

**ADVANCED ASSESSMENT**  
***ENDOCRINE SYSTEM***  
***A System of Ductless Glands***

# ADVANCED ASSESSMENT *ENDOCRINE SYSTEM*

## **AUTHORS**

**Mike Muir AEMCA, ACP, BHSc**

Paramedic Program Manager  
Grey-Bruce-Huron Paramedic Base Hospital  
Grey Bruce Health Services, Owen Sound

**Kevin McNab AEMCA, ACP**

Quality Assurance Manager  
Huron County EMS

## **REVIEWERS/CONTRIBUTORS**

**Rob Theriault EMCA, RCT(Adv.), CCP(F)**  
Peel Region Base Hospital

**Donna L. Smith AEMCA, ACP**  
Hamilton Base Hospital

## **References – Emergency Medicine**

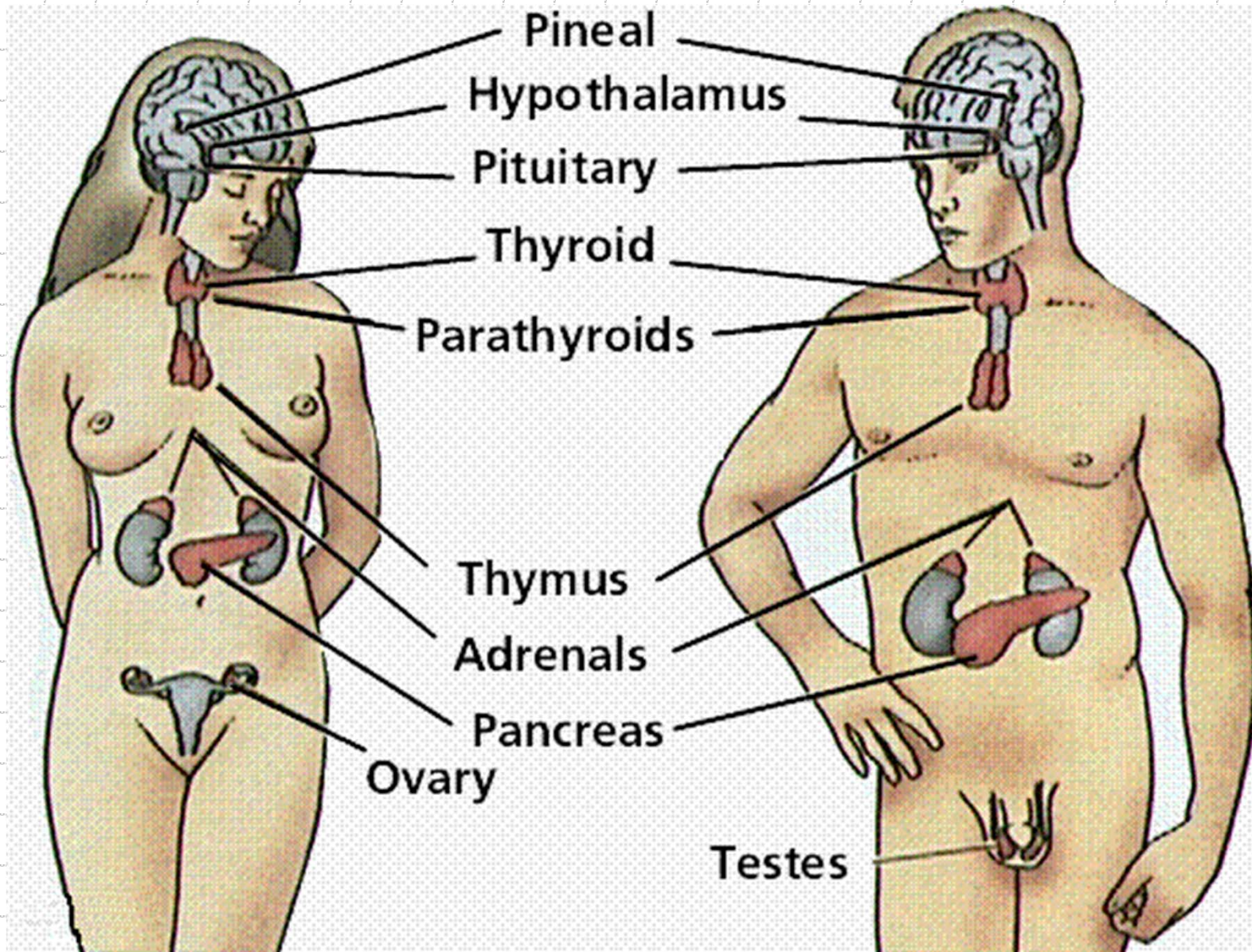
2007 Ontario Base Hospital Group

# *Homeostasis*

- ◆ Maintenance of internal conditions even when the external conditions are changing
- ◆ Body in dynamic equilibrium
- ◆ Endocrine system and nervous system adjust to changes occurring in the body to return it to within narrow limits
- ◆ Positive and negative feedback systems control

# *Endocrine System*

- ◆ A system of ductless glands that produce hormones
- ◆ Helps to regulate all the body functions
- ◆ Controls the rate at which we grow, hunger, body temperature, fluid retention, sexual development, menstruation and much more
- ◆ Could be called the rhythm section of life



- ◆ 1889: Von Mering and Menkowski experimented on dogs
- ◆ They opened up a dog and removed an organ they didn't know
- ◆ The dog got sick and died
- ◆ Before dying the dog urinated a lot
- ◆ Ants were attracted to the urine
- ◆ One of the Doctors tasted the urine and found that it was sweet
- ◆ They concluded that the organ had something to do with carbohydrate metabolism

- ◆ 1922: Banting and Best continued experiments on dogs
- ◆ Removed the same organ which is called the pancreas
- ◆ Dog got sick
- ◆ Replaced pancreas
- ◆ Dog got better
- ◆ Produced a pancreatic extract and used it on a dog with its pancreas removed
- ◆ Dog got better
- ◆ Work on the extract isolated a single protein

- ◆ 1948 to 1958: Sanger worked on isolating and identifying protein
- ◆ Protein was Insulin
- ◆ This was the first protein ever sequenced. Sanger received a Nobel prize.
- ◆ When an animal doesn't have a pancreas or the pancreas doesn't function properly they have an illness called Diabetes Mellitus
- ◆ This can be translated into Sweet Water. Why?

# *Negative Feedback*

- ◆ Most controls use negative feedback.
- ◆ A stimulus causes a change - the feedback system reduces the change
- ◆ Blood sugar increases, insulin is produced to reduce blood sugar

# *Positive Feedback*

- ◆ Stimulus causes change, the feedback increases change
- ◆ Clotting of blood
- ◆ Birth of a baby

# *Glands*

- ◆ A gland is any organ that produces a secretion
- ◆ Endocrine glands: are organized groups of tissues which use materials from the blood to make new compounds called hormones. Endocrine glands are also called glands of internal secretion.

