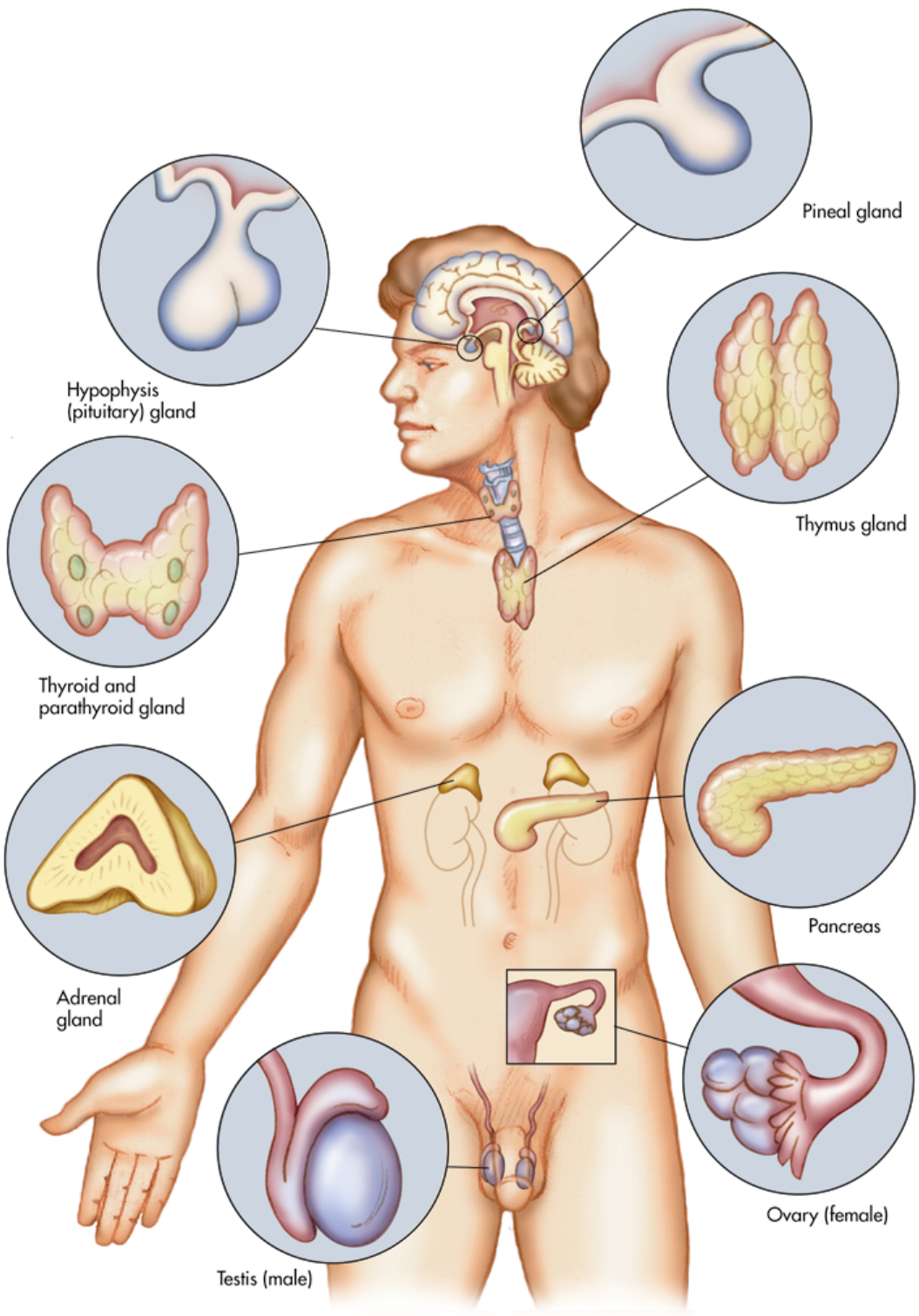


The Endocrine System

BOOKLET 1

World of hormones…1 hour show

https://youtu.be/EHnJjGzp__M

BOOKLET #1

WELCOME TO BIOLOGY 30

LETS GET STARTED…

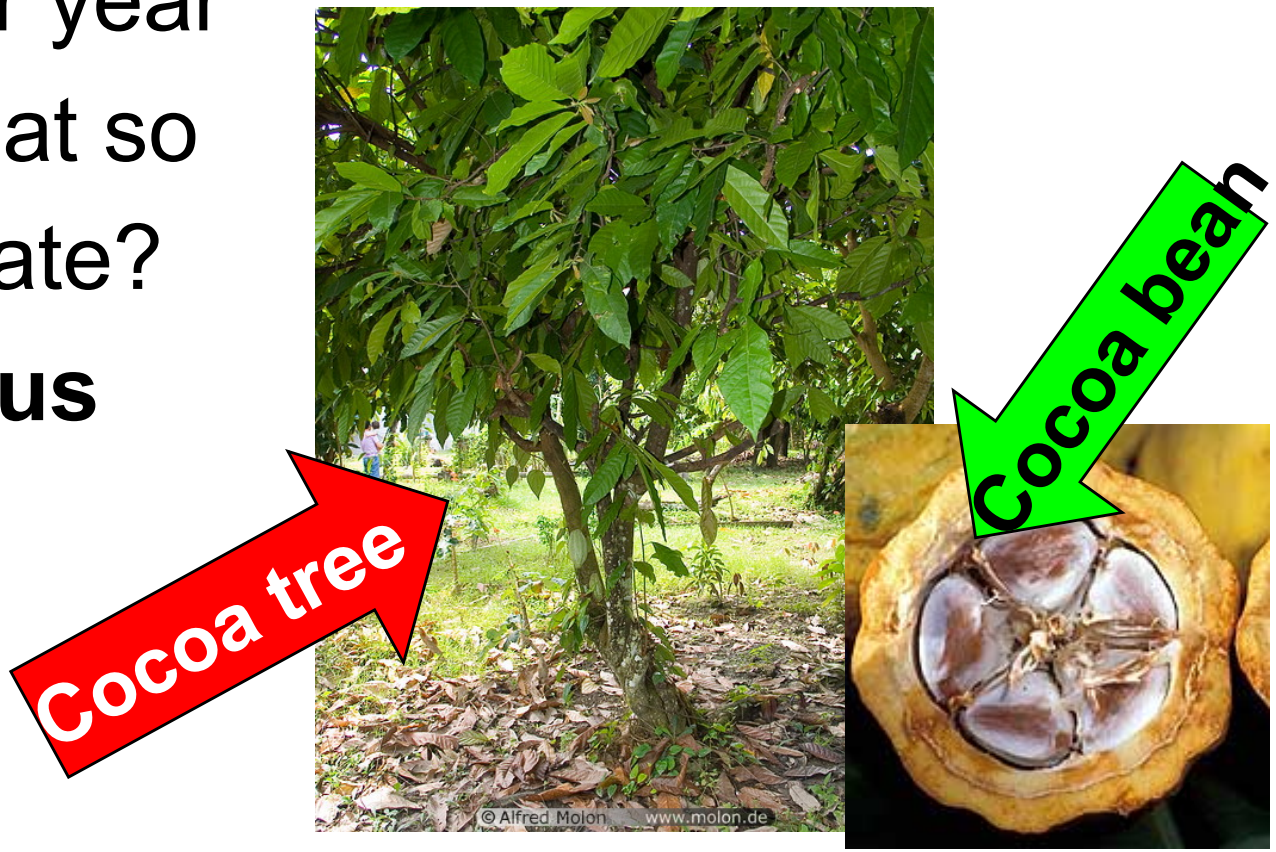
HOMEOSTASIS

and the Endocrine System

Homeostasis

- **Chocolate** comes from the cocoa bean
- The average person eats **11 pounds** of chocolate per year
- Why do we eat so much chocolate?

It makes us HAPPY!



Why does chocolate make me happy?

- Chocolate contains **380 chemicals**, including theobromine
  - Theobromine is poisonous to dogs and chickens
- Chocolate also cause the production of natural **opiods** in the brain
- **Opiods** (such as opium) produce the feeling of euphoria

Why does chocolate make me happy?

- Chocolate also contains substances that act as **cannabinoids**
  - Cannabinoids are found in marijuana
  - This causes an increase in **dopamine** (neurotransmitter) production
  - Also **anandamides** stay in the brain longer without being broken down

So can you get high off chocolate?

You would have to eat 25lbs of chocolate to get the same effects of marijuana!

Homeostasis

Similar

Balance

Homeostasis is a process that allows a constant internal environment to be maintained despite changes in the external environment.

Is controlled by the nervous system AND endocrine system

Ex. Body temperature (37^{oC})
Blood glucose
Electrolytes (Cl^-, Na^+, K^+)
Blood gasses (O_2, CO_2)

Homeostasis

For your internal environment to remain constant you must have a

1. **Monitor** to detect the problem
2. **Control** to fix it

This is like the thermostat in a house.

-A temperature is set to 21^{o}C,
-the thermostat continuously checks to see if the temperature has gone down.

-If the temperature drops below 21^{o}C, then the thermostat turns on the furnace,
-Once the temperature is above 21^{o}C, then the furnace is shut off.

Homeostasis

You have a control mechanism like this in your body for blood sugar levels.

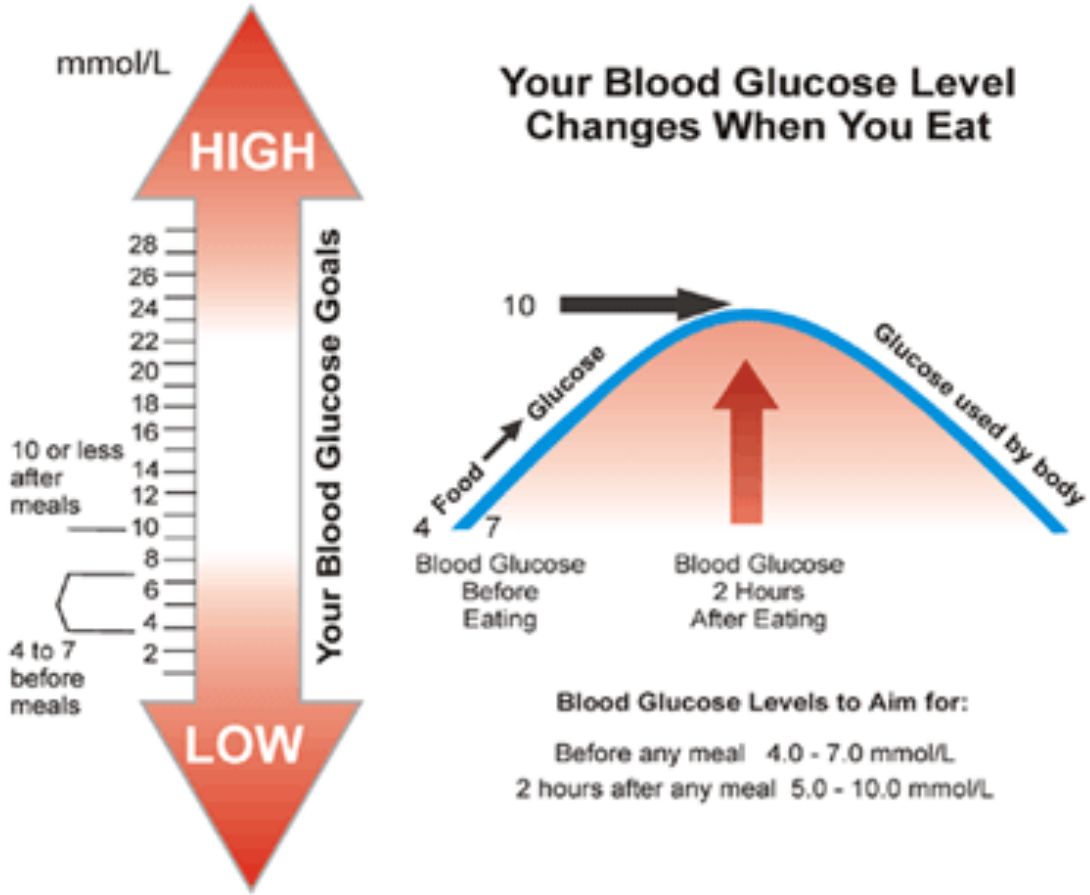
Your house may have a control mechanism like this to cool down your air temperature.

If your blood sugar is too high, then the pancreas(monitor) detects it and secretes insulin, which stimulates the liver (control) to store glucose, which decreases blood sugar levels. Once your blood sugar levels are normal, then the pancreas stops releasing insulin.

If your house is too hot, then the thermostat (monitor) detects it and turns on the AC, which stimulates the compressor (control) to absorb heat, which decreases air temp.
Once the room temperature is normal, then the thermostat stops running the AC.

Homeostasis

This controlling method is called NEGATIVE FEEDBACK or FEEDBACK INHIBITION

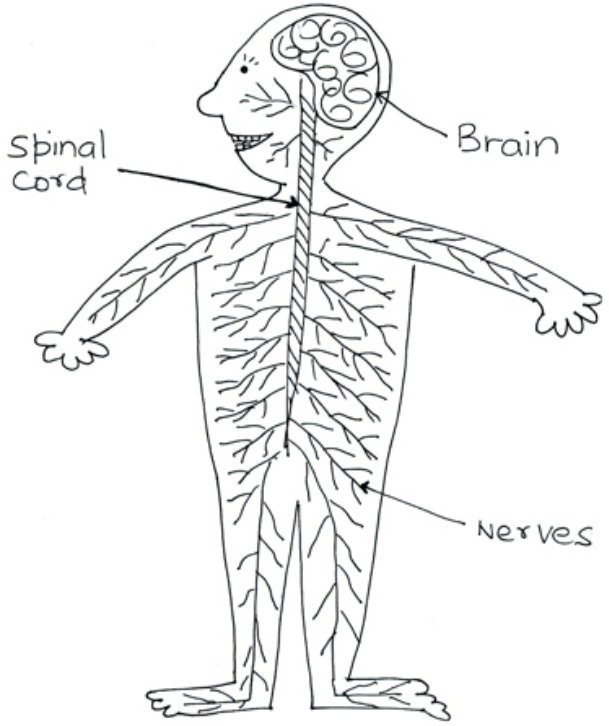


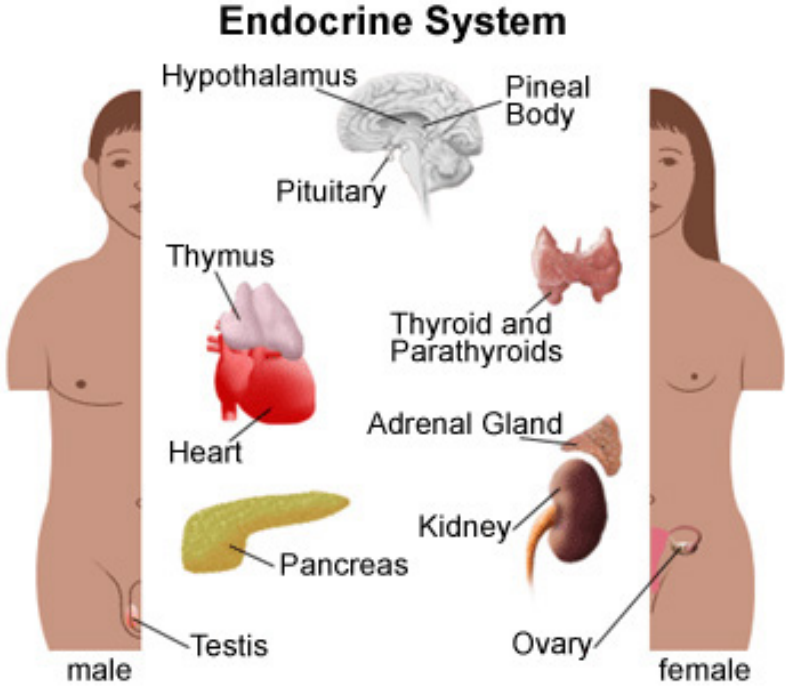
How do our bodies maintain homeostasis?

The **endocrine system**, **ALONG WITH the** **nervous system**, functions in the regulation of body activities.

1. Nervous System – brain, spinal cord and neurons

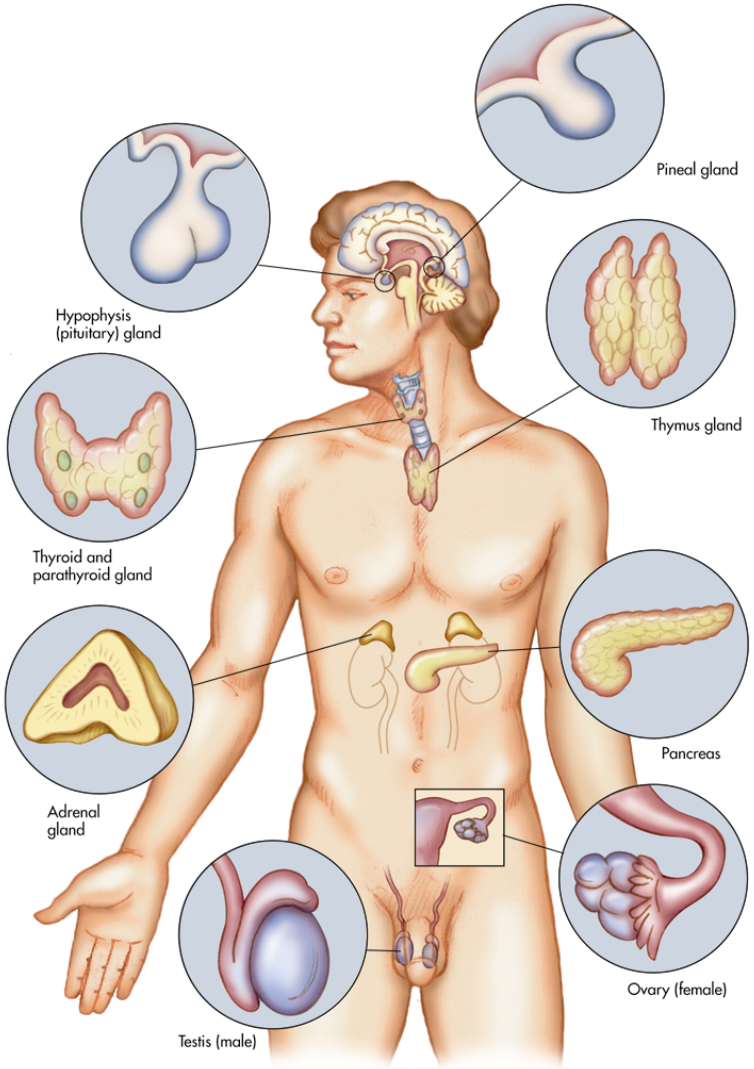
2. Endocrine glands and hormones that they secrete





Homeostasis

and



the

Endocrine system

Learner outcomes…
What you need to know!

