Endocrine System

C. Age-related changes

1. Hormone secretion stays the same, but receptor numbers on target cells tend to decrease
2. Pituitary gland – minimal changes
3. Thyroid gland
    a. T4 production declines by 50% with very old age, but blood levels of thyroxine remain normal
    b. Gland atrophies with increased nodule formation
    c. Basal metabolic rate (BMR) decreases

The Endocrine System

C. Age-related changes

4. Parathyroid glands

a. No atrophy of glands; some fat deposition

b. Post-40, PTH levels in women increase, adding to bone loss problems

5. Adrenal glands

a. No atrophy of glands; increased fibrous tissue

b. Functional capacity isn't loss, but there is a moderate decline in adrenocortical hormone secretion

c. Secretions of adrenal medulla increase with aging

The Endocrine System

C. Age-related changes

6. Pancreatic islets

a. Generally, no decline in insulin

b. Decline in function occurs at target cell level (reduced response time in glucose tolerance tests)

D. Age-related dysfunctions

1. Endocrine disorders are infrequent in old age

2. Changes are pathologic rather than age-related

The Endocrine System

C. Age-related changes

6. Pancreatic islets
    a. Generally, no decline in insulin
    b. Decline in function occurs at target cell level (reduced response time in glucose tolerance tests)

D. Age-related dysfunctions

1. Endocrine disorders are infrequent in old age
2. Changes are pathologic rather than age-related

The Endocrine System

D. Age-related dysfunctions

4. Hypothyroidism

a. 5% over age 65 have thyroid hypofunction

b. Causes = TSH deficiency, radiation therapy, chronic autoimmune inflammation of the gland, removal of the gland

c. Clinical features difficult to diagnose

i. Fatigue, depression, mental confusion

ii. Dry skin, weight gain, constipation

The Endocrine System

D. Age-related dysfunctions

5. Stress responses

a. What is stress?

b. Subtle stresses for the elderly could be social isolation, loss of spouse, decreased community status

c. Activation of the hypothalamo-pituitary-adrenal axis and sympathetic nervous system leads to …

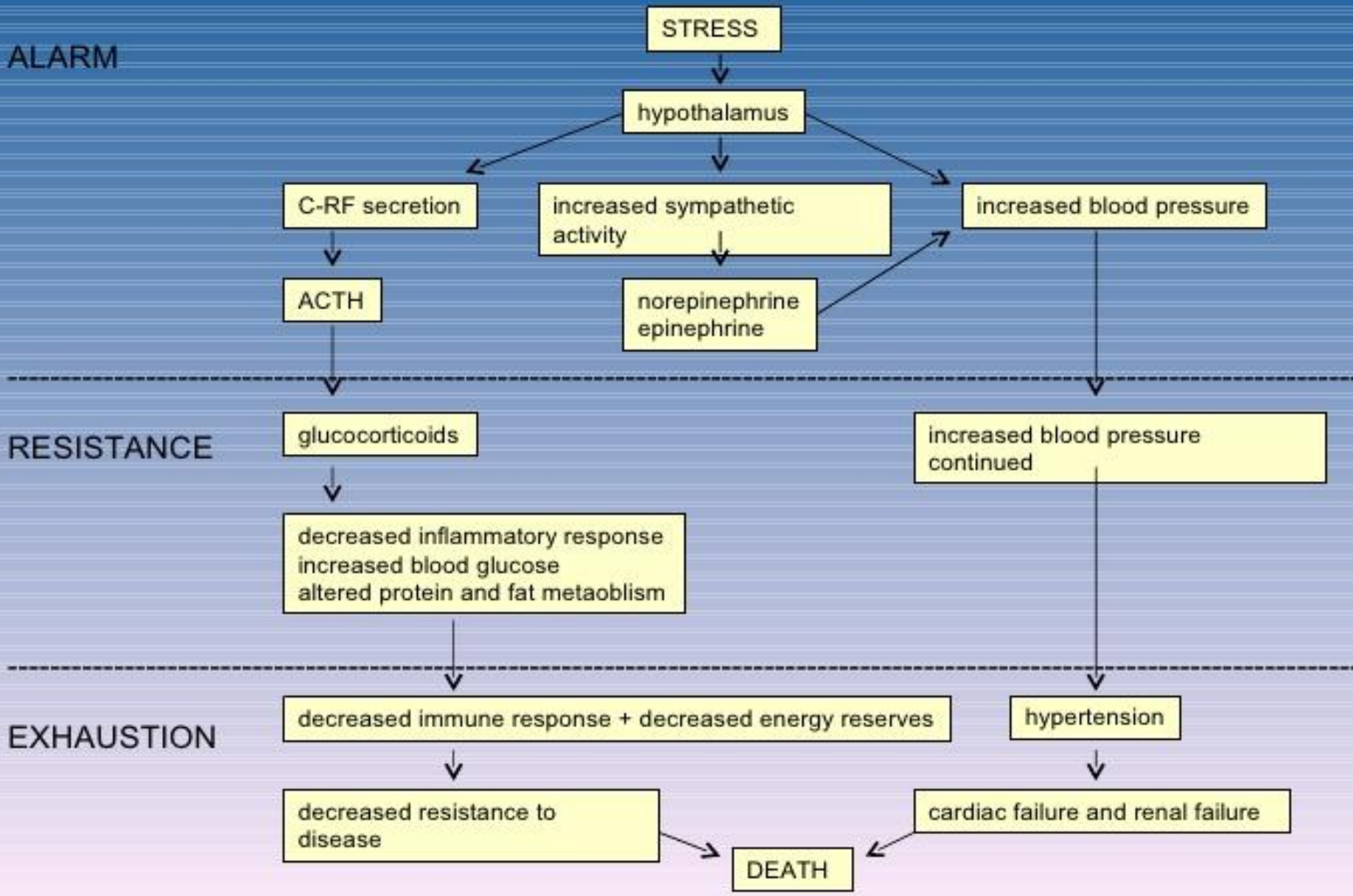
d. General adaptation syndrome

i. Alarm stage

ii. Resistance stage

iii. Exhaustion stage

GENERAL ADAPTATION SYNDROME



The Endocrine System

E. Take home messages

1. Structural changes include atrophy, fibrous and fatty deposition, but nothing major
2. Blood levels remain within normal ranges, except for gonadal hormones
3. Demand for various hormones changes and target cell receptors decrease, altering rates of secretion
4. No convincing evidence that age-related changes in endocrine function promote aging
5. Plenty of evidence that stress promotes aging

end

Groups of hormones

- **Amino acid derivatives**
  - Thyroid hormones, catecholamines, melatonin
- **Peptide hormones**
  - All pituitary hormones
- **Steroid hormones**
  - Reproductive hormones and adrenal (cortex)
- ***Eicosanoids*** ***(****not part of the endocrine system****)***
  - *Such as prostaglandins (anti-inflammatory) and leukotrienes (immune response) that coordinate local cellular activities (not stored but produced as needed by the cell).*