# *Hormones*

- ◆ Biochemicals produced by endocrine glands
- ◆ Informational molecules

# *Glands of Internal Secretion*

- ◆ Types:
  - ◆ Exocrine - has a duct that it releases its products into, this duct carries the secretion to a body surface or organ.
  - ◆ Sweat
  - ◆ Salivary
  - ◆ Lacrimal - Crying
  - ◆ Pancreas

# *Glands of Internal Secretion*

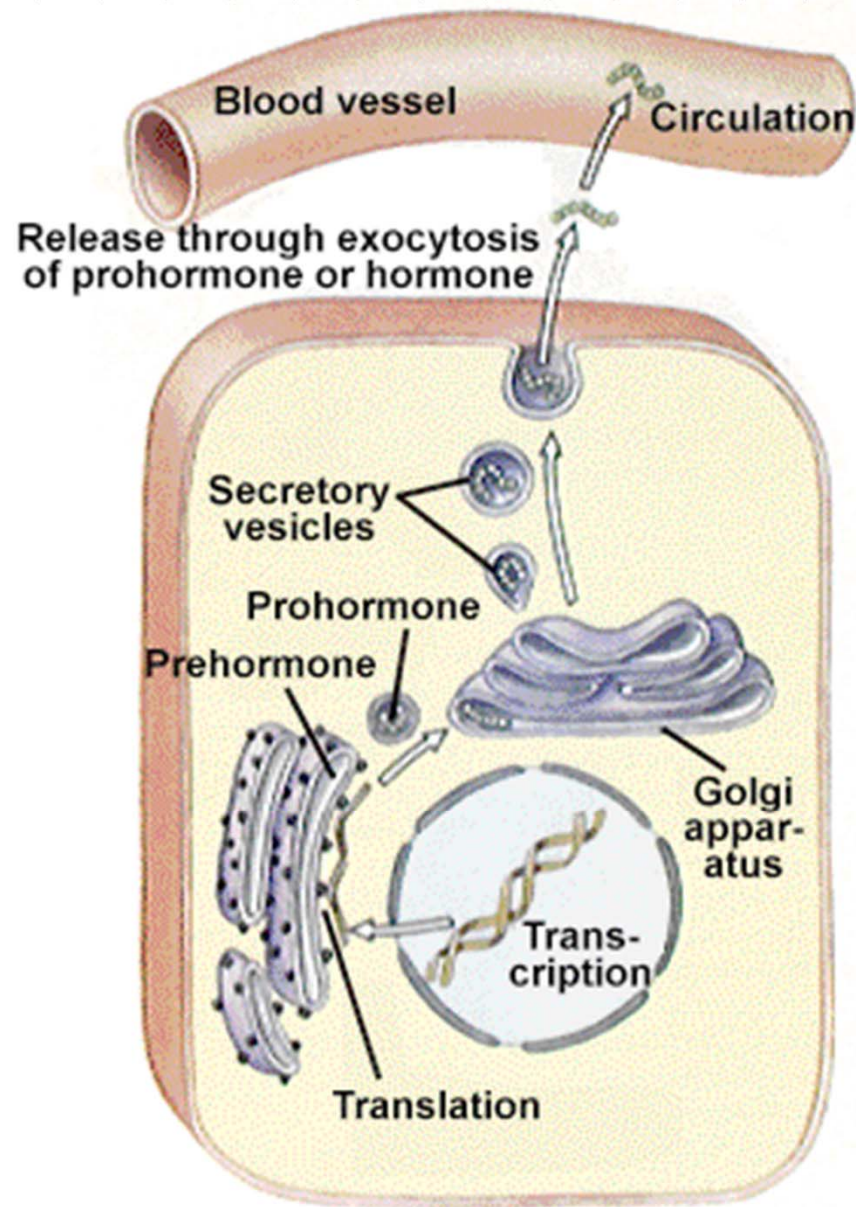
- ◆ Endocrine - no duct, products are secreted into the bloodstream
- ◆ Pineal (brain)
- ◆ Pituitary (brain)
- ◆ Parathyroid
- ◆ Thyroid

# *Examples of Endocrine Glands*

- ◆ Thymus (chest)
- ◆ Adrenal (kidneys)
- ◆ Pancreas
- ◆ Ovary
- ◆ Testes

# *Glands of Internal Secretion*

- ◆ Products of the endocrine glands
  - ◆ Hormones
    - ◆ Produced only when needed (quantity is important)
    - ◆ Target cells somewhere in the body that are stimulated
    - ◆ Optimum quantity range



# *Types of Hormones*

- ◆ Protein (insulin)
- ◆ Amines (amino acid)
- ◆ Steroids (lipid related) (based on the cholesterol molecule)
- ◆ Prostaglandins - hormone-like molecules that work in the area where they are produced
  - ◆ Intracellular compounds
  - ◆ Made up of 20 carbon fatty acids
  - ◆ Many deal with smooth muscle and glands