- identify the principal endocrine glands of humans; i.e., the hypothalamus/pituitary complex, thyroid, parathyroid, adrenal glands and islet cells of the pancreas
- compare the endocrine and nervous control systems and explain how they act together; *e.g., stress and the adrenal gland*

Terms you need to know

Hypothalamus

Anterior Pituitary

Posterior Pituitary

Receptor Site

Target Tissue

Dynamic Equilibrium

Protein hormones

Terms you need to know

Steroid Hormones

Tropic Hormones

Non-Tropic Hormones

Endocrine

Exocrine

Pancreas

Terms you need to know

Negative Feedback Loop

Positive Feedback Loop

Hyposecretion

Hypersecretion

ADH

Diabetes Insipidus

Oxytocin

Terms you need to know

TSH

ACTH

hGH

FSH

LH

PRL

Terms you need to know

Thyroxine

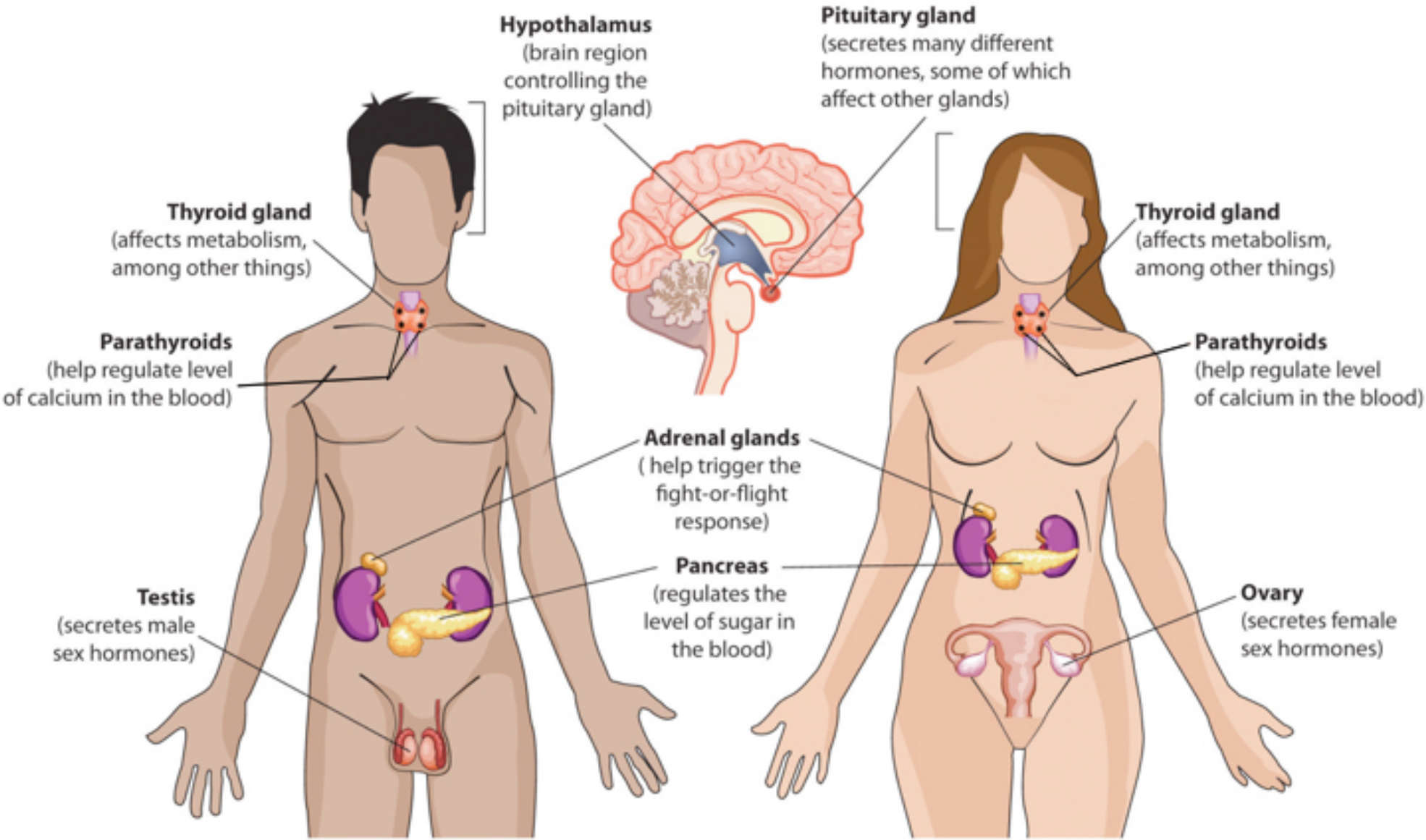
Adrenal Cortex

Adrenal Medulla- middle of adrenal glad that produces (Epinepherine) Adrenaline

Acromegaly

Parts of the Endocrine System

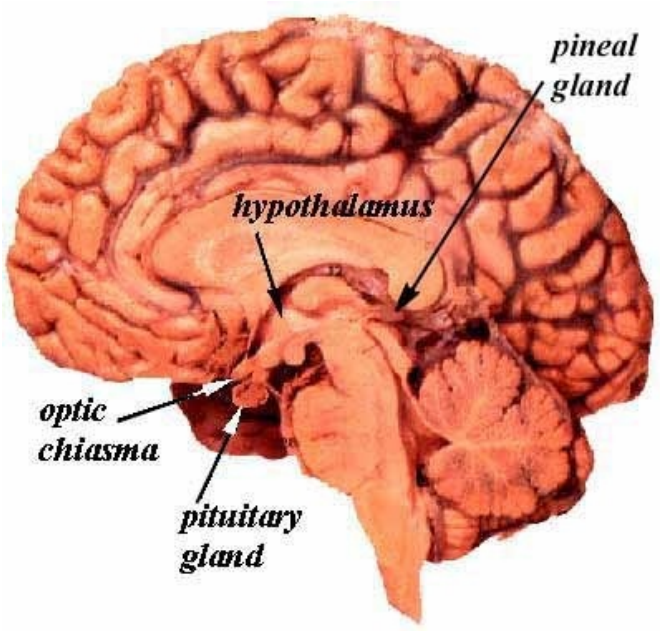
KNOW THEIR LOCATION

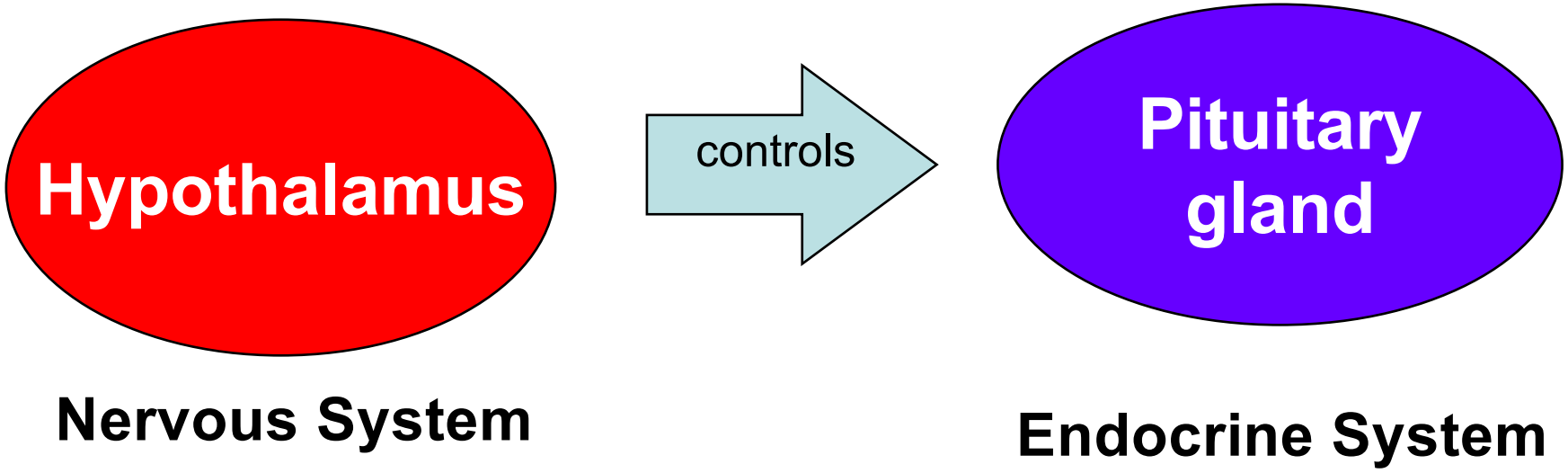


Comparison of Nervous System and Endocrine System

Nervous System	Endocrine System
Produces neurotransmitters	Produces hormones
Direct cell to cell communication	Hormones travel through blood to their target
Fast acting	Speed varies
Short duration	Long lasting
Cause muscle contraction and glandular secretion	Influence growth, development and metabolic activities

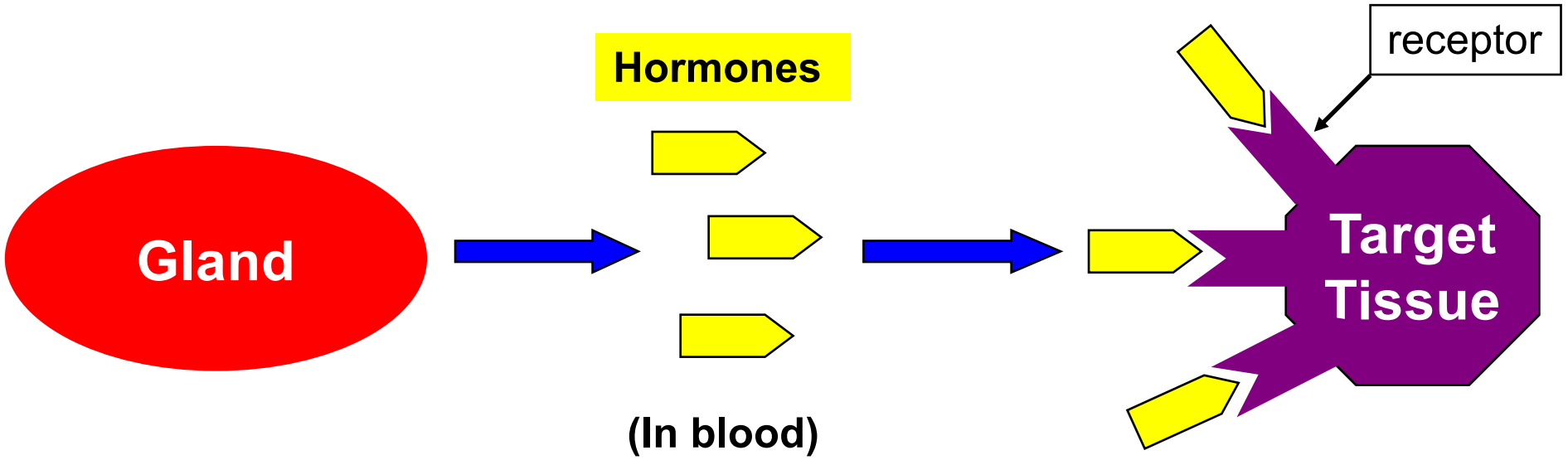
- **The nervous system is tied into the endocrine system…**
  - **The hypothalamus (brain) controls the pituitary gland which is the master gland of the endocrine system.**





Endocrine System

How hormones work...



A gland --- secretes a hormone --- which fits a very specific target tissue

Endocrine System

- Hormones are **carried by the blood throughout the entire body, yet they affect only certain cells.**
- The specific cells that respond to a given hormone have **receptor sites for that hormone.**
- This is like a **lock and key mechanism.**

- If a hormone and a receptor site do not match, then there is no reaction.
- All the cells that have receptor sites for a given hormone make up the **target tissue** for that hormone.

Endocrine system and target tissue:

http://www.youtube.com/watch?v=HrMi4GikWwQ&safety_mode=true&safe=active

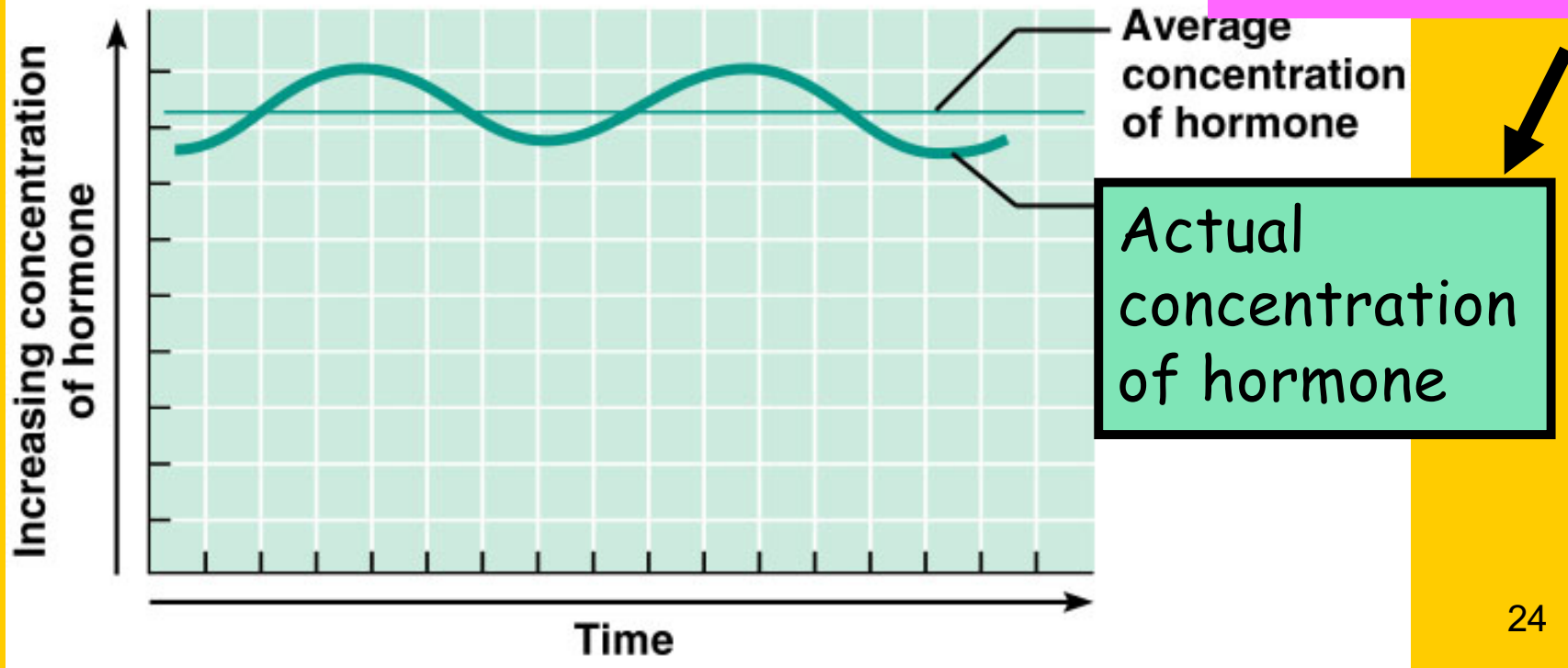
Our body has "set points" for each chemical produced that controls metabolic reactions.

Hormones levels are maintained at a certain level.

Dynamic Equilibrium = Homeostasis

Concentration of Hormones in the Body

DRAW THIS



Characteristics of Hormones

Each hormone produced by the body is unique.

Each one is different in its **chemical composition, structure, and action**, however there are some similarities as well.

Hormones can be classified as either…

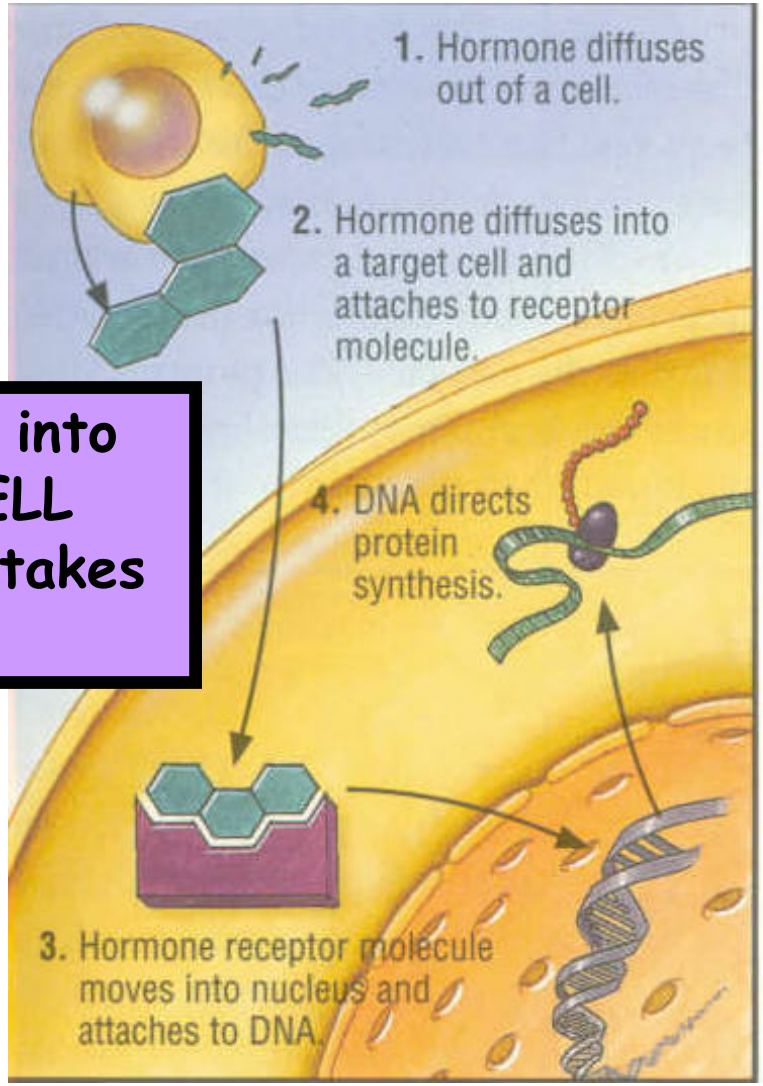
PROTEINS	or	**STEROIDS**
(water soluble)		**(lipid/fat soluble)**
(eg) Insulin		(eg) Testosterone
Growth Hormone		Estrogen & Progesterone
Epinephrine(adrenaline)		Cortisol

Steroid Hormones

(Lipid soluble)

SLOW

Moves into the CELL which takes time!

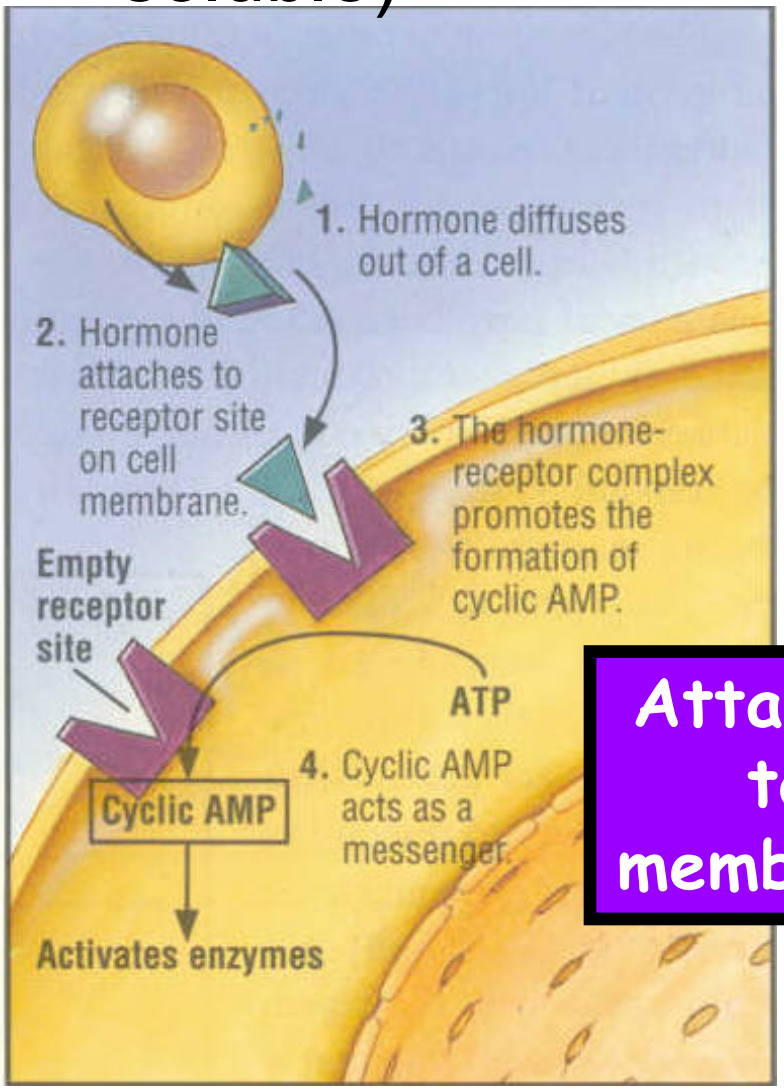


Protein Hormones

(water soluble)

PROMPT

Attaches to membrane



Tropic vs. Non-tropic Hormones

Tropic Hormones

Affects or targets another gland
which in turn…
causes secretion of other hormones

FSH, LH, ACTH, TSH (FLAT)

We will get to what these are in a bit…

Non-Tropic Hormones

Do NOT affect other glands,
but instead…
affect specific body cells or tissues

hGH
PRL
Oxytocin
ADH

don't cause others glands to secrete other hormones

Tropic Hormones - F.L.A.T.