# *How Do Protein Hormones Work?*

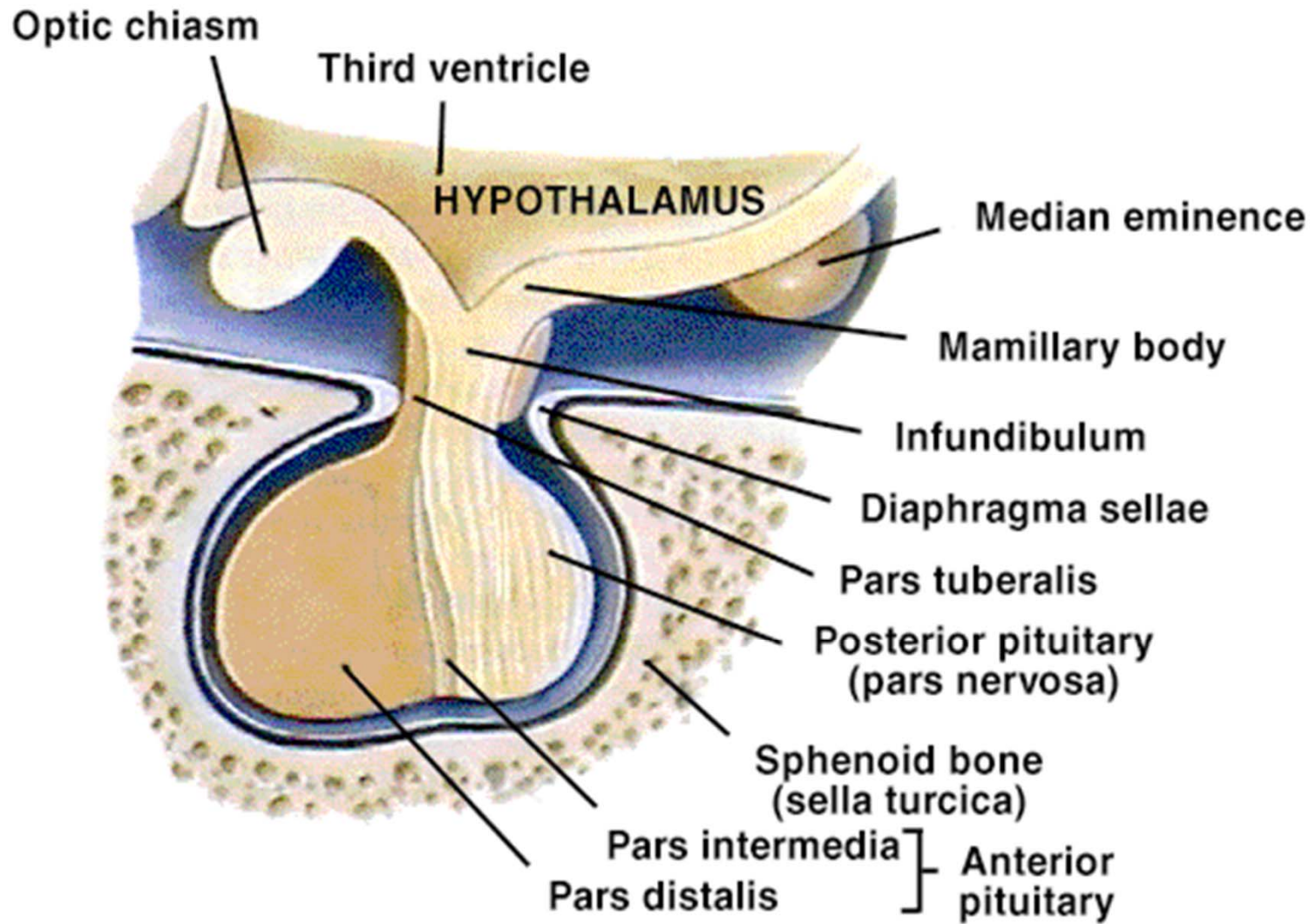
- ◆ First messenger
  - ◆ Hormone attaches to a membrane receptor site
  - ◆ Adenylate cyclase is released inside the membrane
  - ◆ Adenylate cyclase converts ATP to cyclic AMP
- ◆ Second messenger
  - ◆ Cyclic AMP activates a regulatory enzyme
  - ◆ The regulatory enzyme performs a function associated with the specific tissue

# *Steroid Hormones*

- ◆ Lipid penetrates the membrane
- ◆ Inside the cell it joins with a protein carrier and is transported to the nucleus
- ◆ Acts on the cell's DNA

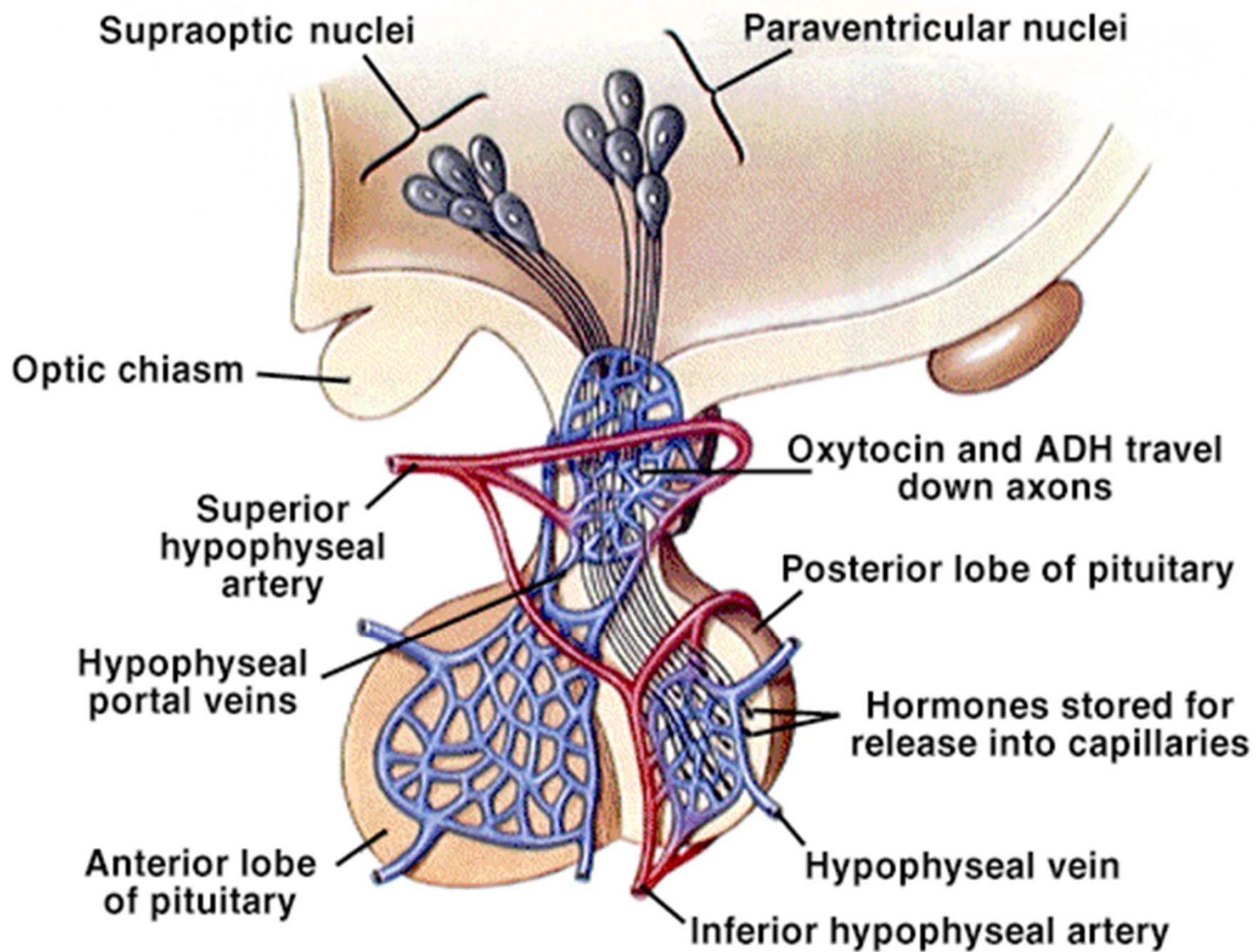
# *Hypothalamus (Floor of the Brain)*

- ◆ Drive centers are located here and the subconscious control center
- ◆ Hypothalamus secretes releasing factors or inhibiting factors into the blood supply of the infundibulum which is connected to the anterior lobe of the pituitary. They stimulate or inhibit hormone production. Each hormone from the anterior lobe will have its own specific set of control factors from the hypothalamus.



# *Hypothalamus (Floor of the Brain)*

- ◆ There is no glandular tissue in the posterior lobe of the pituitary. Neuron processes from the hypothalamus hold and release hormones through this tissue when they are needed.
- ◆ Hypophyseal portal vein
  - ◆ Blood supply between the brain and the pituitary
  - ◆ Between 2 capillary beds
  - ◆ Contains releasing or inhibiting factors from the hypothalamus



# *Hormone Functions*

- ◆ Pituitary gland (AKA hypophysis)
  - ◆ 2 lobes (anterior and posterior)
  - ◆ Anterior adenohypophysis
    - ◆ 7 different hormones
  - ◆ Posterior neurohypophysis
    - ◆ 2 different hormones

# *Hormone from the Pituitary Gland*

1. Thyroid-stimulating hormone (TSH)
2. Adrenocorticotrophic hormone (ACTH)
3. Follicle-Stimulating hormone (FSH)
4. Luteinizing Hormone (LH)
5. Prolactin (PRL)
6. Growth Hormone (GH)
7. Melanocyte-Stimulating hormone (MSH)

# *Thyroid Stimulating Hormone (TSH)*

- ◆ Target tissue is the thyroid (indirect)
- ◆ Releases thyroid hormones
- ◆ Influenced by stress (increases production)

# *Adrenocorticotrophic Hormone (ACTH)*

- ◆ Stimulates the release of steroid hormones by the adrenal glands.
- ◆ ACTH specifically targets cells producing hormones called glucocorticoids which affect glucose metabolism.
- ◆ Influenced by stress

# *Follicle-Stimulating Hormone (FSH)*

- ◆ Promotes egg development in women and stimulates the secretion of estrogens (steroid hormones) produced by ovarian cells
- ◆ In men, FSH production supports sperm production in the testes

# *Luteinizing Hormone (LH)*

- ◆ It induces ovulation in women and promotes the ovarian secretion of estrogens, which prepare the body for the possibility of pregnancy

# *FSH & LH are aka as Gonadotropic Hormones*

- ◆ Follicle stimulating hormone (FSH)
  - ◆ Gonads (direct and indirect)
  - ◆ Direct - stimulates sex cell production
  - ◆ Indirect - stimulates hormone production in females
- ◆ Luteinizing hormone (LH)
  - ◆ Gonads
  - ◆ Direct - stimulates ovulation in females
  - ◆ Indirect - stimulates hormone production in males (testosterone)

# *Prolactin*

- ◆ Stimulates the development of the mammary glands and the production of milk
- ◆ Has no effect on human male

# *Prolactin*

- ◆ Breast tissue (mammary glands - direct)
- ◆ Works with 6 other hormones to stimulate breast development
- ◆ Limited to women
- ◆ Inhibited by sex hormones
- ◆ Causes sensitivity to breast tissue prior to flow phase of the menstrual cycle
- ◆ Mechanical stimulation of breast tissue causes increase in prolactin production (nursing)

# *Growth Hormone*

- ◆ Stimulates cell growth and replication by the rate of protein synthesis.
- ◆ GH breaks down glycogen reserves and the release of glucose into the circulation causing the blood glucose levels to rise.

# *Growth Hormone*

- ◆ Hyposecretion:
  - ◆ Children - pituitary dwarf (normal body proportions) usually no taller than 4 feet tall.
  - ◆ Adults - Simmond's disease (atrophy and premature aging)

# *Growth Hormone*

- ◆ Hypersecretion
  - ◆ Children - pituitary giants (8 –9 feet tall)
  - ◆ Adults – acromegaly
    - ◆ Widened bones and thick fingers
    - ◆ Lengthening of the jaw and cheek bones
    - ◆ Thick eyelids, lips, tongue, and nose

# *Melanocyte Stimulating Hormone (MSH)*

- ◆ Epidermis, basal cell layer (direct)
- ◆ Stimulates the melanocytes of the skin, increasing their production of melanin.
- ◆ MSH is important in the control of skin and hair pigmentation.

# *Posterior Pituitary (Neurohypophysis)*

2. Antidiuretic Hormone (ADH)
3. Oxytocin Hormone

# *(Neurohypophysis) Composed of Nervous Tissue*

- ◆ Hormones are made by the hypothalamus
- ◆ Stored and released in the posterior lobe
  - ◆ Oxytocin (birth hormone)
    - ◆ Target organs are the uterus and mammary glands.
    - ◆ Stimulate muscles in the uterine wall to contract in labor and delivery processes
    - ◆ baby suckles - sensory information is sent from the breast to the hypothalamus. The hypothalamus responds by sending nerve impulses to the pituitary gland, causing the release of oxytocin.

# *Antidiuretic Hormone (ADH)*

- ◆ Is secreted by the posterior pituitary gland.
- ◆ The primary target organ is the Kidneys
- ◆ Causes reabsorption of water and returns it to the blood
- ◆ Decreases the amount of urine excreted
- ◆ Inhibited by alcohol
- ◆ Hyposecretion is called diabetes insipidus (note this is not diabetes mellitus)

# *Antidiuretic Hormone (ADH)*

- ◆ Increased by or responds from conditions:
  - ◆ Pain
  - ◆ Stress
  - ◆ Drugs (morphine and nicotine)
  - ◆ The absence of ADH will will cause an increase in diuresis up to 25 liters/day