"TARGET an ENDOCRINE gland"

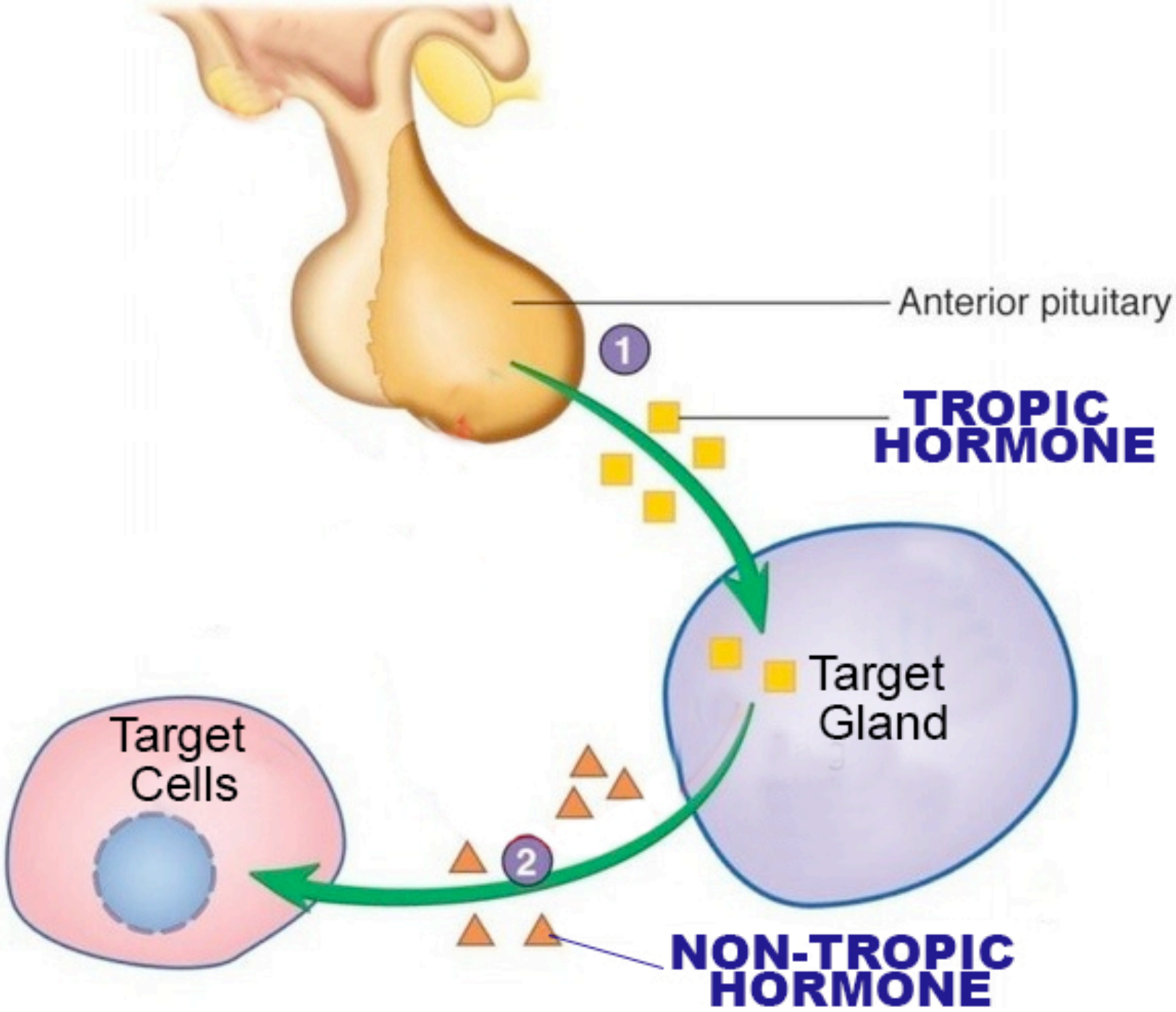
- **FSH and LH** are tropic because they make the reproductive system produce Testosterone(testis) and estrogen and progesterone (ovaries)
- **ACTH** is tropic because it makes the adrenal gland release cortisol and aldosterone
- **TSH** is tropic because it makes the thyroid produce thyroxine

Non-Tropic

"TARGET various CELLS"

- **hGH** is non tropic because it targets various cells in the body for growth
- **Oxytocin** is non-tropic because it causes contractions only (no hormone produced)
- **ADH** is non-tropic because it causes the kidney to hold back water (no hormone produced)
- **PRL** is non-tropic because it causes the mammaries to create milk (not another hormone)

Tropic and Non-Tropic Hormones



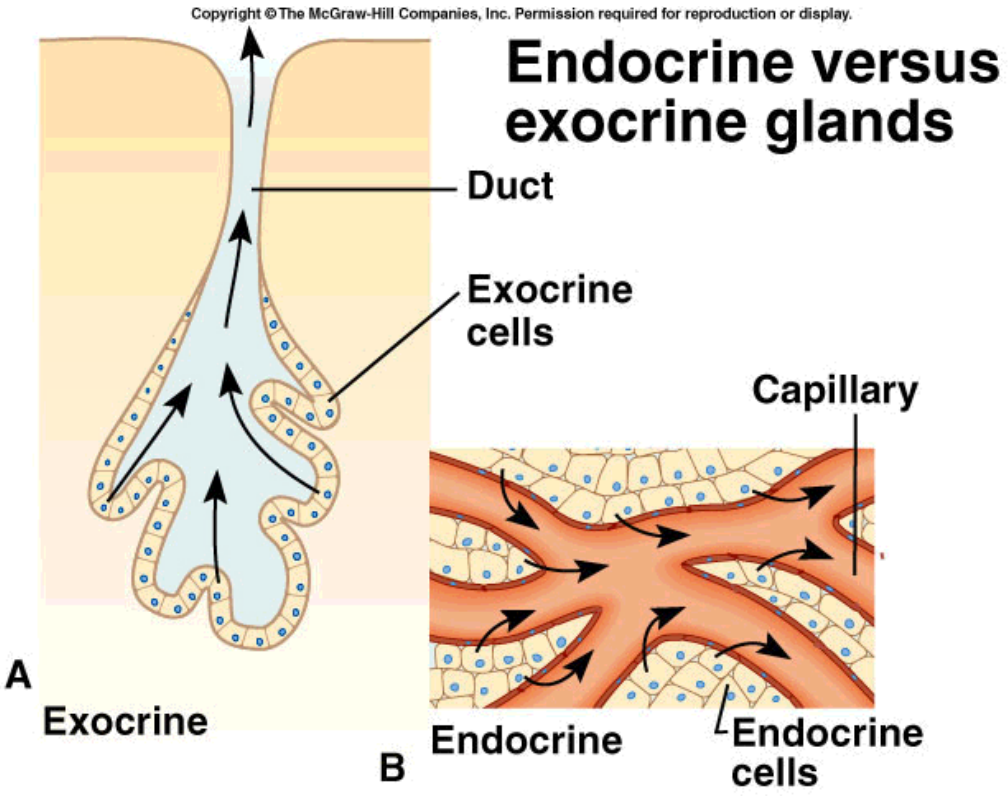
Endocrine vs. Exocrine glands

Endocrine glands

- Release substances into the blood directly
  - Ex. Pituitary gland

Exocrine glands

- Release substances into **ducts**
  - Ex. Salivary glands and sweat glands



Pancreas

The pancreas is an endocrine and an exocrine gland.

Exocrine - Secretion of digestive enzymes into small intestine

Endocrine - Secretion of hormones (eg. insulin and glucagon) directly into blood.

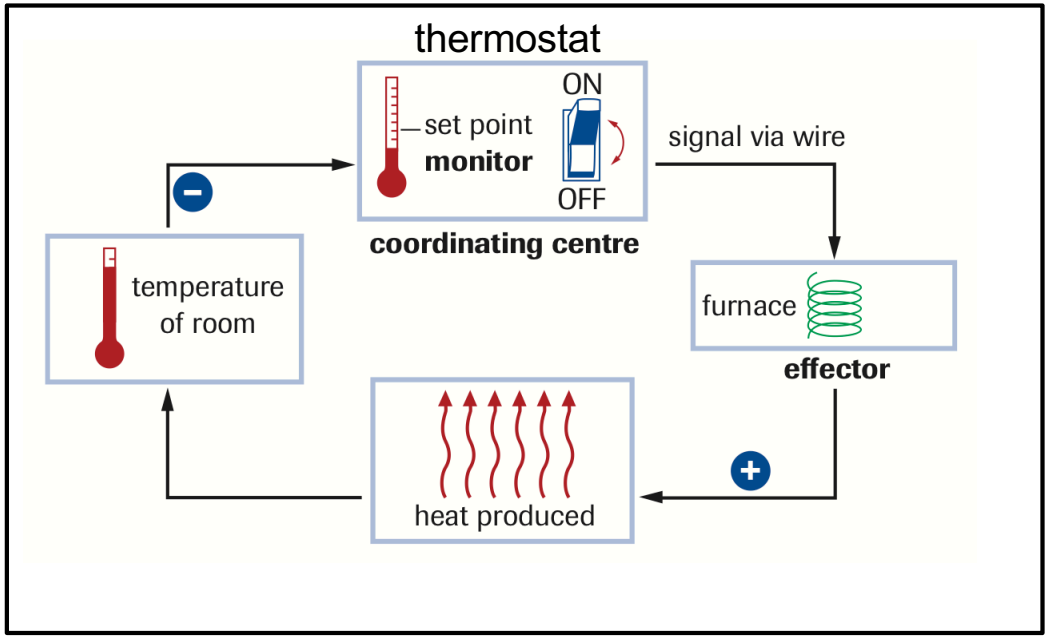
Feedback Loops

NEGATIVE FEEDBACK LOOP (not a bad thing)

-mechanisms that make adjustments to bring the body back into an acceptable range

-a control mechanism is used to counteract further change (ie. the thermostat prevents the furnace from staying on once the temp. has been hit)

-our bodies mostly use this type of feedback



Negative Feedback Loop

Feedback Loops

NEGATIVE FEEDBACK EXAMPLES

The following are all trying to get back to a "NORMAL"

Body temperature - The hypothalamus of a human responds to temperature fluctuations and responds accordingly. If the temperature drops, the body shivers to bring up the temperature and if it is too warm, the body will sweat to cool down due to evaporation.

Blood pressure - When blood pressure increases, signals are sent to the brain from the blood vessels. Signals are sent to the heart from the brain and heart rate slows down, thus helping blood pressure to return to normal.

Blood Sugar- When blood sugar rises, insulin sends a signal to the liver, muscles and other cells to store the excess glucose. Some is stored as body fat and other is stored as glycogen in the liver and muscles.

Production of human red blood cells (erythropoiesis) - A decrease in oxygen is detected by the kidneys and they secrete erythropoietin. This hormone stimulates the production of red blood cells which will increase oxygen.

Feedback Loops

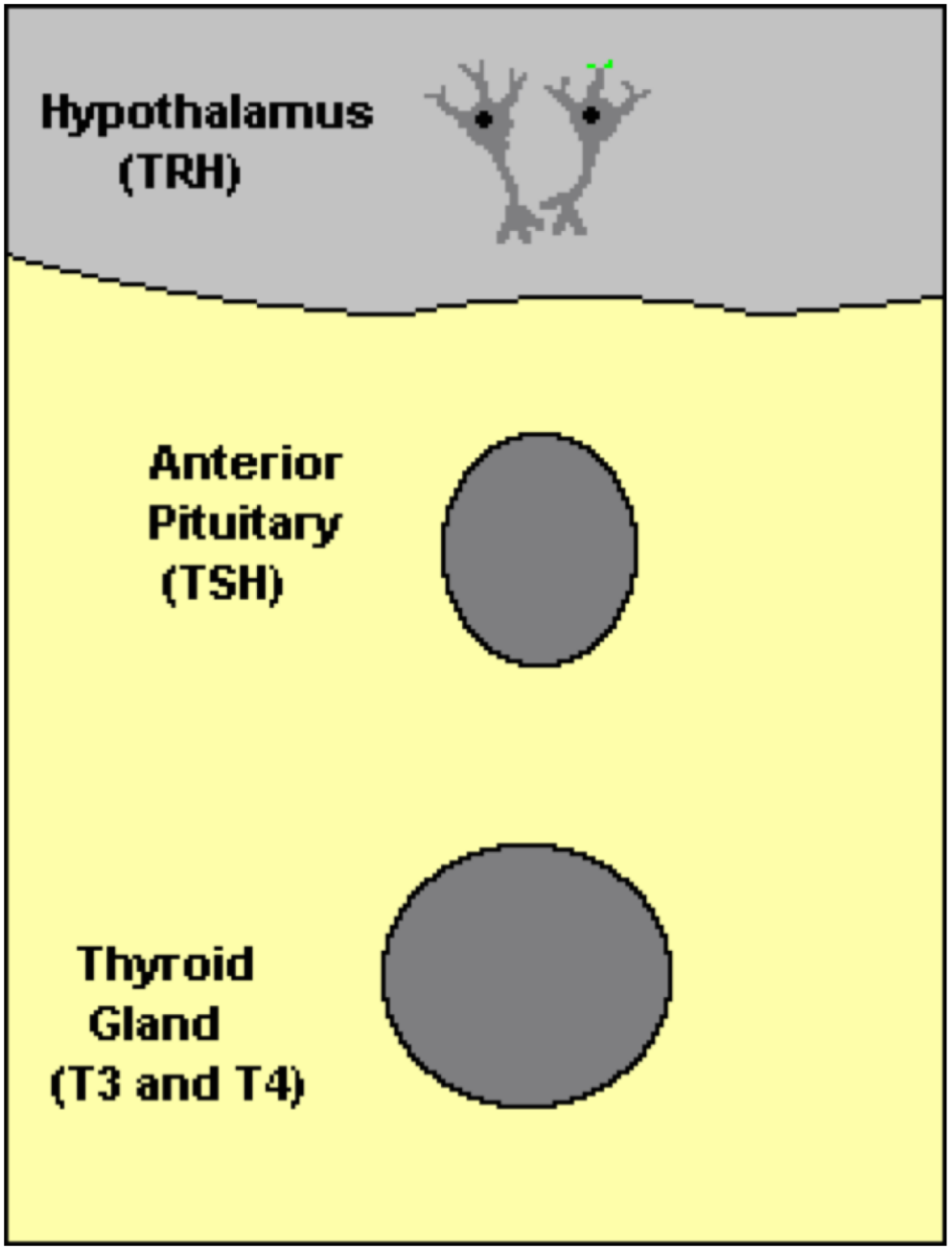
Yes there is a positive feedback loop but more rare!!

POSITIVE FEEDBACK LOOP
-a small effect is **amplified** until the desired effect is accomplished

(eg) giving birth (oxytocin keeps on being released into the body until the baby is born)

(eg) body keeps sending more and more platelets to clot a bleeding cut until the cut is sealed

Negative Feedback Loop



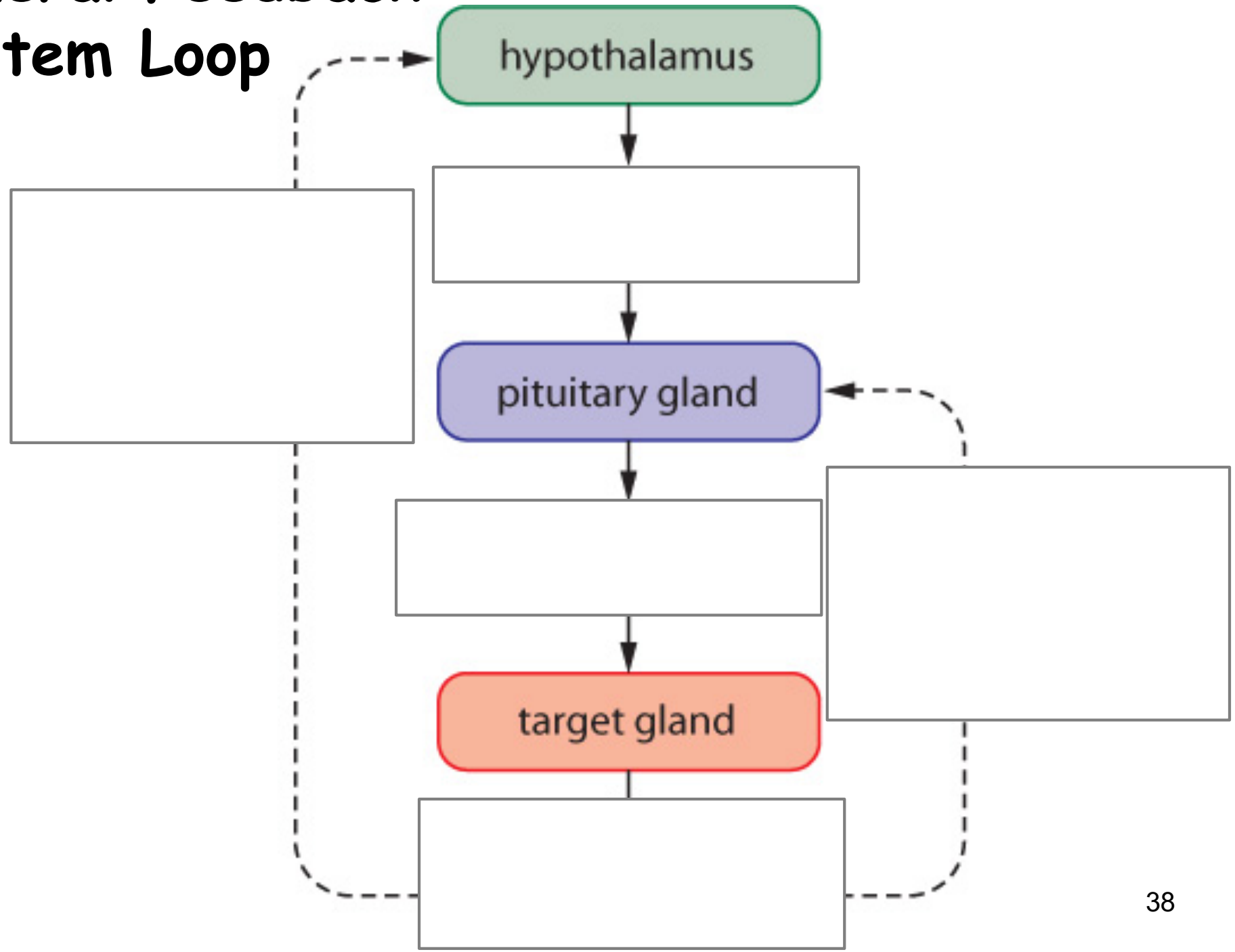
Negative feedback or feedback inhibition

- Prevents **chemical imbalances** in the body
- Once a hormone produces the desired effect, hormone production must **decrease**
- Important in maintaining **homeostasis**

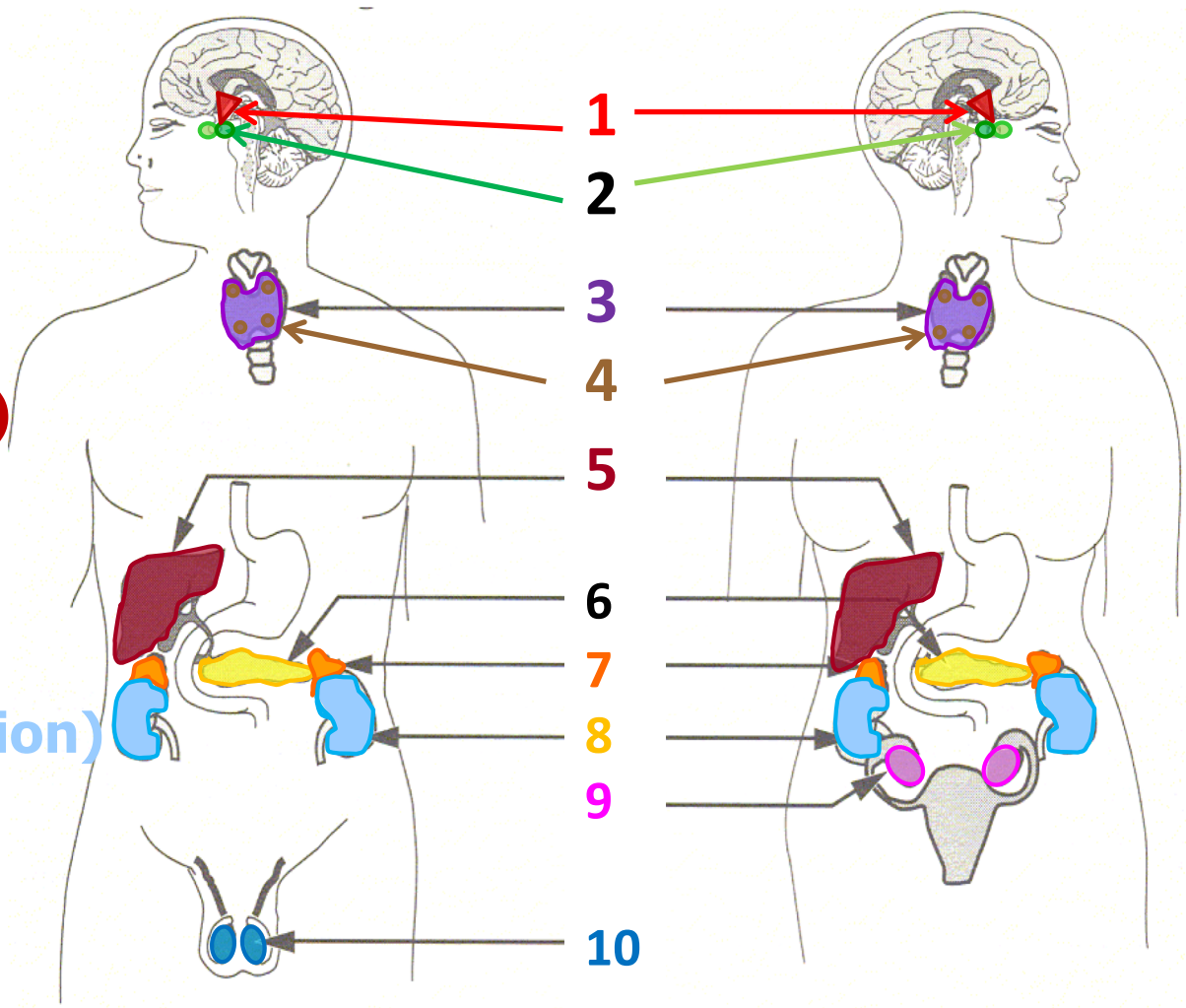
The feedback that inhibits the release of a hormone can be…

- **an inhibiting hormone** (ie) inhibin used to stop production of testosterone or high amounts of estrogen will inhibit FSH release
- **receptors that sense a change** (ie.) Change in blood pressure
  Change in blood glucose
- **high hormone level.** (ie)High ACTH will inhibit hypothalamus from sending messages to the pituitary to release more ACTH
- (ie) high TSH will inhibit hypothalamus…

General Feedback System Loop



1. Hypothalamus
2. Pituitary Gland
3. Thyroid gland
4. Parathyroid
*5. Liver (stores glucose)
6. Pancreas
7. Adrenal Gland
*8. Kidney (water regulation)
9. Ovary
10. Testes



* Are not endocrine glands, but are target tissue for hormones.