# *ADH (aka Vasopressin)*

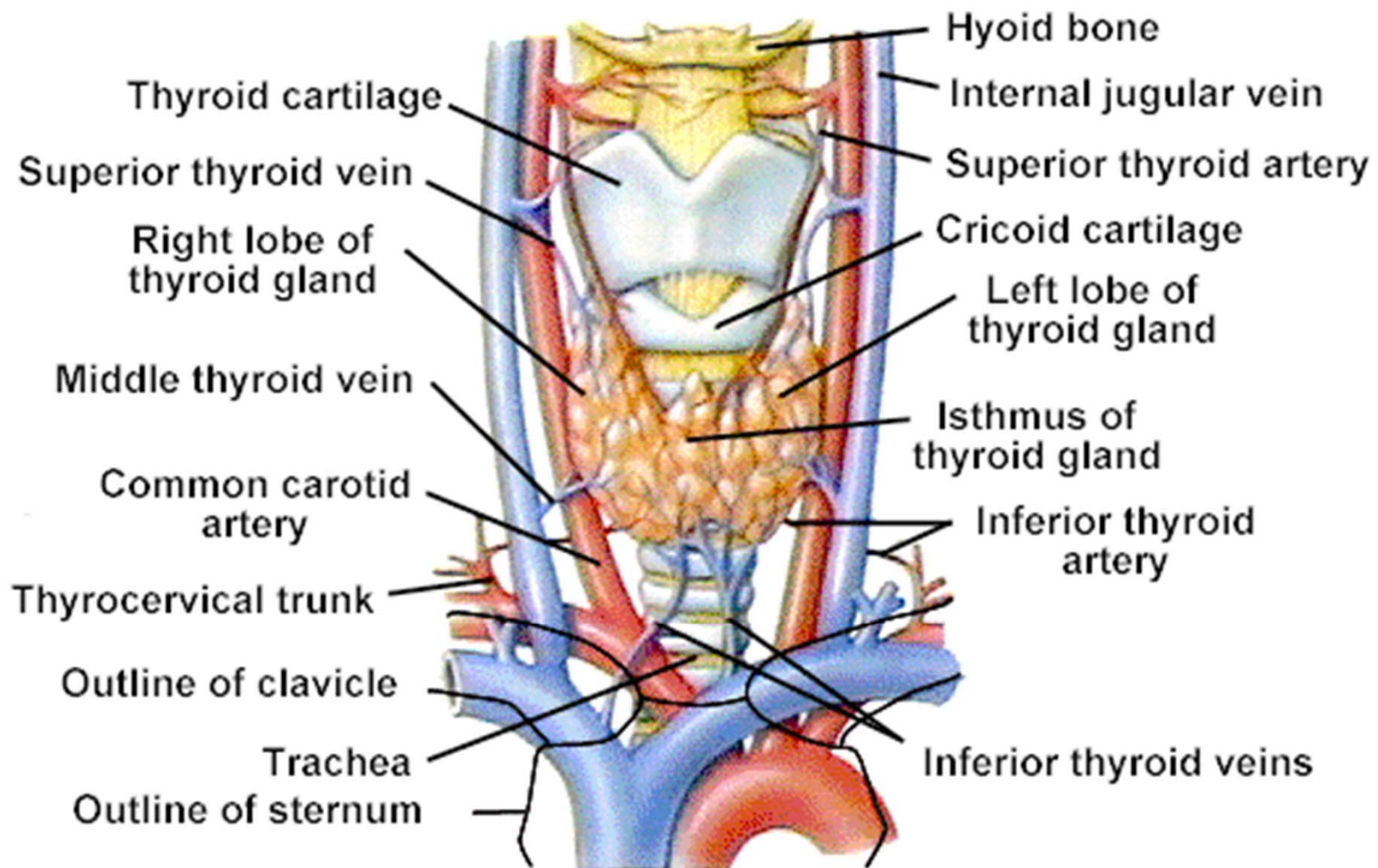
- ◆ Decreases the amount of water lost through the kidneys and causes vasoconstriction, both mechanisms serve to increase the BP

# *Vasopressin*

- ◆ Vasopressin can be used to treat certain types of cardiac arrest, (Ventricular Fibrillation) and GI bleeding (especially esophageal varices). In women it can cause uterine contraction.
- ◆ It's properties increase blood flow to the brain and heart

# *Thyroid*

- ◆ Only 1 gland
- ◆ Located in the anterior throat
- ◆ Stores its own hormones
  1. Triiodothyronine T3
  2. Tetraiodothyronine T 4 or thyroxine



# *Thyroid Glands*

- ◆ They regulate the metabolism of:
  1. Carbohydrates
  2. Proteins
  3. Fats

# *Thyroid Glands*

- ◆ Thyroid hormones increase the rate of metabolism of most cells.

# *Thyroxin*

- ◆ Hyposecretion
  - ◆ Child - cretinism (a form of dwarfism)
    - ◆ Retarded and sluggish
    - ◆ Lower temperature and heart rate
  - ◆ Adult - myxedema (slow and puffy)
    - ◆ Is a slowed down metabolic state
    - ◆ Retains water (increasing blood pressure)
    - ◆ Low temperature and slow heart rate
    - ◆ No retardation

# *Thyroxin*

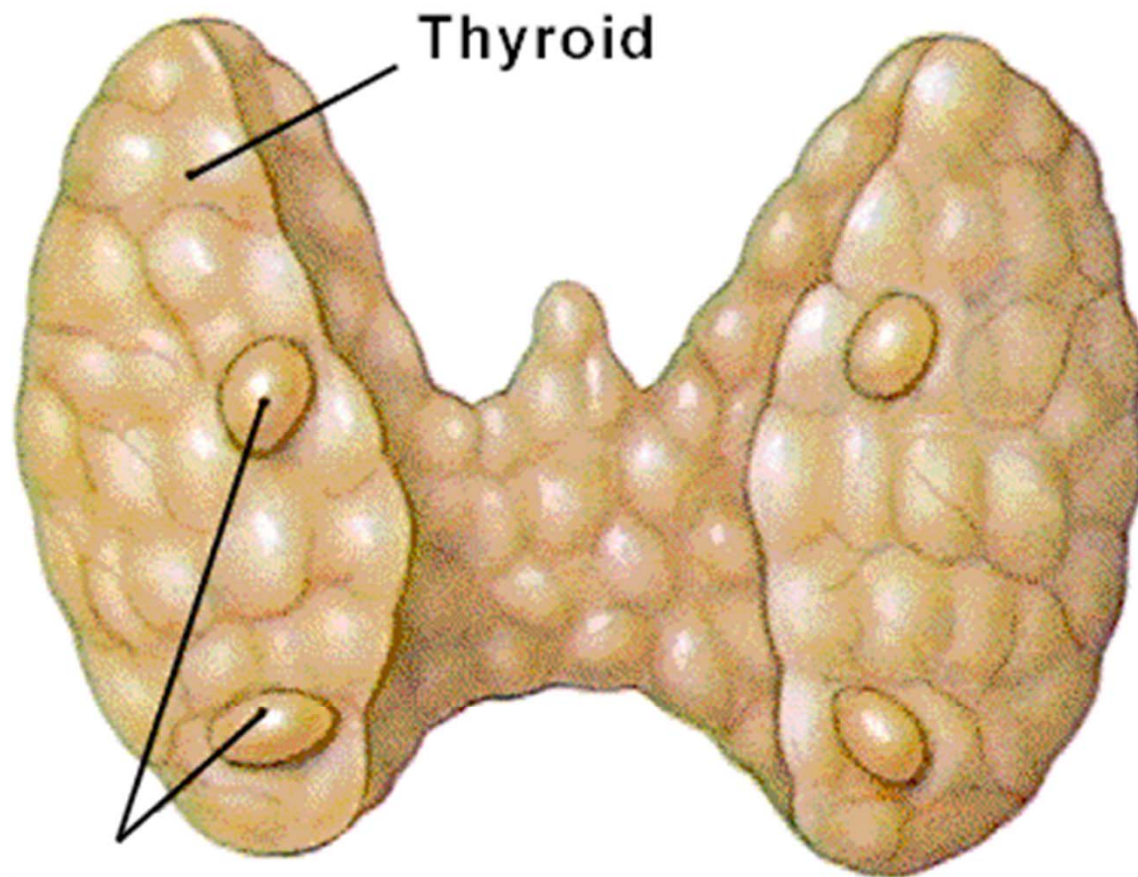
- ◆ Hypersecretion: (Grave's disease)
  - ◆ Mostly in adults and women
  - ◆ Speeds up metabolic state
  - ◆ Exophthalmic goiter (thyroid 2-3X normal size)
  - ◆ Bulging eyes, forced forward by fat deposits
  - ◆ Increased metabolism and decreased weight
  - ◆ Opposite of hyposecretion (increased temperature and heart rate)
  - ◆ Wide emotional swings