- COMPLETE WORKBOOK

  PAGE 3 and 4

Check Your Understanding

1) How is the endocrine system like a “lock and key” mechanism?

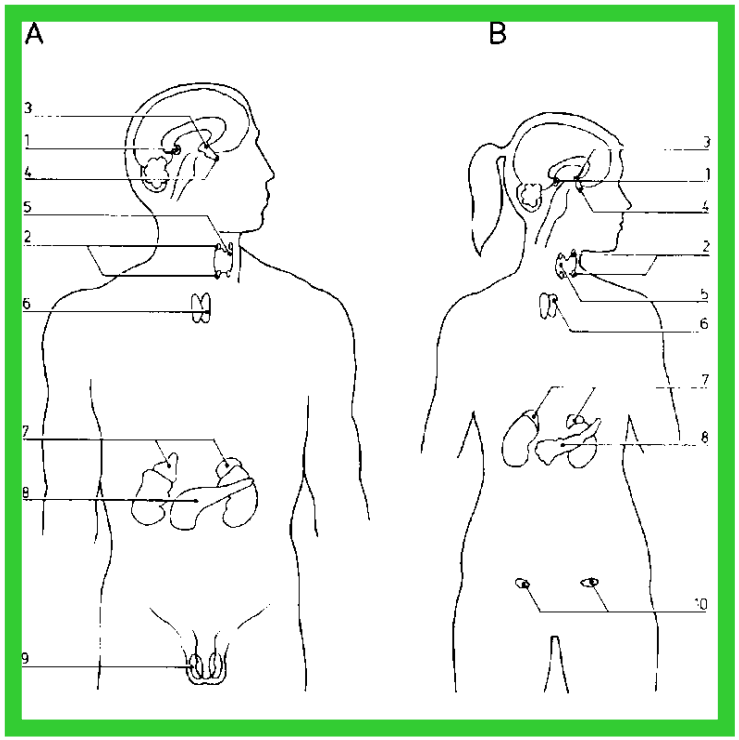
2) What are two categories hormones can be classified as?

3) Compare TROPIC vs NON-TROPIC

4) What is a “negative feed back loop”?

5) Compare exocrine vs endocrine?

6) What organ has both exocrine and endocrine function?



Endocrine System Video- bozeman

(Disregard info on Pineal gland. Do not need to know that.)

http://www.youtube.com/watch?v=-S_vQZDH9hY&safety_mode=true

The Hypothalamus and Pituitary

The hypothalamus CONTROLS the release of hormones from two lobes:

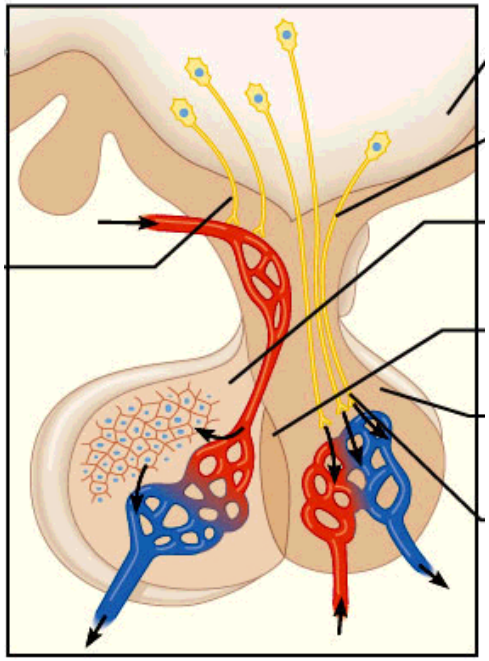
a) posterior pituitary by **nerve impulses**

b) anterior pituitary by **Releasing Hormones (RH or RF)**
aka (releasing factors) and also **inhibiting factors (IF)**

HYPOTHALAMUS

CONTROLS ANTERIOR PITUITARY

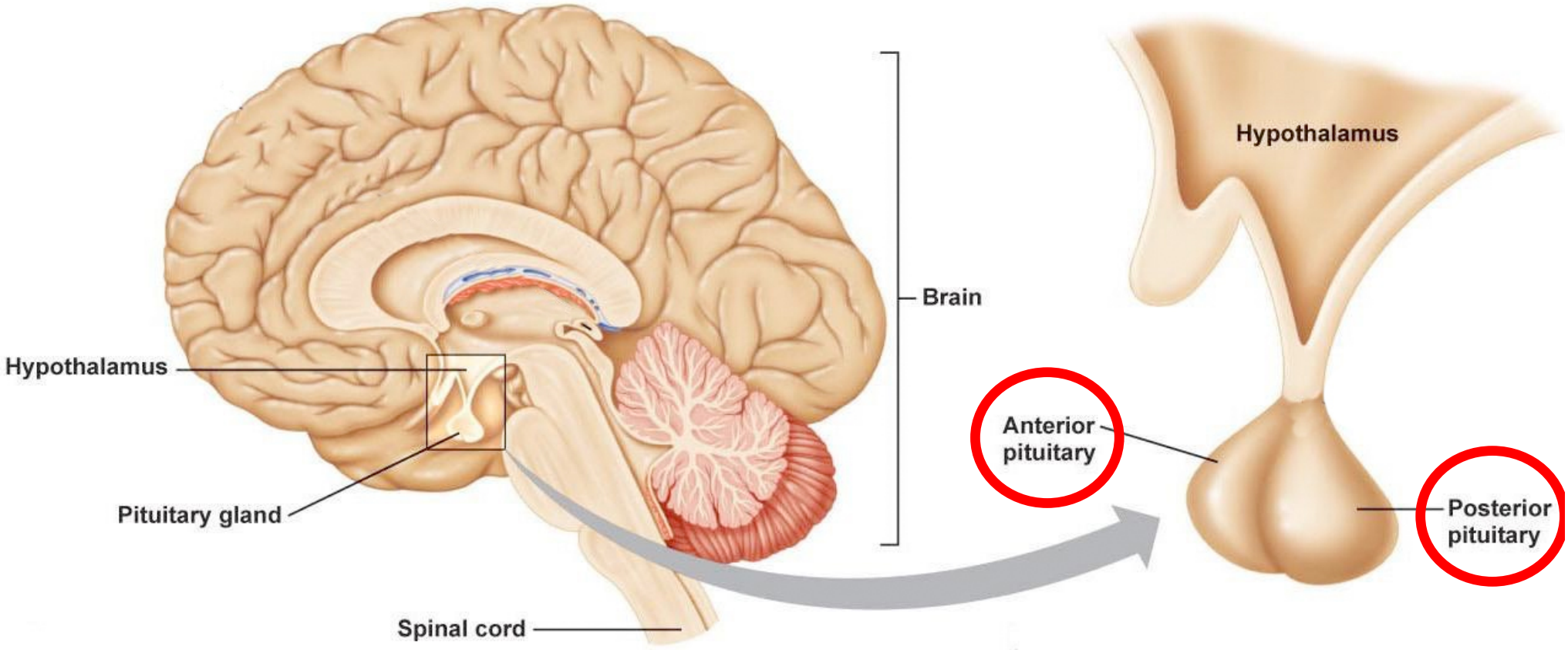
by using HORMONES



CONROLS POSTERIOR PITUITARY

by using NEURONS

The pituitary gland

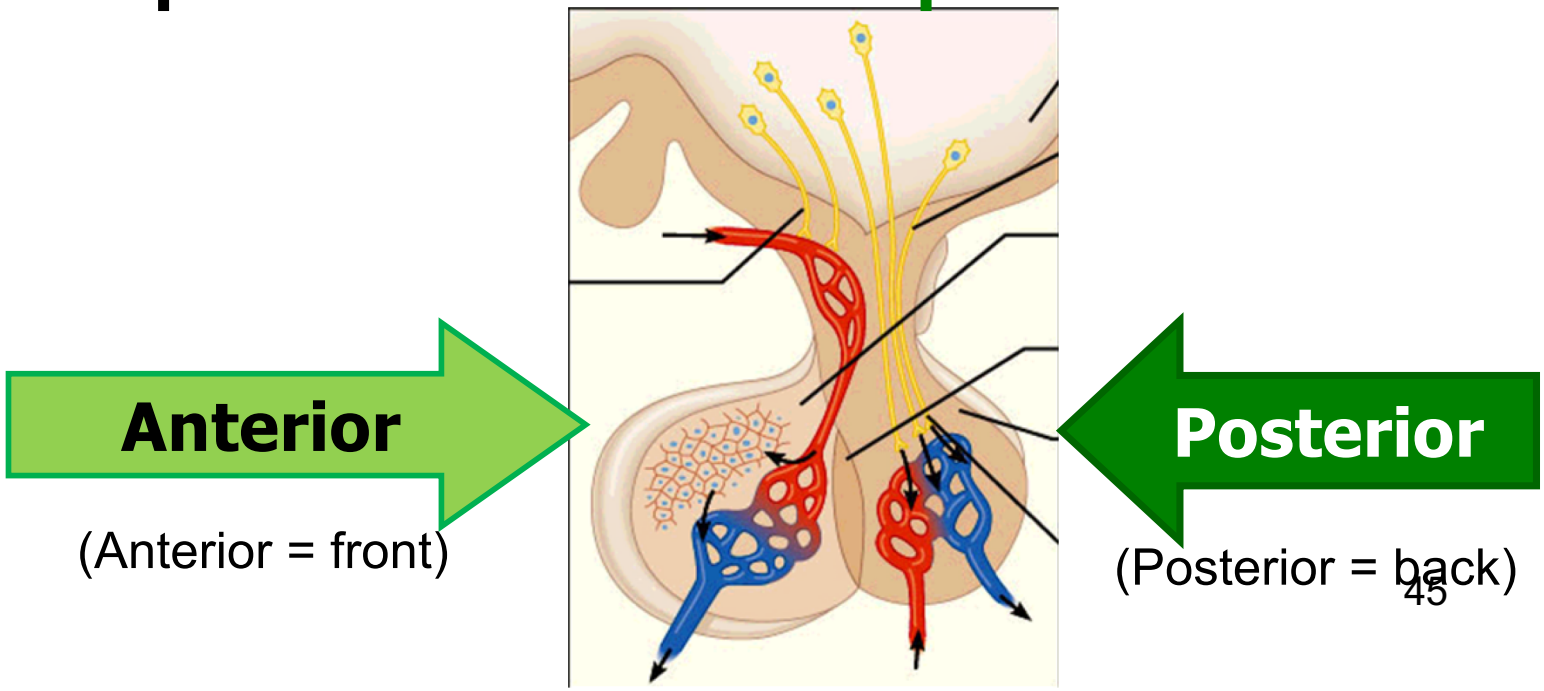


The pituitary gland

- The pituitary gland controls most of the other glands in the body
  - By sending out hormones that affect those glands, in other words

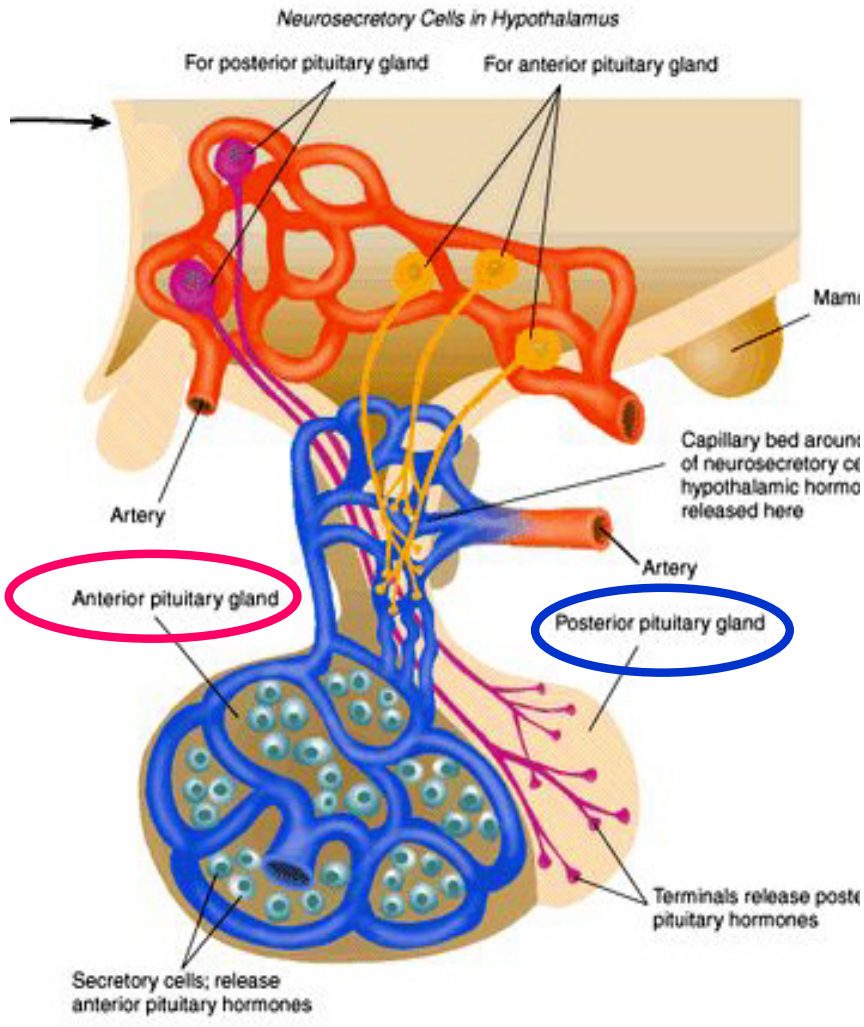
    it releases tropic hormones to control glands!!!

Made up of two parts – anterior and posterior lobes



The pituitary gland

- **Anterior lobe <u>produces</u> 6 hormones,** which are released into the blood stream
- **Posterior lobe <u>stores</u> 2 hormones** (produced in hypothalamus) which are released into the blood stream
  1) **Antidiuretic hormone (ADH)**
  2) **Oxytocin**



Generally our body wants to keep that perfect balance of hormones but sometimes things may go awry…

HYPOsecretion
vs
HYPERsecretion

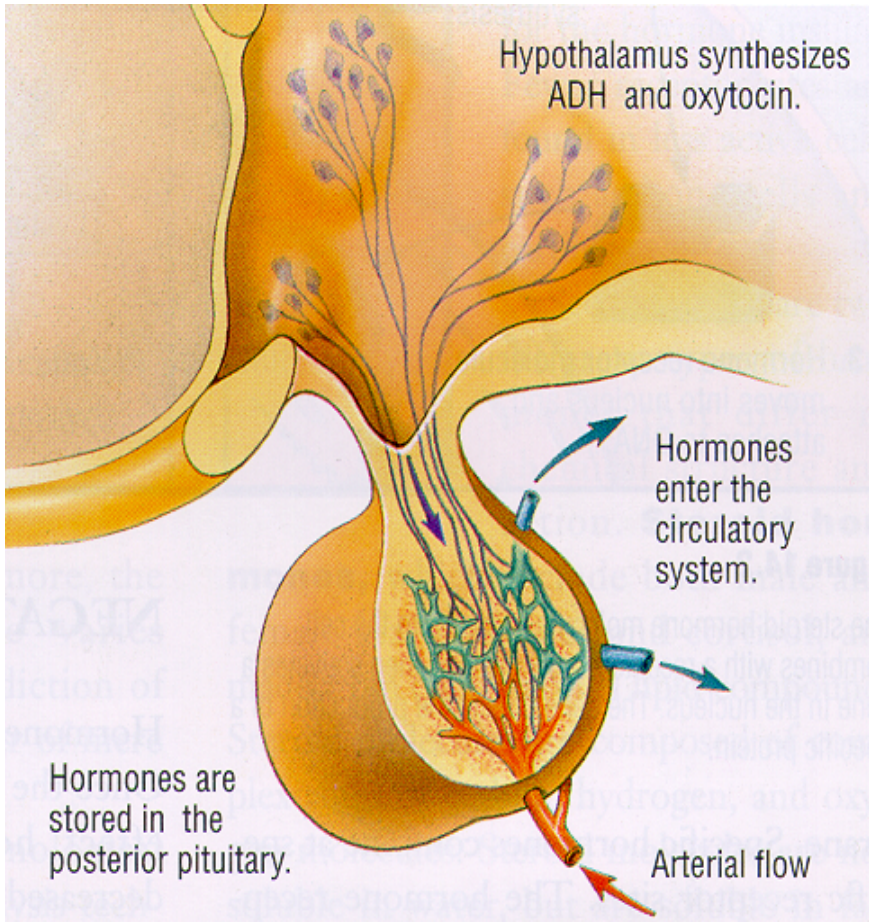
Hyposecretion: production of too little of a hormone
-results in lack of target cell response
(cells don't respond enough
Hypersecretion: production of too much of a hormone

Posterior Pituitary

STORES

ADH **Oxytocin**

MADE BY
Hypothalamus



Posterior lobe – ADH (Antidiuretic hormone)

- **Released in <u>response</u> to dehydration (thirsty)**
  (ADH released when blood plasma too thick)
- **<u>Production site</u>:** hypothalamus
  (stored in the posterior pituitary)
- **<u>Target:</u>** kidneys (and blood vessels)
- **<u>Function</u>:** increases water reabsorption by the kidneys, to increase **blood pressure**

Other Effects: **Urine output DECREASES**

Urine concentration INCREASES

Blood solute concentration DECREASES
(stuff in the fluid)

- **Hypersecretion:**(too much) abnormal water retention
- **Hyposecretion:** (too little) **diabetes insipidus** (urinate more often)

Posterior Lobe - Diabetes insipidus

(this is NOT the diabetes associated with blood sugar)

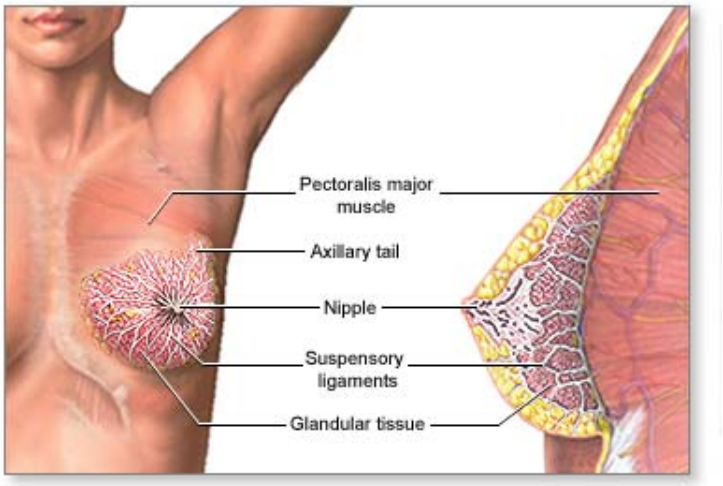
- Caused by decreased secretion of ADH or incorrect receptors for ADH in kidney.

- Symptoms:
  - excessive urination (up to 16 liters a day)
  - excessive thirst

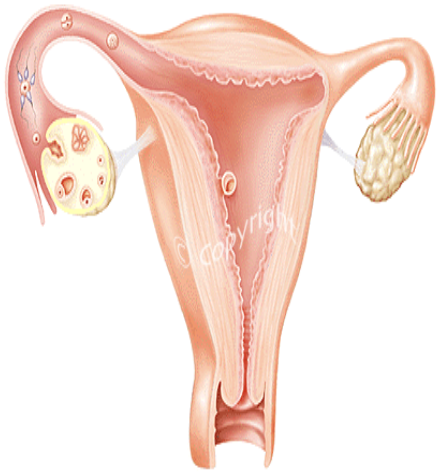
Diabetes insipidus is a disorder in which the body fails to produce sufficient ADH. One symptom of this disorder that is directly related to ADH secretion is

A. the production of large amounts of dilute urine
B. a decrease in the glucose concentration in the blood
C. an increase in the glucose concentration in the urine
D. the production of small amounts of concentrated urine

Posterior lobe - OXYTOCIN



adam.com



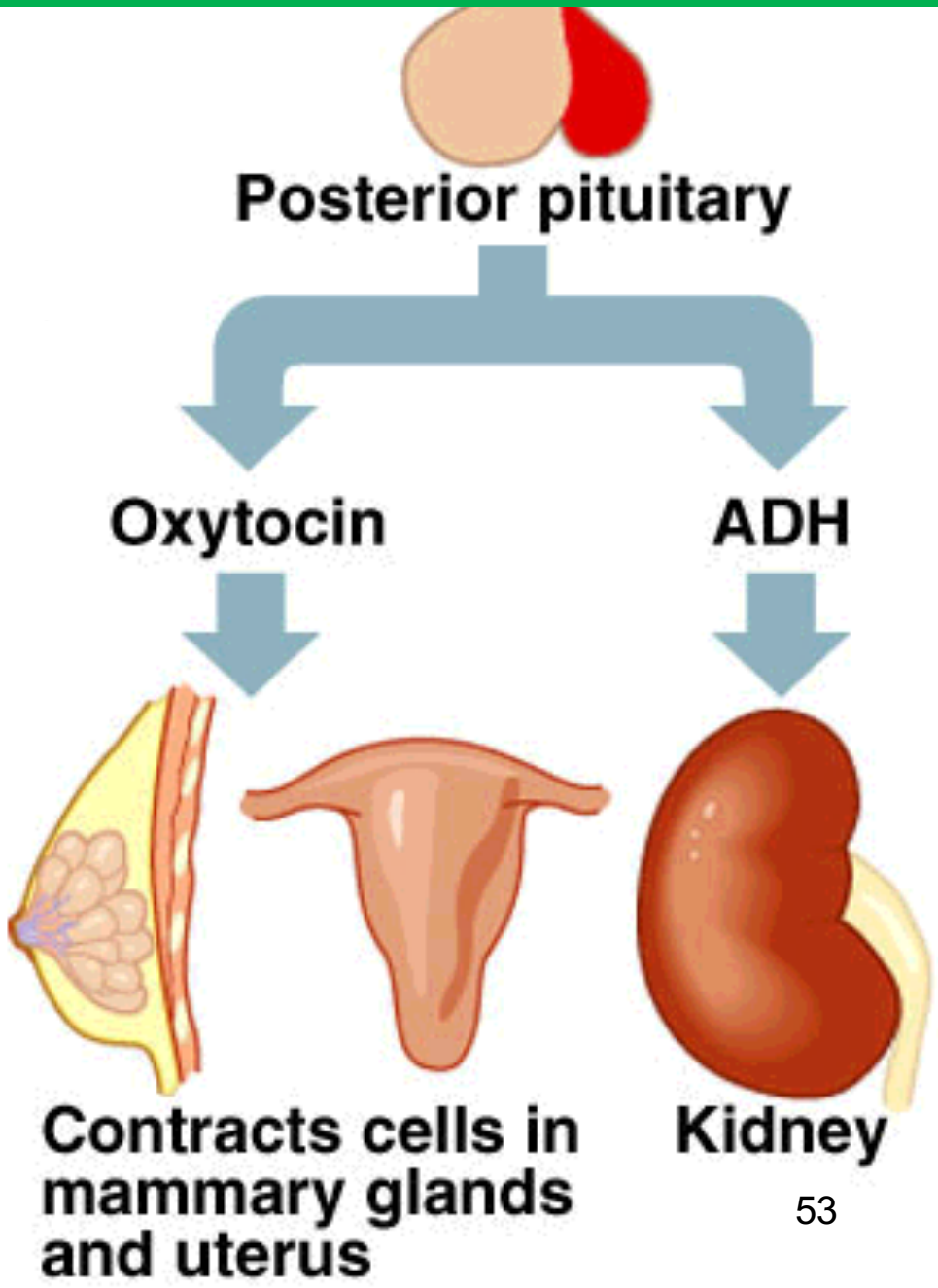
- **Production site: hypothalamus** (stored in the posterior pituitary)
- **Targets: uterus and mammary glands**
- **Functions: initiates contractions**

- **Hyposecretion:** prolonged or difficult birth
- **Hypersecretion:** inappropriate ejection of milk

SUMMARY Posterior Pituitary

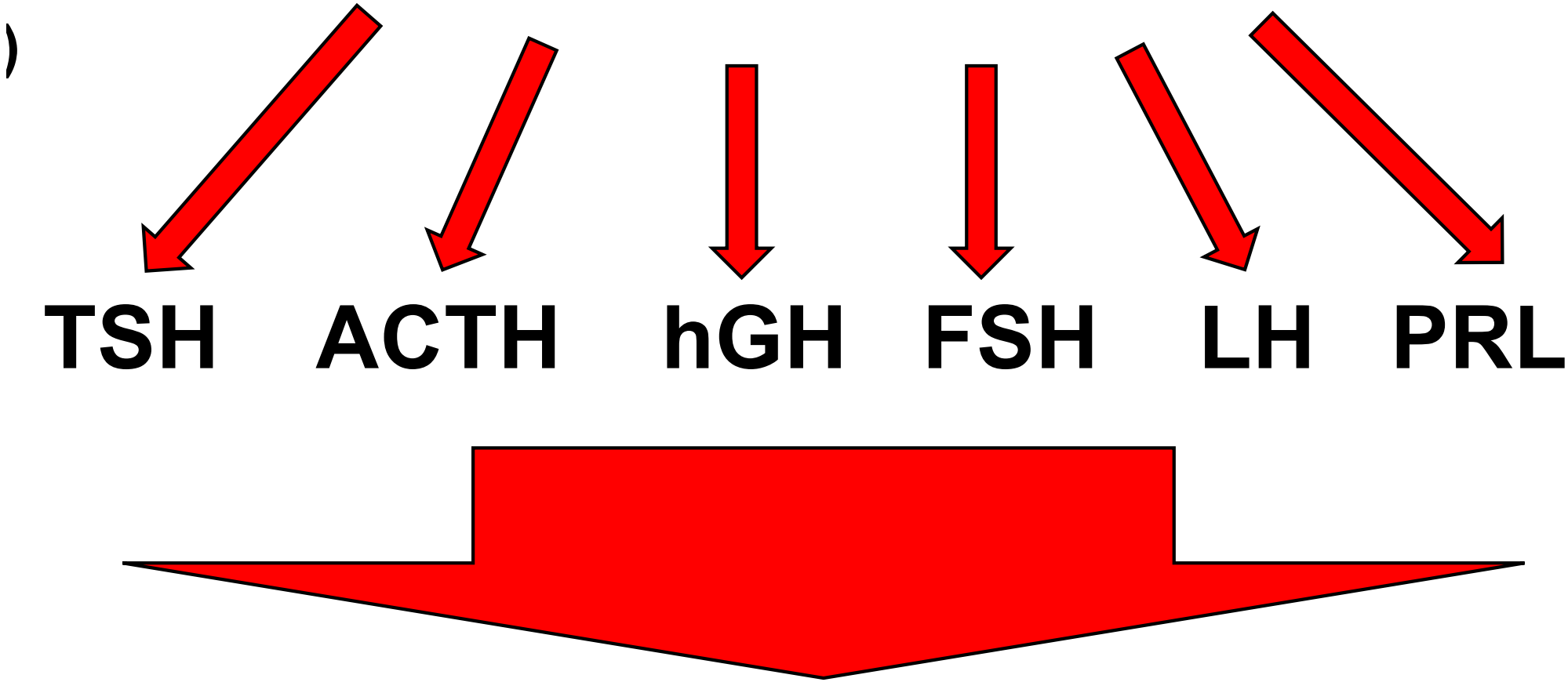
Remember:

1: what the hormones are,
2: where they are produced,
3: target organ, and
4: function (what they do)



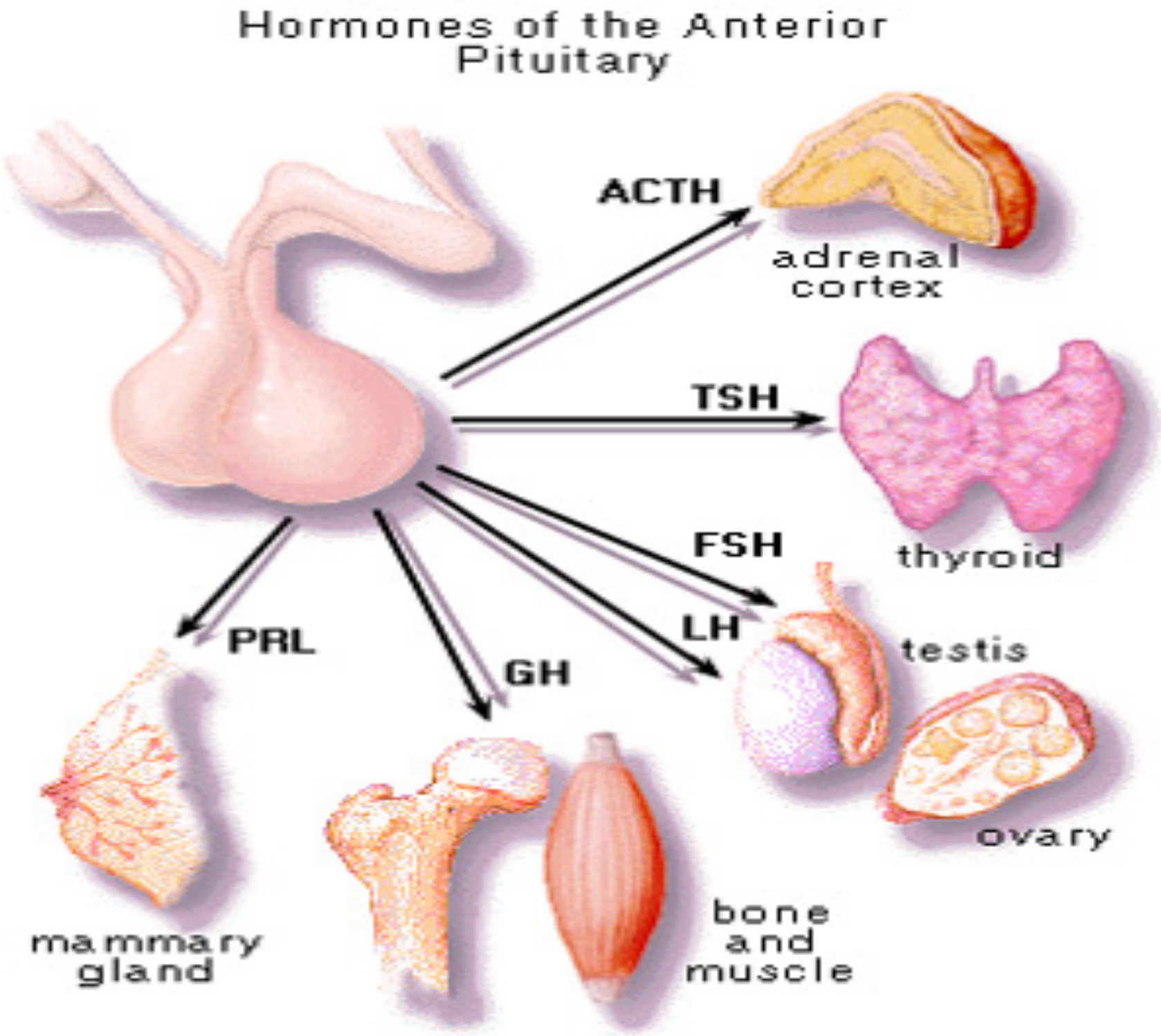
ANTERIOR PITUITARY

PRODUCES



TSH ACTH hGH FSH LH PRL

REGULATED BY
Hypothalamus

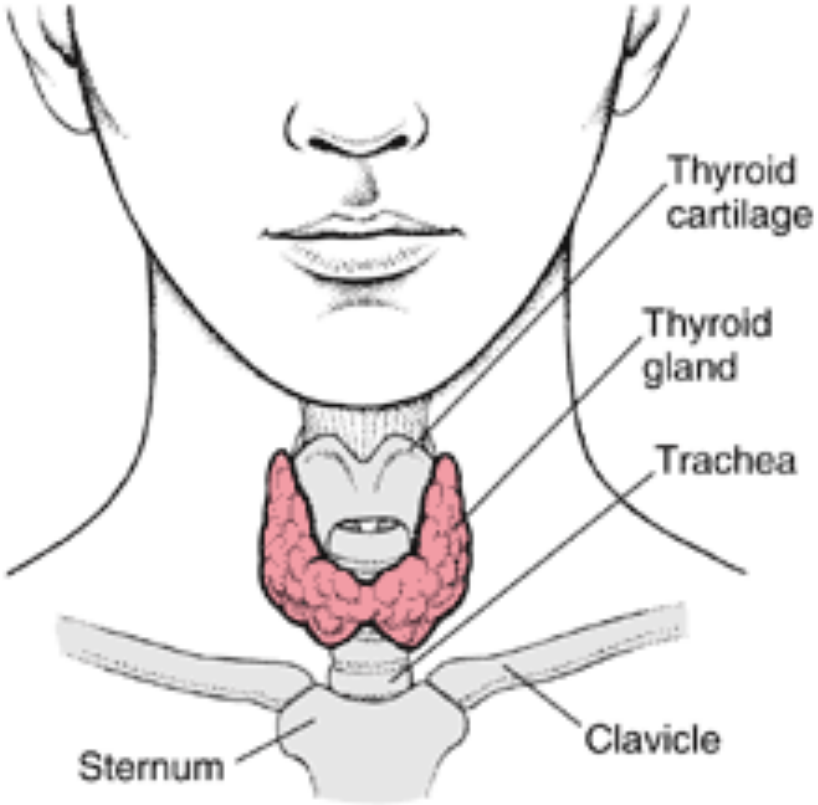

Hormones of the Anterior Pituitary
ACTH
adrenal cortex
TSH
thyroid
FSH
LH
testis
ovary
PRL
mammary gland
GH
bone and muscle

- COMPLETE WORKBOOK
  PAGE 5

ANTERIOR PITUITARY
Thyroid stimulating hormone (TSH)

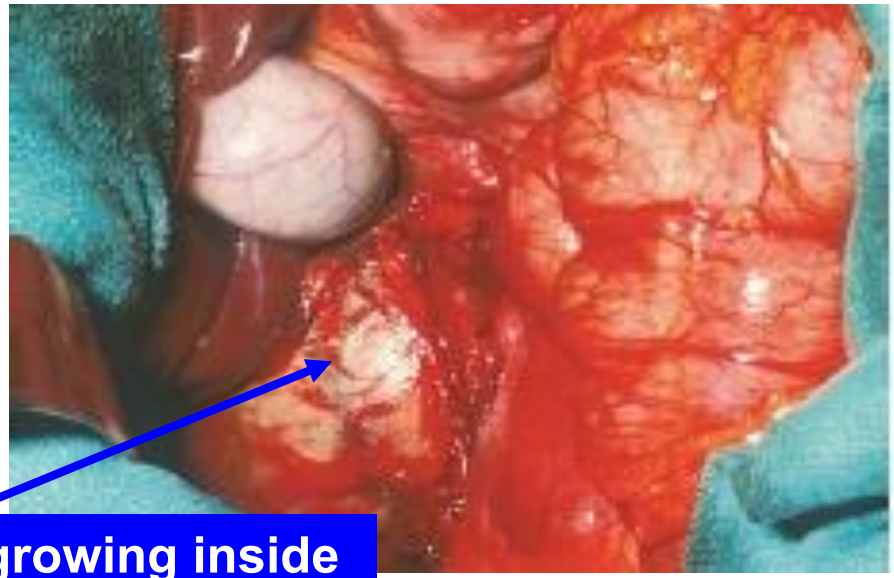
- **Production site:** anterior pituitary
- **Targets** the **thyroid gland**
- **stimulates** thyroid gland to produce **thyroxine**

(increases metabolism and regulates growth)

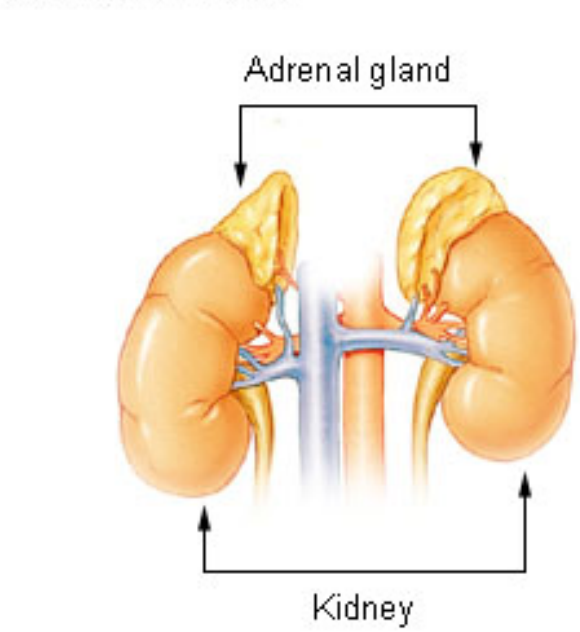


ANTERIOR PITUITARY
Adrenocorticotropic hormone (ACTH)

- **Production site: anterior pituitary**
- **Targets** the **adrenal cortex**
- **stimulates** the release of stress hormones **aldosterone**(water retention) **& cortisol** (provide blood glucose to deal with elevated energy requirements)



Tumor growing inside the adrenal cortex



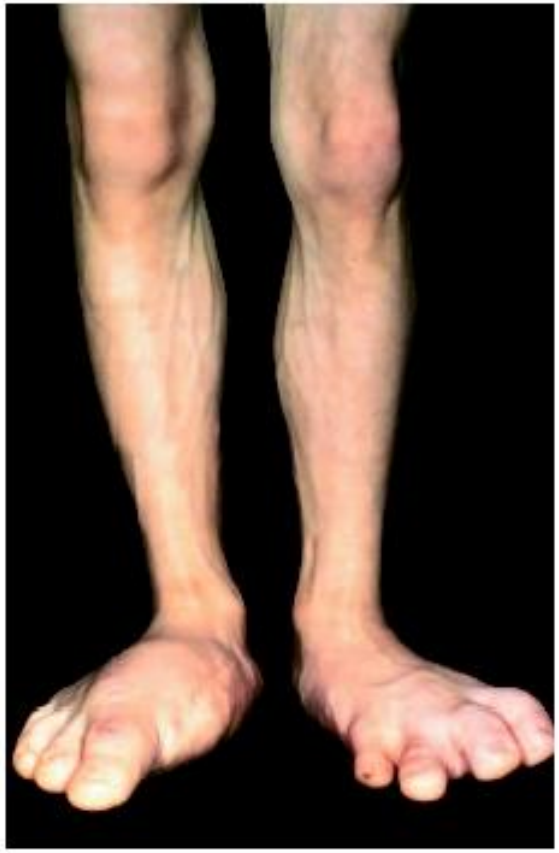
ANTERIOR PITUITARY
human growth hormone (hGH) aka somatotropin

- **Production site:** anterior pituitary
- **Targets** most cells
  (bones and muscles)
- **Promotes** growth

- **Hyposecretion:** dwarfism
- **Hypersecretion:** gigantism (child) or acromegaly (adult)

ANTERIOR PITUITARY
Gigantism

Due to the continuous production or over production of the growth hormone



https://www.youtube.com/watch?v=5McWw03Ryrs

“General Tom Thumb”
and
Livia Warren

ANTERIOR PITUITARY
human growth hormone (hGH)

- Can affect cartilage and bone cells

- **Acromegaly is broadening of facial features, hands and feet**
  - excess hGH can **no longer cause an increase in height**, so the bones and soft tissues of the body widen. Thus, over time, the face widens, the ribs thicken and the feet and hands enlarge. There are also some health consequences due to acromegaly.