# Calcitonin

- ◆ Bone
- ◆ Increases rate of  $\text{Ca}^{++}$  deposit in bone
- ◆ Hyposecretion - hypercalcemia - increased  $\text{Ca}^{++}$  in the blood
- ◆ Hypersecretion - hypocalcemia - decreased  $\text{Ca}^{++}$  in the blood

# *Parathyroid Hormones (PTH)*

- ◆ Four, small, posterior thyroid surface
- ◆ Parathyroid hormone
  - ◆ PTH has 3 target organs
  - ◆ Bone
  - ◆ Kidneys
  - ◆ GI tract



Thyroid

Parathyroid  
glands

# *Parathyroid Hormones*

- ◆ Activates vitamin D (works in the intestine) (Ca<sup>++</sup> absorption)
- ◆ Increases blood Ca<sup>++</sup> level
- ◆ In the kidneys it helps with reabsorption of Ca<sup>++</sup> and magnesium with phosphate being lost

# *Parathyroid Hormones*

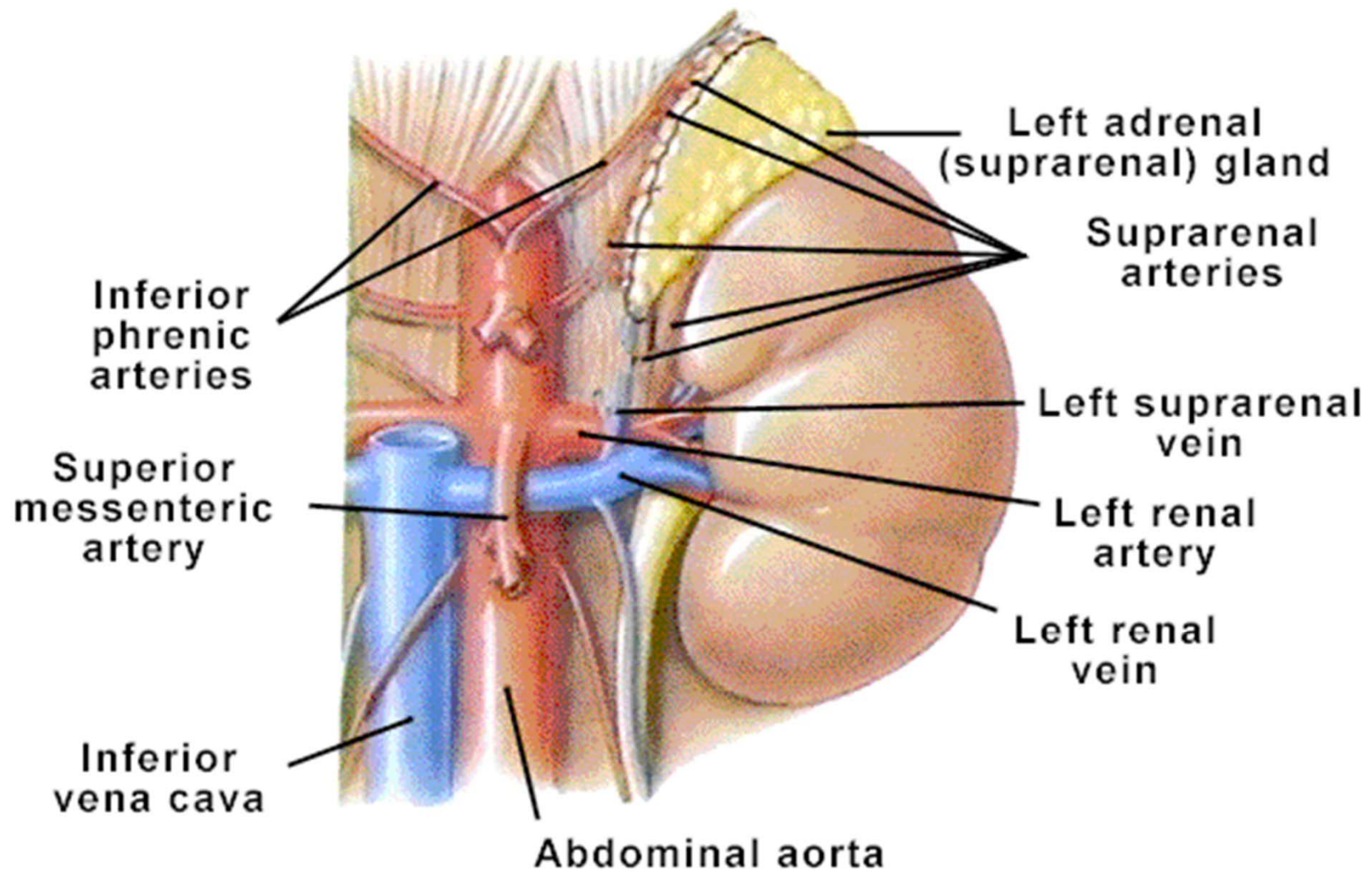
- ◆ Hyposecretion
  - ◆ Surgery or damage to the thyroid
  - ◆ Causes hypocalcemia
  - ◆ Causes muscle tetany
  - ◆ Trousseau's sign - causes contracture of the hand if the BP cuff is applied