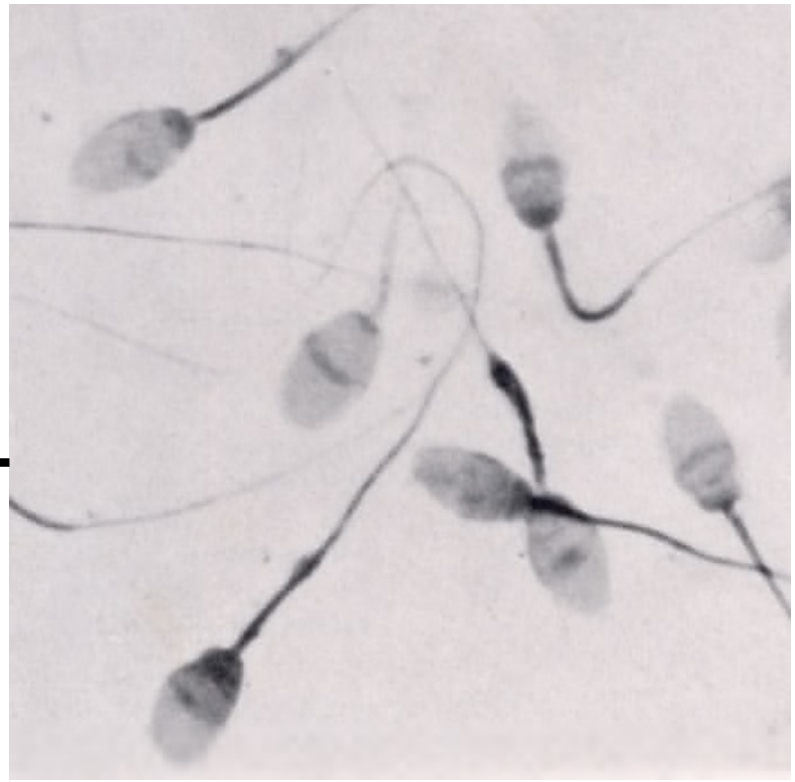
A B C

Kosen is 31 years old, and hails from Turkey. Dangi is 75 and comes from Nepal.

Sultan Kosen, a towering 8 feet, three inches tall (2.5m) shook hands with Chandra Bahadur Dangi, just 21.5 inches tall (55 cm)

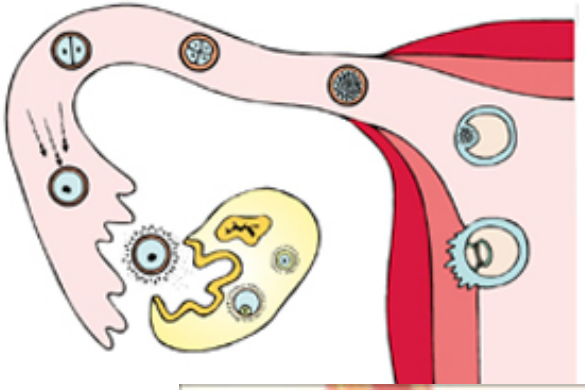
ANTERIOR PITUITARY
Follicle stimulating hormone (FSH)

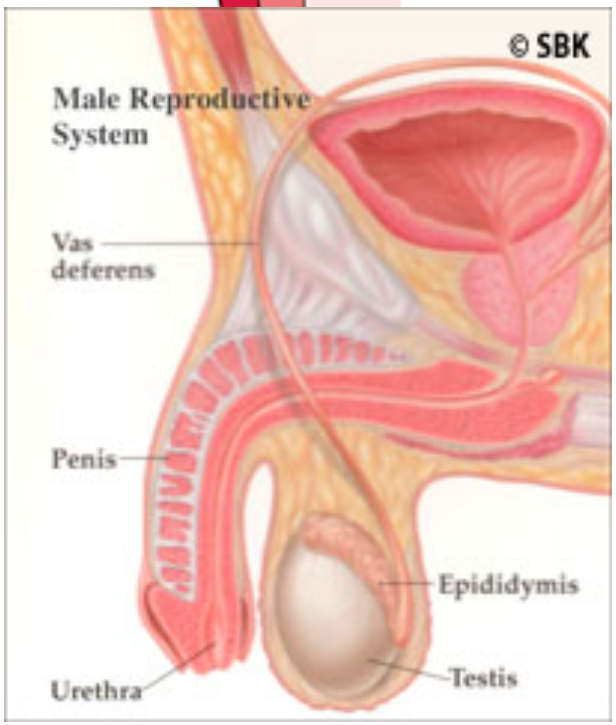
- **Production site:** anterior pituitary
- **Targets** the **ovaries and testes to undergo meiosis cell division**
- **Function:** Stimulates follicle development **production of eggs and estrogen in ovaries; and sperm in testes**



- **Hyposecretion:** inhibits sexual development, causes **sterility**

ANTERIOR PITUITARY
Luteinizing hormone (LH)





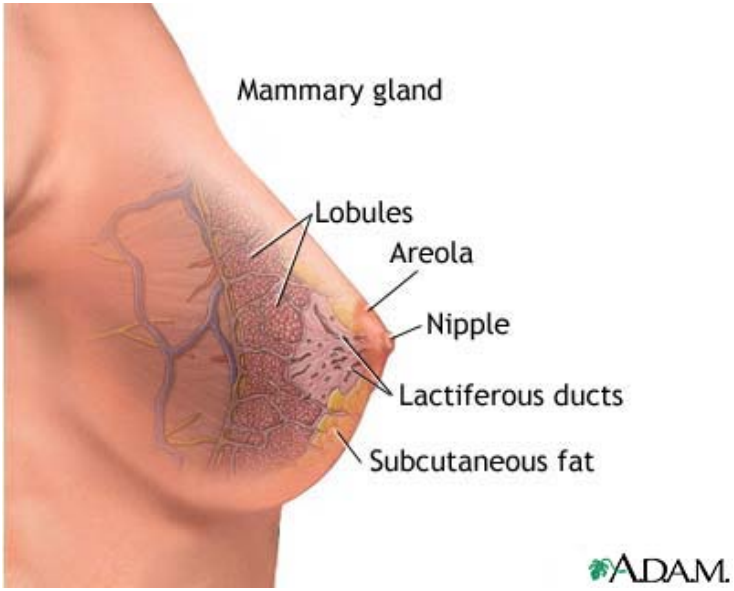
- **Production site**: anterior pituitary
- **Targets** the **ovaries and testes**
- **Functions:** Stimulates **ovulation (release of egg) and progesterone and estrogen production in females and testosterone production in males**

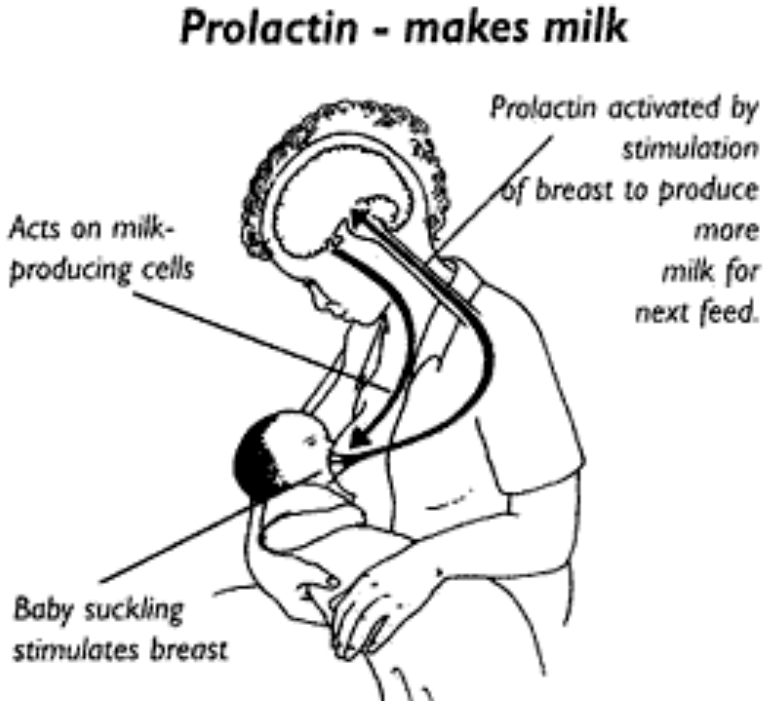
- **Hyposecretion:** inhibits sexual development, causes **sterility**

ANTERIOR PITUITARY
Prolactin (PRL)

- **Production site**: anterior pituitary
- **Stimulated** by baby suckling on breast
- **Targets** the **mammary glands**
- **Function**: stimulates and **maintains**

milk production in females





How to Remember the Pituitary Hormones:

GH(hGH)

Posterior pituitary
- **O**xytocin
- **A**DH

TSH

FSH

LH

ACTH

PRL (prolactin)

- COMPLETE WORKBOOK
  PAGE 6

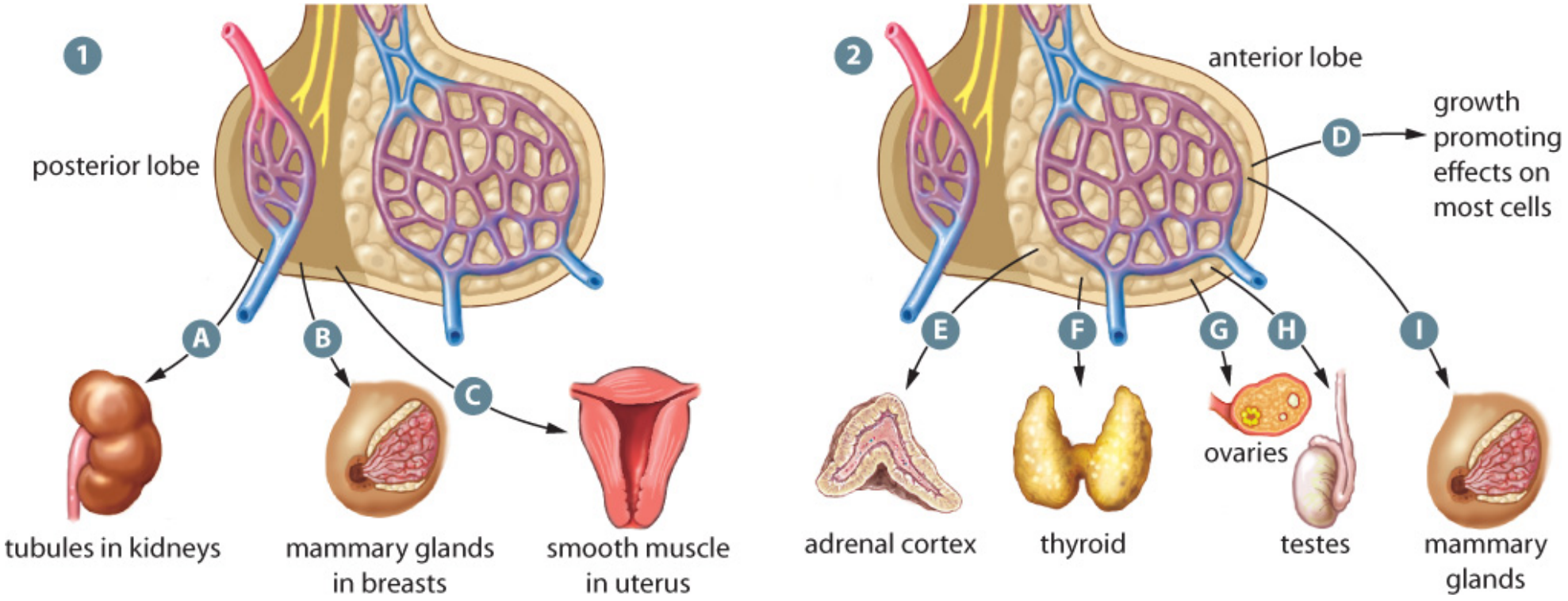
COMPLETE VOCABULARY

Hormone	Target	Primary Function
Anterior Lobe		
Thyroid **S**timulating Hormone (**TSH**)	Thyroid gland	Stimulates release of thyroxine from thyroid. Thyroxine regulates cell metabolism
Adreno**C**orticotropic **H**ormone (**ACTH**)	Adrenal cortex	Stimulates the release of hormones involved in stress responses.
human **G**rowth **H**ormone (h**GH**)	Most cells	Promotes growth.
Follicle **S**timulating **H**ormone **(FSH**)	Ovaries, testes	In females, stimulates follicle development in ovaries. In males, promotes the development of sperm cells in tissues

Hormone	Target	Primary Function
Anterior Lobe		
Luteinizing **H**ormone (**LH**)	Ovaries, testes	In females, stimulates ovulation and formation of the corpus luteum. In males, stimulates production of the sex hormone, testosterone.
Prolactin (**PRL**)	Mammary glands	Stimulates and maintains milk production in females

Hormone	Target	Primary Function
Posterior Lobe		
Oxytocin	Uterus Mammary Glands	Initiates strong contractions. Triggers milk production.
Anti**D**iuretic **H**ormone (**ADH**)	Kidney	Increases water reabsorption by kidneys.

Pituitary Hormone Review



A: ADH
B: Oxytocin
C: Oxytocin
D: hGH

E: ACTH
F: TSH
G: FSH & LH
H: FSH & LH

I: PRL

Check your understanding

1. What part controls the pituitary?
2. The Pituitaries lobes are each controlled a different way. Explain.

3. Where is the posterior pituitary in relation to the anterior pituitary?
4. What are the hormones of the posterior pituitary?

5. What are the hormones of the anterior pituitary?

6. What is a releasing hormone and where does it come from?

7. Compare hypo-secretion vs hyper-secretion.

BOOKLET 2

TARGET GLANDS

1) Thyroid gland
2) Parathyroid gland
3) Adrenal gland

Learner outcomes…
What you need to know!

- describe the function of the hormones of the principal endocrine glands, i.e., thyroid-stimulating hormone (TSH)/thyroxine, calcitonin/parathyroid hormone (PTH), adrenocorticotropic hormone (ACTH)/cortisol, glucagon/insulin, human growth hormone (hGH), antidiuretic hormone (ADH), epinephrine, aldosterone, and describe how they maintain homeostasis through feedback

Learner outcomes…
What you need to know!

- explain the metabolic roles hormones may play in homeostasis; i.e., thyroxine in metabolism; insulin, glucagon and cortisol in blood sugar regulation; hGH in growth; ADH in water regulation; aldosterone in sodium ior regulation
- explain how the endocrine system allows humans to sense their internal environment and respond appropriately; *e.g., calcium balance, osmotic pressure of blood*

Terms you need to know

Thyroxine

Calcitonin

Hyperthyroidism

Hypothyroidism

Goiter

Thyroid

Parathyroid

Terms you need to know

PTH

Adrenal Medulla

Adrenal Cortex

Epinephrine

Aldosterone

Cortisol

THYROID GLAND

- Located at the base of the **neck**, in front of the trachea
- Stimulated by **TSH** from the **anterior pituitary to release thyroxine**

Produces 2 important hormones:

- **Thyroxine (T^4)** and **calcitonin**

1) Thyroxin **increases metabolism**

(how fast we **burn calories**)

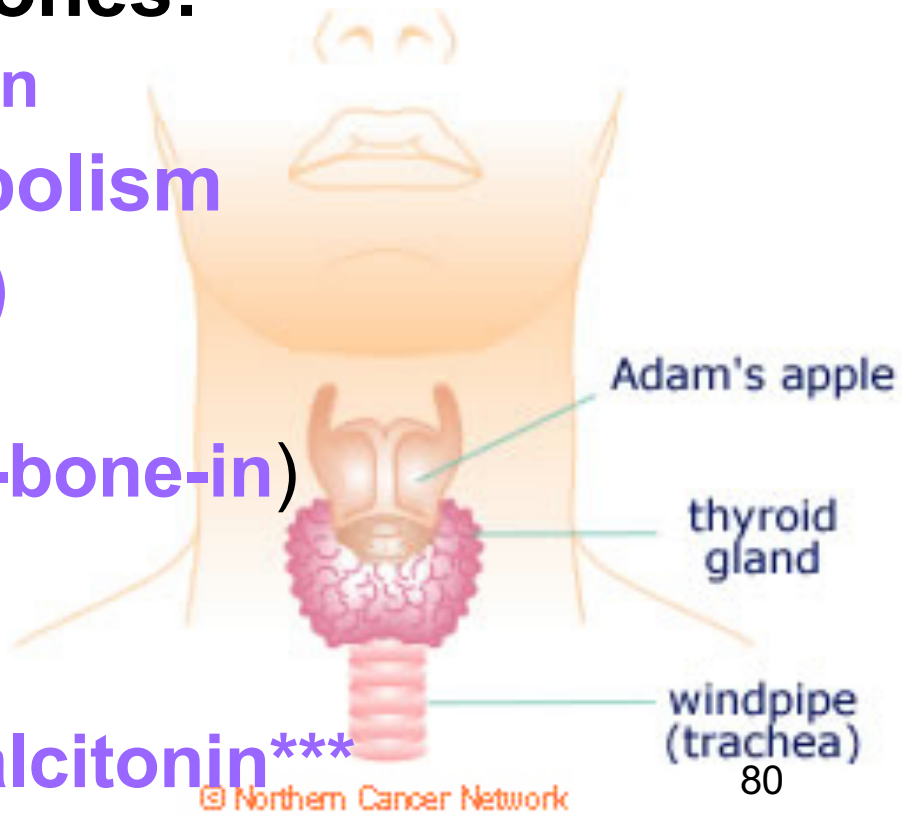
-stimulated by TSH

2) Calcitonin (rhymes with **calci-bone-in**)

lowers blood calcium by putting

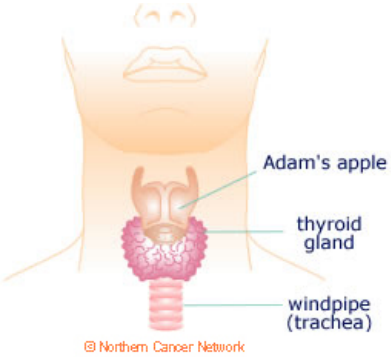
calcium **into** bones

*****TSH DOES NOT stimulate calcitonin*****



THYROID GLAND

Thyroxine (T_4)



Target: the **body cells**

Function: increases rate of **metabolism,** which is the rate at which the body **converts glucose into energy**

= cellular respiration

oxygen + glucose → carbon dioxide + water + ATP

**Would thyroxine increase or decrease blood glucose?

It would **decrease** it because it is converting it into ATP!!!

THYROID GLAND- DISORDERS

Thyroxine (T_4)

- **Hypersecretion**: **Hyperthyroidism** – high metabolic rate, can't sit still, always warm, and tend to be thin , **Grave's** disease

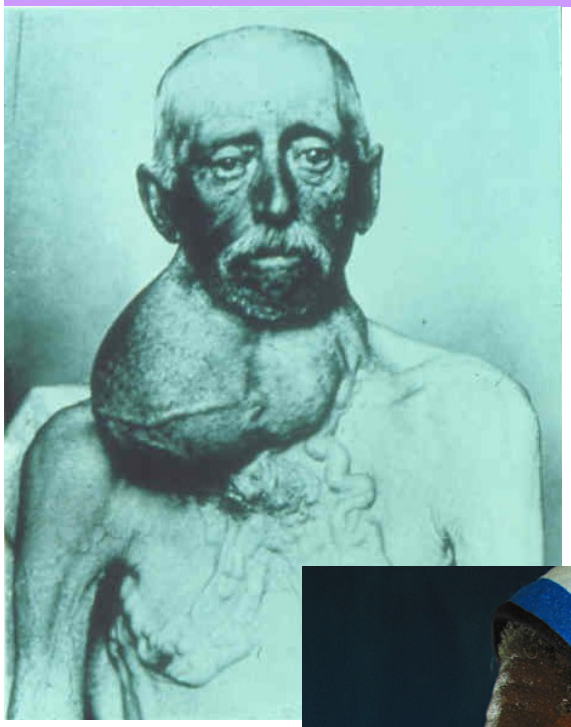
Grave's Disease: a severe state of **hyperthyroidism** that results in the thyroid gland **to produce too much thyroxine.**

- Some symptoms include: anxiety, irritability, heat sensitivity, weight loss, goiter, bulging eyes

- **Hyposecretion: Hypothyroidism** – low metabolic rate, less energy, intolerant of cold, dry skin and gain weight,

  cretinism – children with hypothyroidism can be short, stocky and have mental development delays

THYROID GLAND
Disorder: Goiter (insufficient dietary iodine)

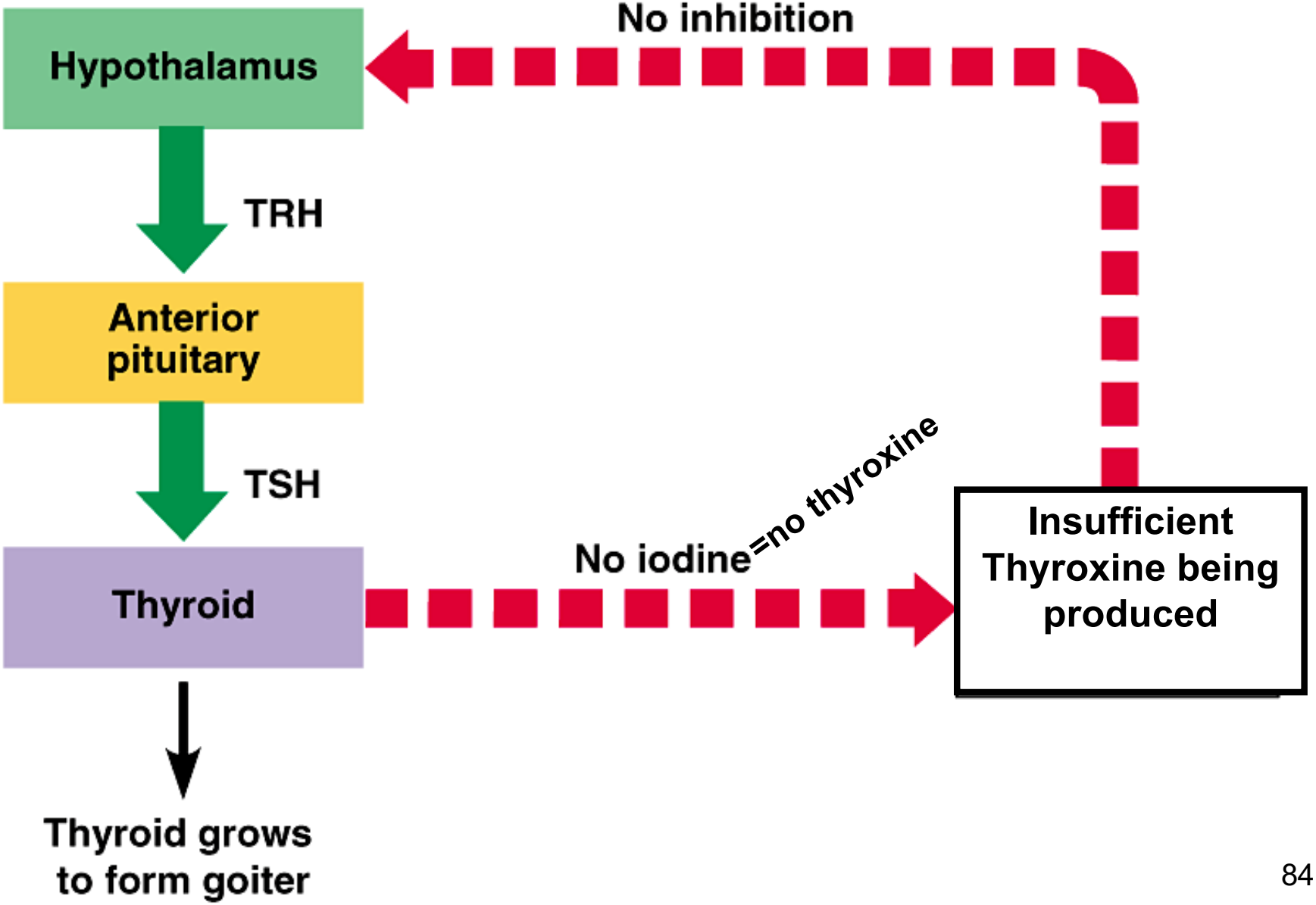


- **The body uses iodine to make thyroxine**
- Iodine is found in fish and salt
- Goiter = enlargement of the thyroid gland due to no thyroxine being produced
- The pituitary continues to make TSH so that thyroxine can be produced

Excess TSH overstimulating the Thyroid makes it enlarge

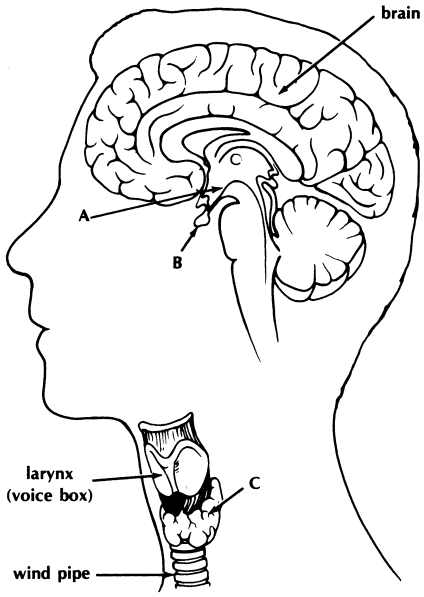
- In this case, the negative feedback system is not working properly

Goiter Formation



THYROID GLAND

Negative feedback for TSH



1 **Stimulus:**
Metabolic rate decreases

2 **Hypothalamus**

↓

TSH-RF (Releasing Factor)

↓

Anterior Pituitary

↓

TSH

↓

Thyroid gland

↓

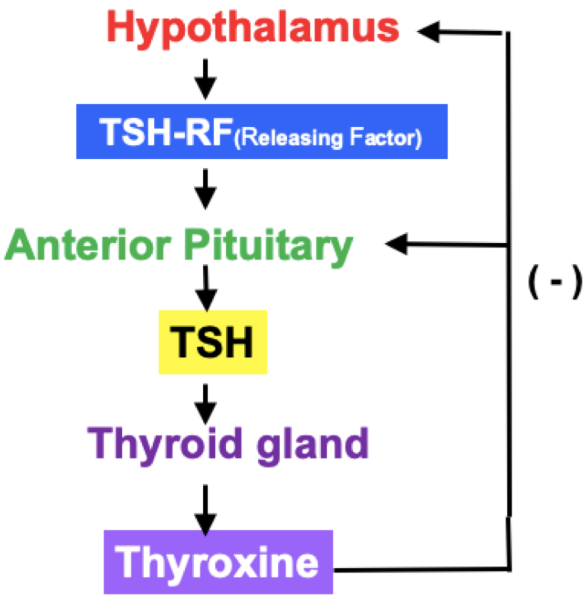
Thyroxine

(-)

Metabolism increases

THYROID GLAND

Negative feedback for TSH



In this example..

-If thyroxine levels are high then this **inhibits** TSH-RH and TSH from being released

-The hypothalamus is monitoring metabolism. If metabolism is high this will also **inhibit** the release of TSH and TSH-RH

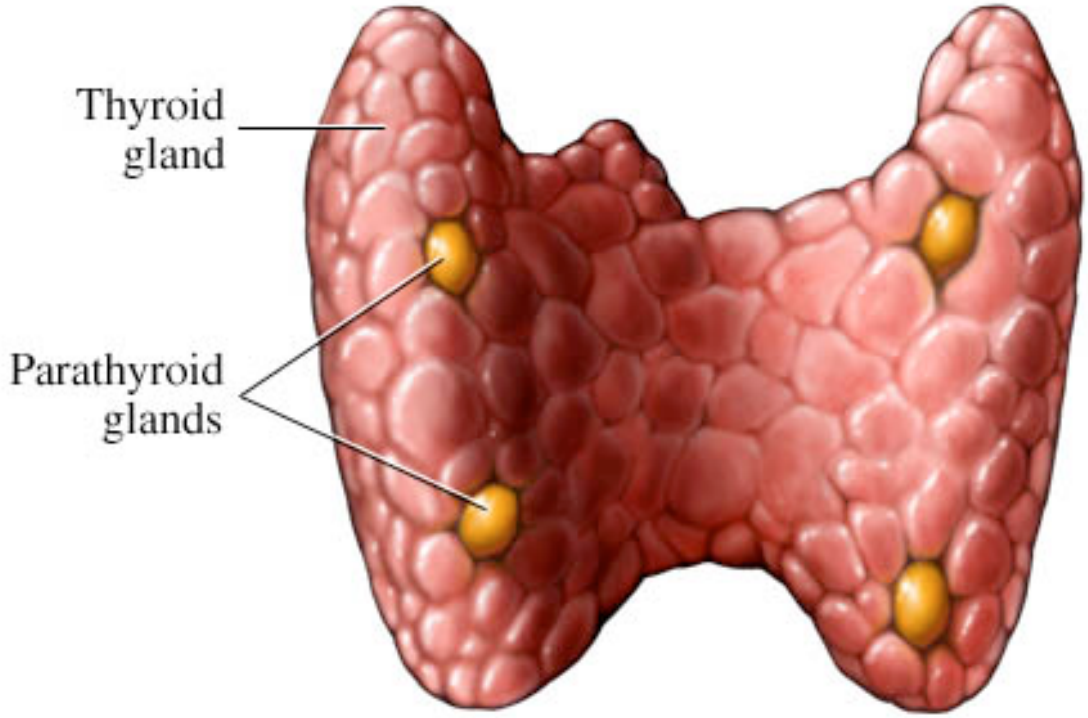
If Ava is missing half her thyroid gland, how would this affect her thyroxin levels?

What about her TSH levels?

a. Thyroxin levels would be not as high
b. TSH levels would go up because body senses not enough thyroxin being produced

THYROID and PARATHYROID GLAND

- The thyroid gland is also involved in regulating **calcium** levels in the blood
- The **thyroid** and **parathyroid** gland are separate structures that function closely together to control calcium



Control of Calcium

Calcitonin

- **Production site**: thyroid gland
- **Targets: bones, kidneys and small intestine**
- **Function:**

decreases blood calcium by **depositing calcium in bones**

- Excess Ca^{2+} is excreted in urine

(PTH) Parathyroid hormone

- **Production site**: parathyroid gland
- **Targets: bones, kidneys and small intestine**
- **Function: increases blood calcium by**

removing calcium from bones

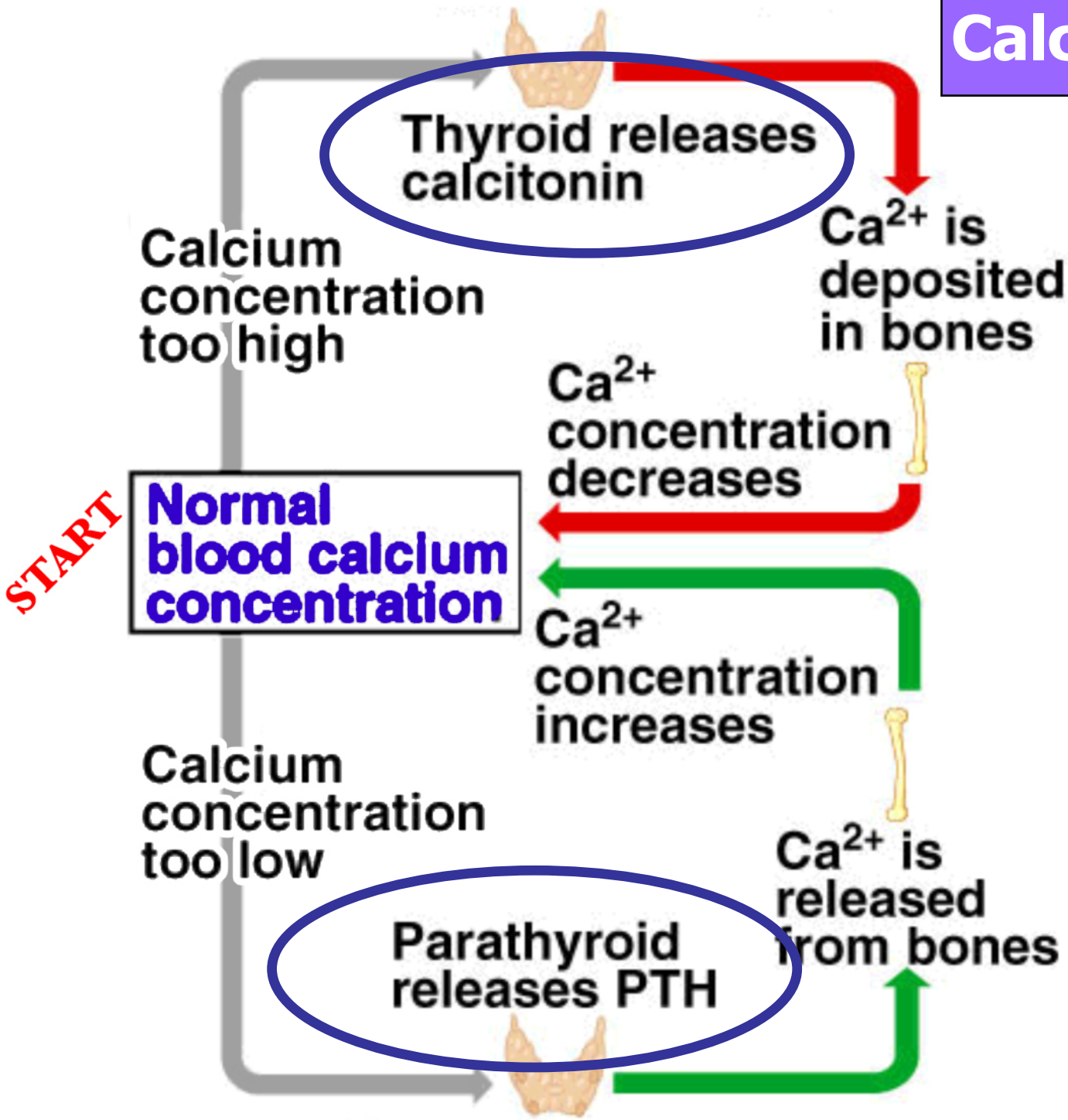
- Lactation stimulates the release of **PTH** (milk contains calcium)