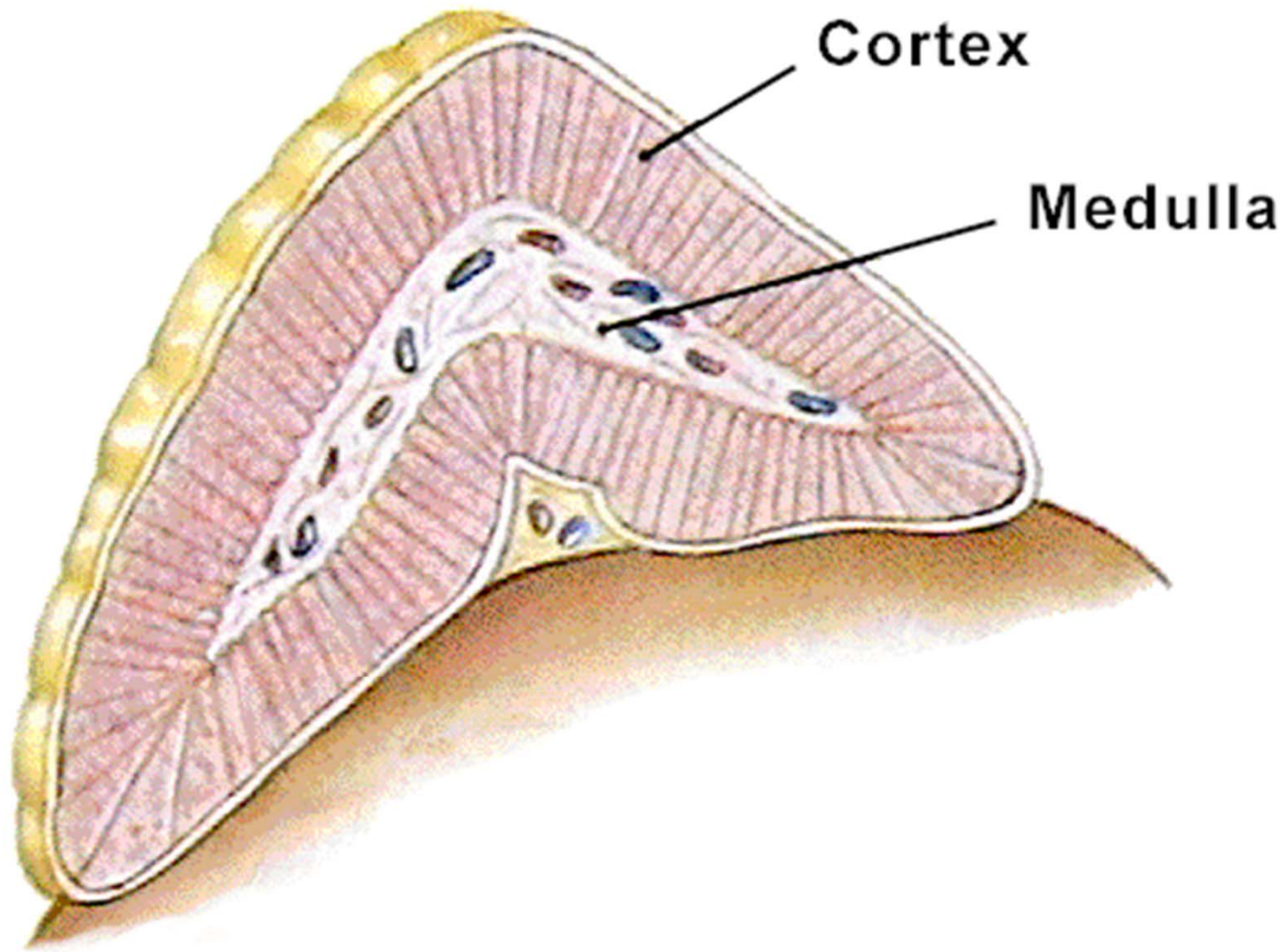
# *Parathyroid Hormones (PTH)*

- ◆ Hypersecretion
  - ◆ Usually associated with tumor (VonRecklinghausen's disease)
  - ◆ Hypercalcemia
  - ◆ Increase in urine production and increase in kidney stones
  - ◆ Deformity and pain in bones

# *Adrenal Glands (Suprarenal)*

- ◆ Paired and double structures
- ◆ Adrenal cortex: makes 28 steroid hormones and is linked with cholesterol
  - ◆ Aldosterone (mineralocorticoid)
    - ◆ Causes Na<sup>+</sup> absorption and excretion of K<sup>+</sup>
    - ◆ Conserves water, Cl<sup>-</sup>, and bicarbonate
    - ◆ Kidney, distal convoluted tubule





# *Adrenal Cortex (Outer Region)*

The adrenal cortex secretes 3 steroids:

1. Glucocorticoids
2. Mineralocorticoids
3. Sex Hormones

# *Glucocorticoid*

- ◆ Cortical (hydrocortisone)
- ◆ Decreases inflammation response
- ◆ Slows the healing process, decreases resistance to some diseases
- ◆ They assist to ensure a steady supply of glucose for the brain and other cells

# *Adrenal Cortex (Outer Region)*

- ◆ Hyposecretion - cortex degeneration
  - ◆ Addison's disease (adrenal insufficiency)
    - ◆ A. generalize weakness
    - ◆ B. muscle atrophy
    - ◆ C. severe fluid loss
    - ◆ D. bronzing of the skin
    - ◆ E. must be tx with steroids & fluids

# *Adrenal Cortex*

- ◆ Hypersecretion of glucocorticoids
  - ◆ Cushing's syndrome
    - ◆ Obesity
    - ◆ Buffalo hump - fat deposited across the shoulders
    - ◆ Moon faced - often flushed
    - ◆ Abdominal striae - stretch marks
    - ◆ Heavy abdomen and skinny legs
    - ◆ Thin skin that bruises easily

# *Mineralocorticoids*

- ◆ The chief mineralocorticoid is Aldosterone
  - ◆ It's role is regulation of:
    - A. blood volume
    - B. blood pressure

# *Mineralocorticoids*

- ◆ The primary targeted organ is the kidney
- ◆ Aldosterone conserves sodium and water and eliminates potassium

# *Sex Hormones (Gonadocorticoids)*

- ◆ Not secreted until puberty
- ◆ Of the gonad hormones, testosterone is dominant
- ◆ Normally production is small

# *Sex Hormones (Gonadocorticoids)*

- ◆ When secreted the female hormone is called estrogens
- ◆ When secreted the male hormone is called androgens

# *Adrenal Medulla*

- ◆ Secretes 2 hormones
- ◆ 1. Epinephrine (adrenalin)
- ◆ 2. Norepinephrine
- ◆ known as catecholamines
- ◆ secreted in stress situations

# *Adrenal Medulla*

- ◆ Classified as Amine type hormones, 80% of secretion is epinephrine
- ◆ Production stimulated by stress
- ◆ Related to the sympathetic half of the autonomic nervous system

# *Epinephrine (Adrenalin) and Norepinephrine*

- ◆ Functions
  - ◆ Increases blood pressure, heart output and respiratory rate
  - ◆ Increases blood sugar

# *Epinephrine (Adrenalin) and Norepinephrine*

- ◆ Dilation of bronchial tubes
- ◆ Inhibits digestion response
- ◆ Prolongs sympathetic nerve response by 10X

# *Epinephrine (Adrenalin) and Norepinephrine*

- ◆ Increase metabolic rate of most cells, thereby making more energy
- ◆ Causing bronchodilation to increase the flow of air into the lungs
- ◆ Changing blood flow patterns, causing dilation of the blood vessels to the heart and muscles and constriction of the blood vessels to the GI tract

# *Epinephrine (Adrenalin) and Norepinephrine*

- ◆ Hypersecretion
  - ◆ Usually caused by a tumor
  - ◆ Cause of increased blood pressure and hyperglycemia
  - ◆ Prolonged stress response

# *Kidneys*

- ◆ The kidneys are NOT primarily endocrine organs, but they release 3 hormones:
  1. Calcitriol
  2. Erythropoietin
  3. Renin

# *Renin*

- ◆ Is released by the kidney cells in response to a decrease in blood volume or BP

# *Pancreas*

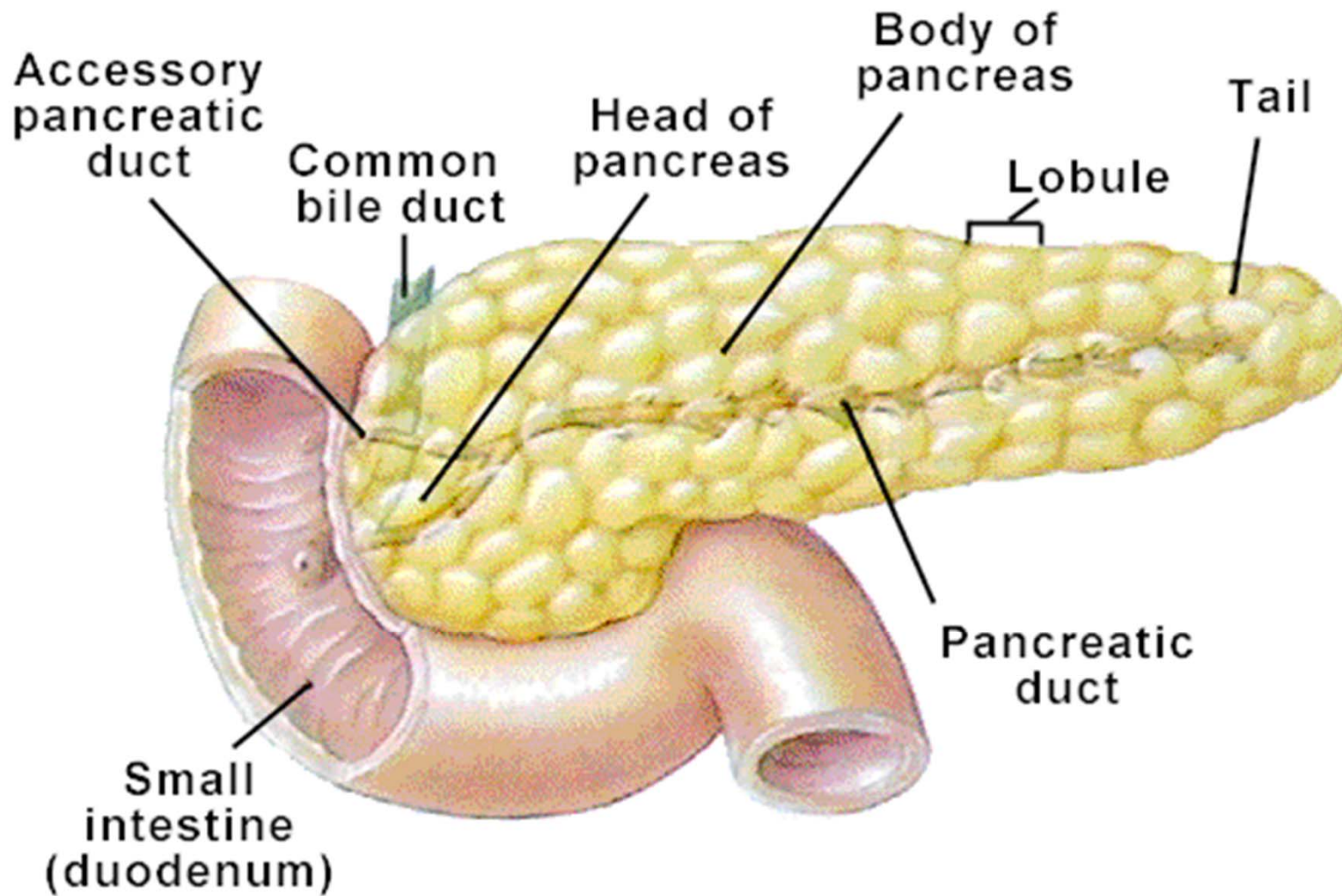
- ◆ One organ with a double function, half digestion (exocrine), half endocrine
- ◆ Islets of Langerhans - the endocrine half of the pancreas
- ◆ Pancreas secretes 2 hormones
  1. Insulin
  2. Glucagon
- ◆ Hormones are proteins

# *Pancreas*

- ◆ The islets of Langerhans have 2 types of cells:
  1. Alpha cells (secrete glucagon)
  2. Beta cells (secrete insulin)
- ◆ Both regulate blood glucose levels

# *Pancreas*

- ◆ The overall effect of insulin is to lower blood glucose levels
- ◆ The overall effect of glucagon is to increase blood glucose levels



# *Insulin*

- ◆ Beta cells produce this (represent 75% of the Islets)
- ◆ Removes glucose from the blood into the body cells
- ◆ Hypersecretion:
  - ◆ Insulin shock (hypoglycemia)
  - ◆ Can lead to seizures and unconsciousness

# *Insulin*

- ◆ Insulin helps to control carbohydrates, protein, and fat metabolism in the cell. Insulin stimulates the breakdown of glucose for energy.
- ◆ The liver and skeletal muscles store excess glucose as the form of glycogen

# *Insulin*

- ◆ Hyposecretion
  - ◆ Diabetes mellitus
  - ◆ Hyperglycemia and glucose in the urine
  - ◆ Dehydration from excess urine production, Na<sup>+</sup> loss, thirst
  - ◆ Acidosis
  - ◆ Retina deterioration, circulation problems, atherosclerosis, amputations

# Glucagon

- ◆ Producing cells are the alpha cells - 25% of the Islets
- ◆ Increase blood glucose level
- ◆ Hyposecretion: hypoglycemia
- ◆ Hypersecretion: hyperglycemia

# *Other Pancreatic Hormones*

- ◆ Somatostatin
  - ◆ Produced by the delta cells of the Islets
  - ◆ Suppresses insulin and glucagon release by other cells
- ◆ Pancreatic polypeptide
  - ◆ Produced by the F cells of the Islets
  - ◆ Inhibits gallbladder contractions

# Testes

- ◆ Two of them, double structure and double function
- ◆ Testosterone: stimulated by pituitary at puberty
  - ◆ Produced by interstitial cells
  - ◆ Produce the steroid androgens
  - ◆ Responsible for secondary sex characteristics and the sex drive

# Ovaries (*Female Sex Cells, Ova*)

- ◆ Two - double structure and function
- ◆ Estrogen: comparable to testosterone and begins in quantity at puberty (sets the timing for the reproductive process)
  - ◆ Produced by the follicle
  - ◆ Responsible for secondary sex characteristics and sex drive
- ◆ Progesterone accelerates the movement of fertilized eggs along the uterine tubes and prepares the uterus for the arrival of a developing embryo

# *Pineal Gland*

- ◆ Located in the roof of the thalamus between the cerebellum and the cerebral hemispheres
- ◆ Secretes the hormone - Melatonin
  - ◆ Works through the hypothalamus
  - ◆ Inhibited by light, the more the light the more melatonin secreted
  - ◆ Inhibits the hormone that stimulates the ovaries (slows the timing of sexual maturity)
  - ◆ Involved in regulation of the menstrual cycle
  - ◆ Influence on production of ACTH

# *Thymus*

- ◆ Endocrine gland in part
- ◆ Located in the membrane above the heart (in humans it is at its maximum size during puberty)
- ◆ Thymosin
  - ◆ Target tissues - T cell lymphocytes
  - ◆ Effect - stimulates production
  - ◆ Net effect - stimulates cellular immunity

I'm so full of  
this stuff



*Well Done!*

Ontario Base Hospital Group  
Self-directed Education Program