Bones are like a "bank vault" of calcium

PTH is the key needed to make Ca^{+} withdrawals

Calcitonin needed to make deposits

Calcium Regulation



also…

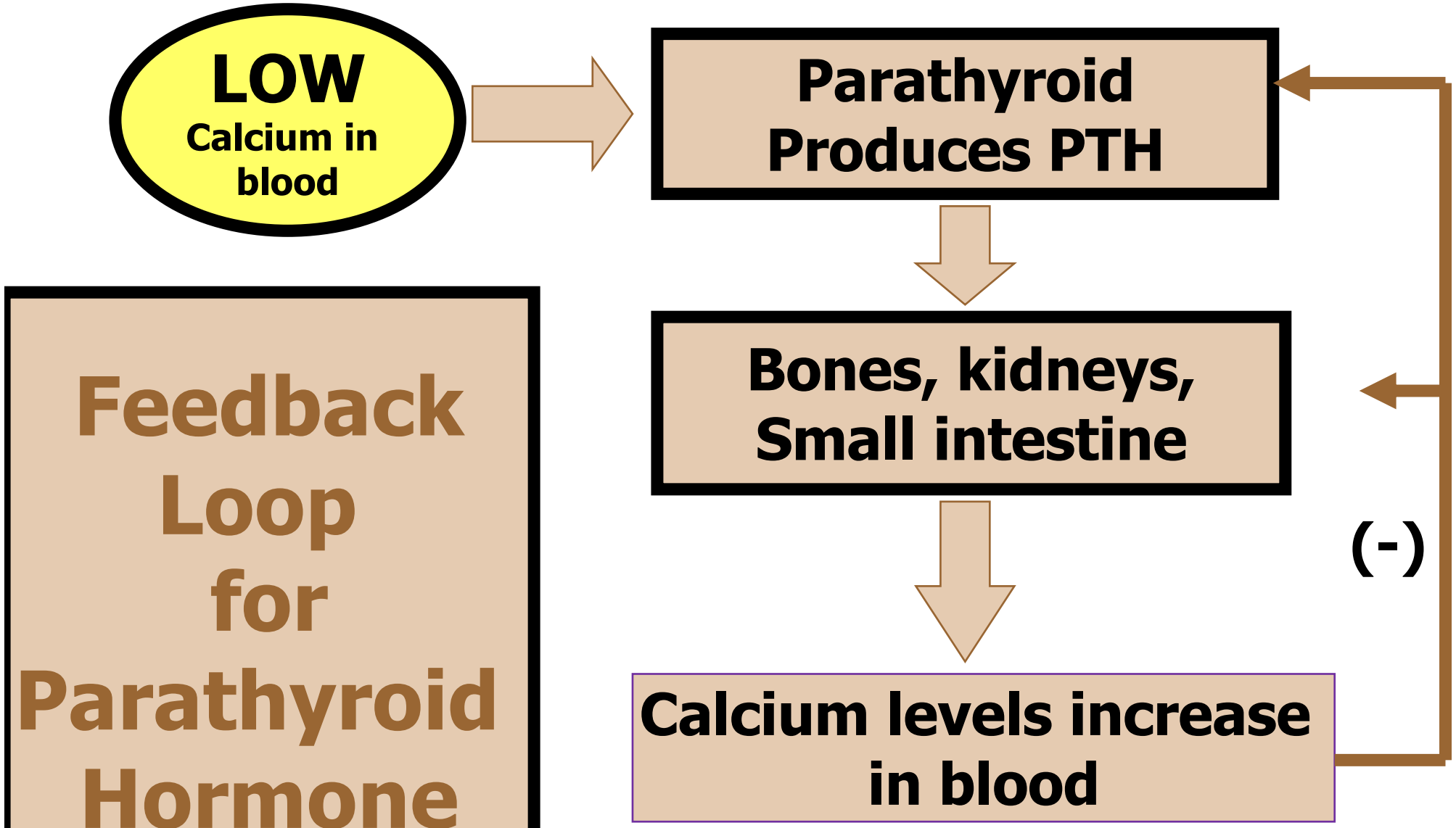
Ca^{2+} is excreted by kidneys

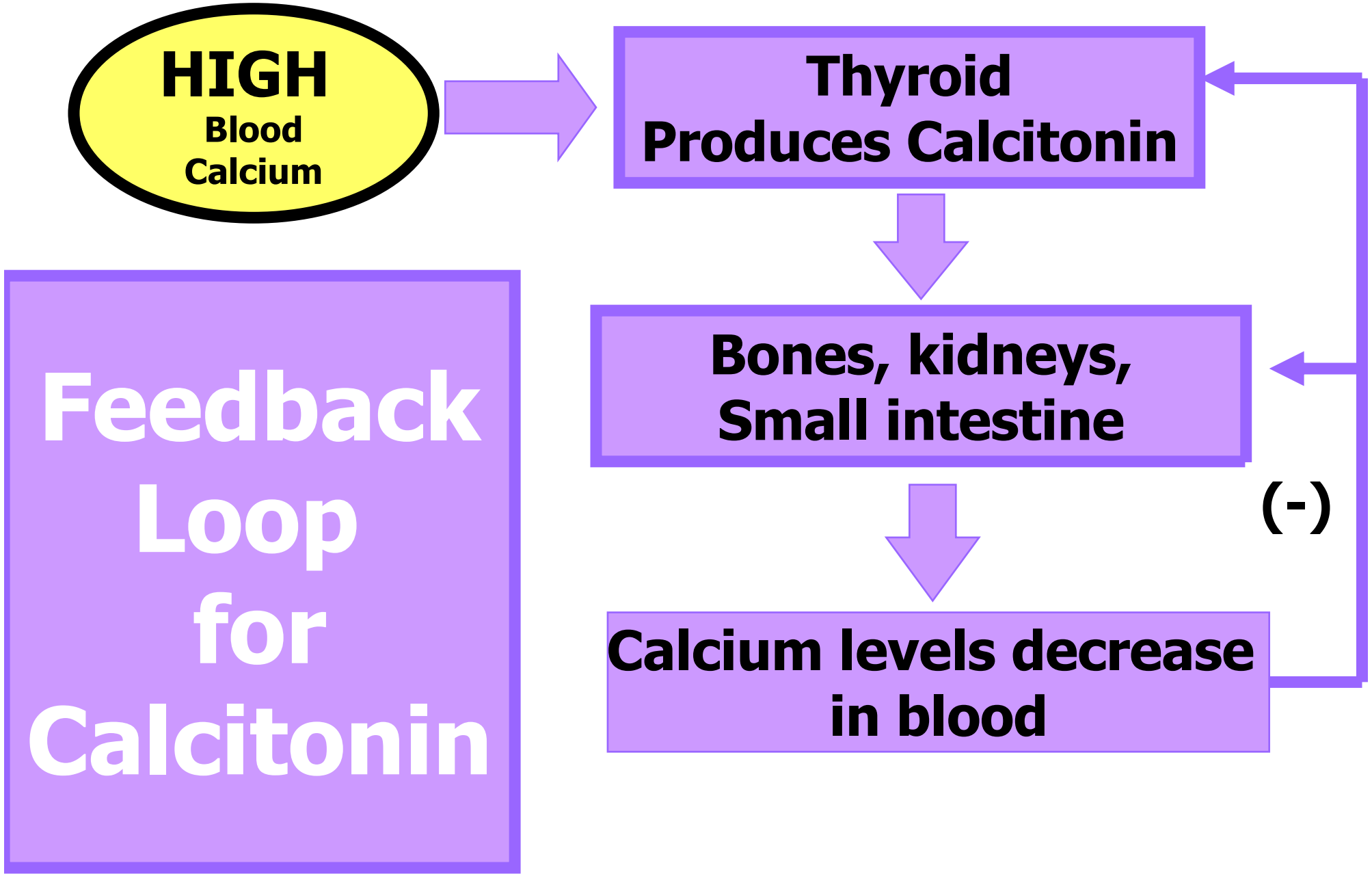
Absorption of Ca^{2+} is reduced in intestines

also…

Ca^{2+} is conserved in kidneys

Ca^{2+} is absorbed by intestines


LOW
Calcium in blood
Parathyroid Produces PTH
Bones, kidneys, Small intestine
Calcium levels increase in blood
(-)
Feedback Loop for Parathyroid Hormone


HIGH
Blood
Calcium
Thyroid
Produces Calcitonin
Bones, kidneys,
Small intestine
(-)
Calcium levels decrease
in blood
Feedback
Loop
for
Calcitonin

Low levels of calcium ions in the blood cause

A. decreased secretion of PTH and increased deposition of calcium in the bones

B. decreased secretion of calcitonin and increased deposition of calcium in the bones

C. increased secretion of PTH and movement of calcium from the bones to the blood

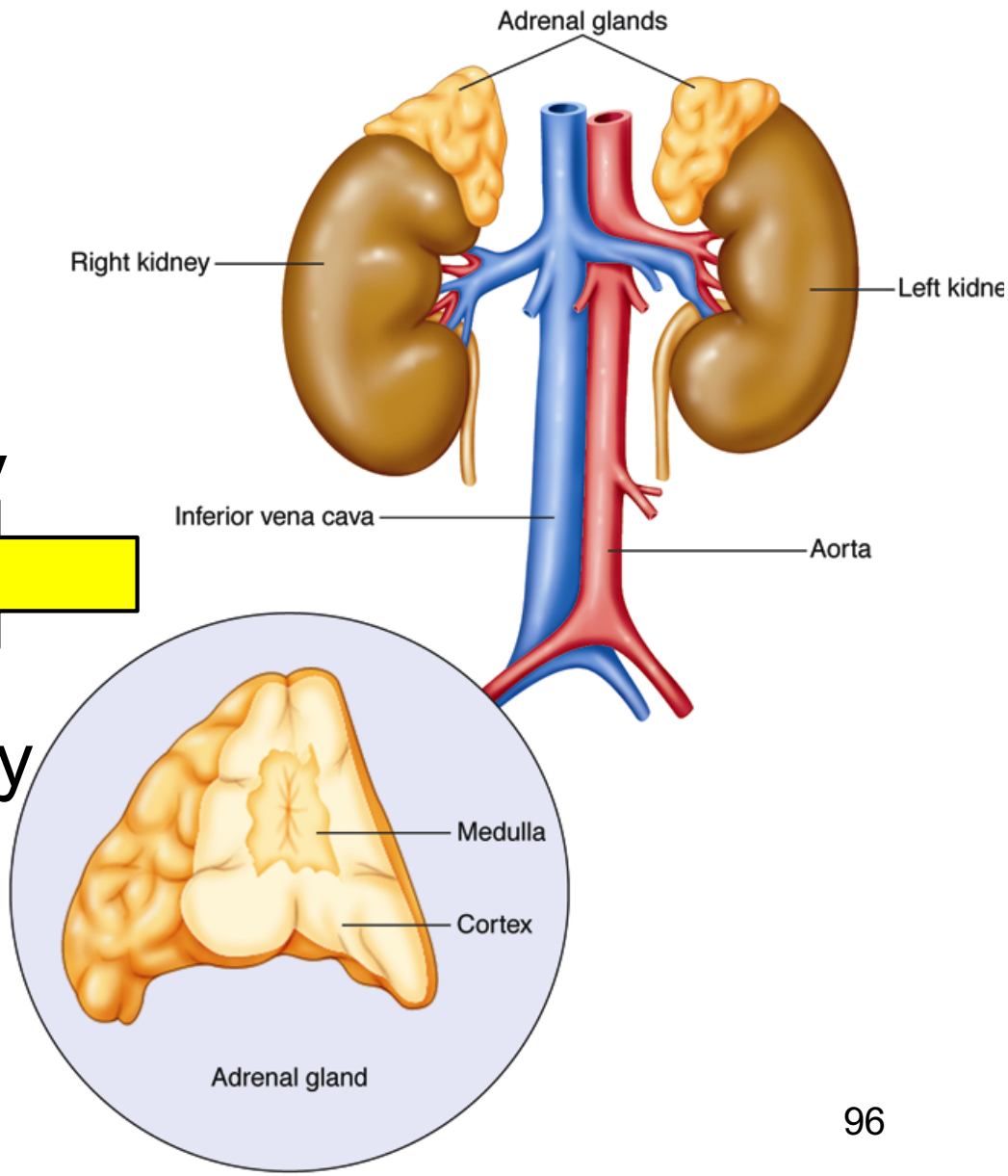
D. increased secretion of calcitonin and movement of calcium from the bones to the blood

- COMPLETE WORKBOOK

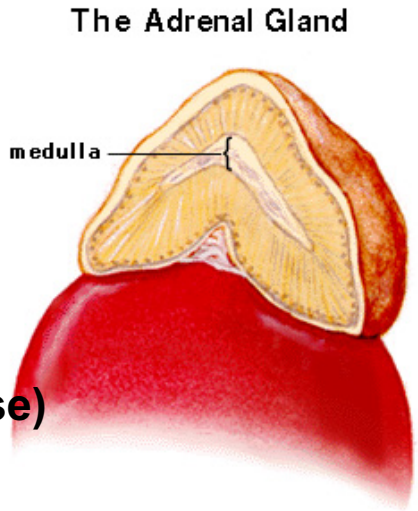
  PAGE 7,8

THE ADRENAL GLAND

- **Above each kidney**
- The **adrenal gland** Is made up of **2 glands**
  - **Adrenal medulla (middle)** – regulated by the **nervous system**
  - **Adrenal cortex (outside)** – regulated by **hormones**



Adrenal MEDULA



- activated by the **sympathetic nervous system**
- **Adrenal medulla** produces 2 hormones **during immediate stress** **(initiates the fight-or-flight response)**
- **1) Epinephrine** (adrenaline)
- 2) **Norepinephrine** (noradrenaline)

Short term Stress

- Increase blood glucose by converting **glycogen to glucose**
- Increase **heart rate**
- Increase **breathing rate**
- Blood vessels **dilate** (get bigger)
- Pupils **dilate**

Adrenal CORTEX

Aldosterone

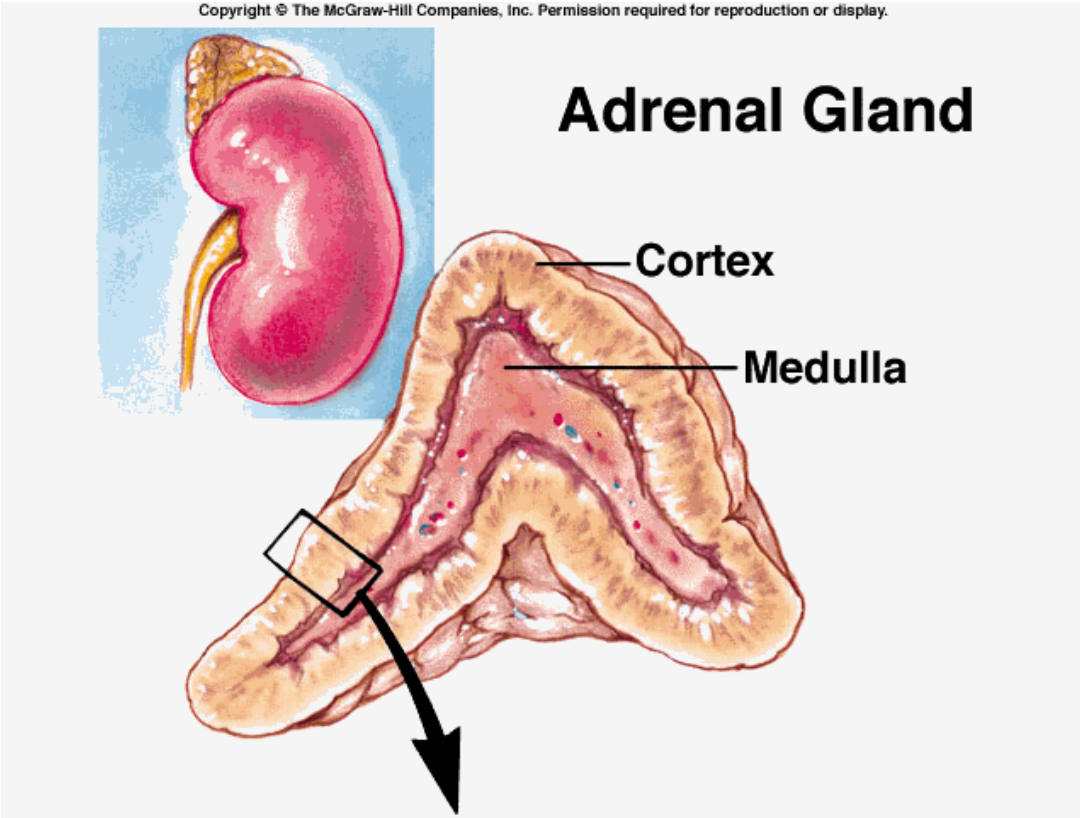
Cortisol

-Activated by the pituitary

Adrenal CORTEX produces 2 hormones

- **1) Aldosterone**
- 2) **Cortisol**

Stimulated by **ACTH** from the anterior pituitary



Adrenal CORTEX -Cortisol-

Long term stress

- **Targets:** Liver and muscles
- **Function:** increases levels of **amino acids** in blood which are then converted to glucose by liver = **more energy**
  - **Anti-inflammatory and immune suppressant**

**Does cortisol increase or decrease blood glucose?

It increases it.

Why would your body suppress your immune system in times of stress?

Hyposecretion: Addison's disease

Hypersecretion: Cushing's Syndrome

Can Stress Actually Kill You?

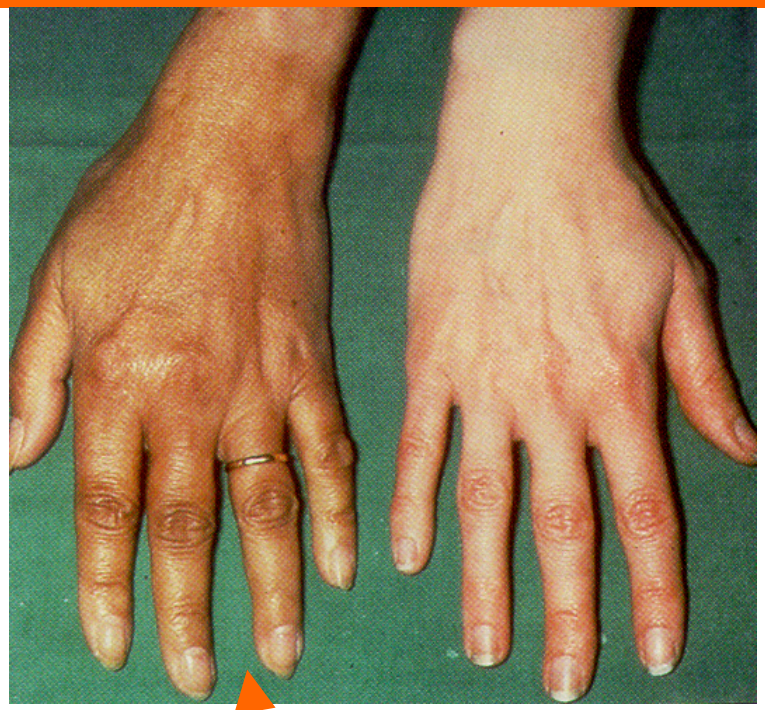
http://www.youtube.com/watch?v=vzrjEP5MOT4&safety_mode=true

Adrenal CORTEX

Too little Cortisol: Addison's Disease

Symptoms:

Weight loss, low energy, low blood pressure, occasionally areas of hyper-pigmentation



Bronzing of the skin

Adrenal CORTEX

Long term stress

Too much Cortisol: Cushings Syndrome

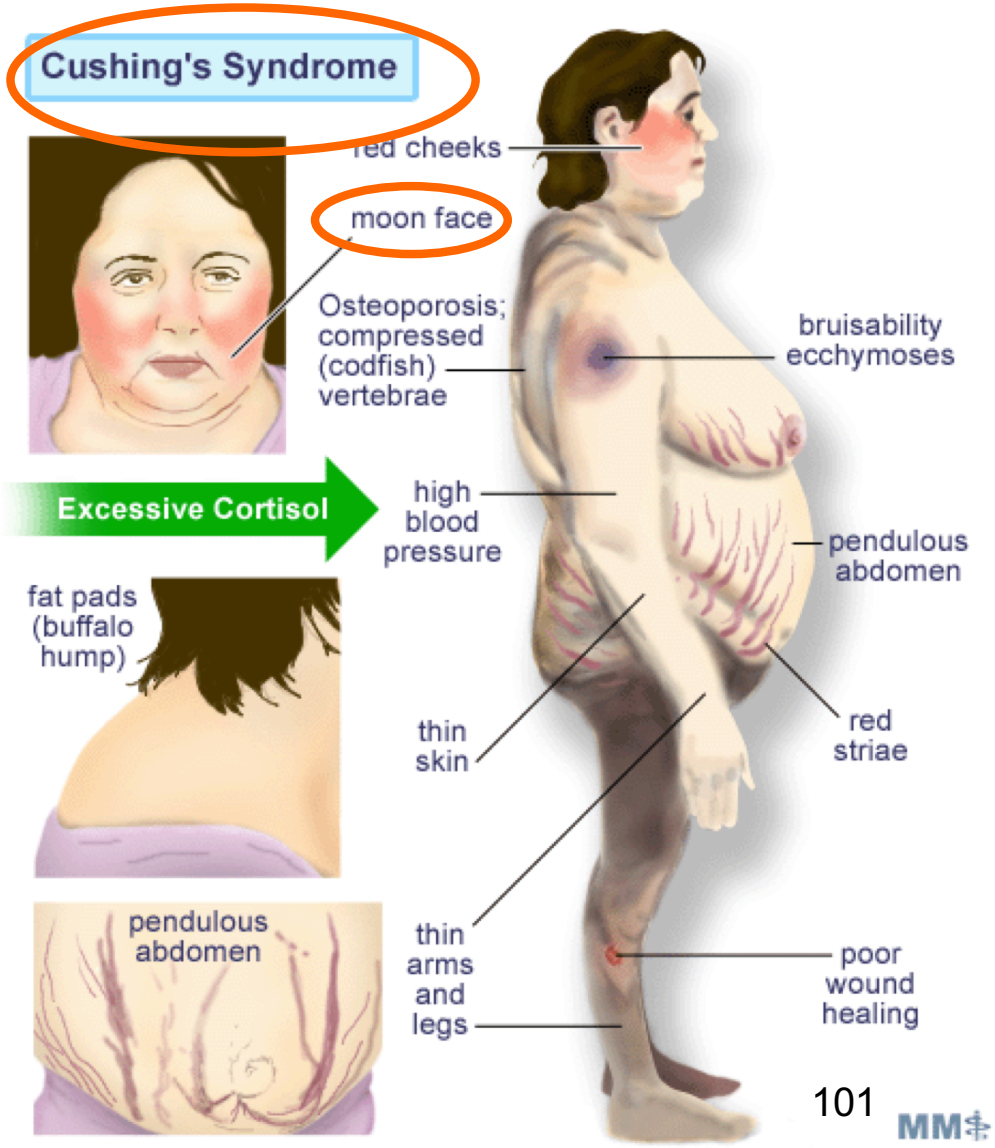
Symptoms :

-moon face,

-osteoporosis,

-pendulous abdomen,

-bruise easily



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Adrenal CORTEX

Too much Cortisol: Cushing Syndrome

Due to **hypersecretion** of **cortisol** in the adrenal cortex

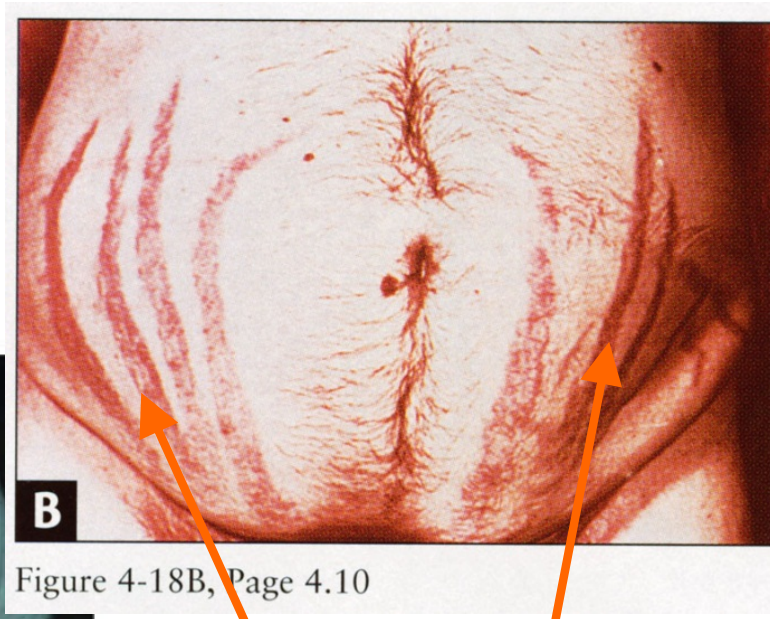
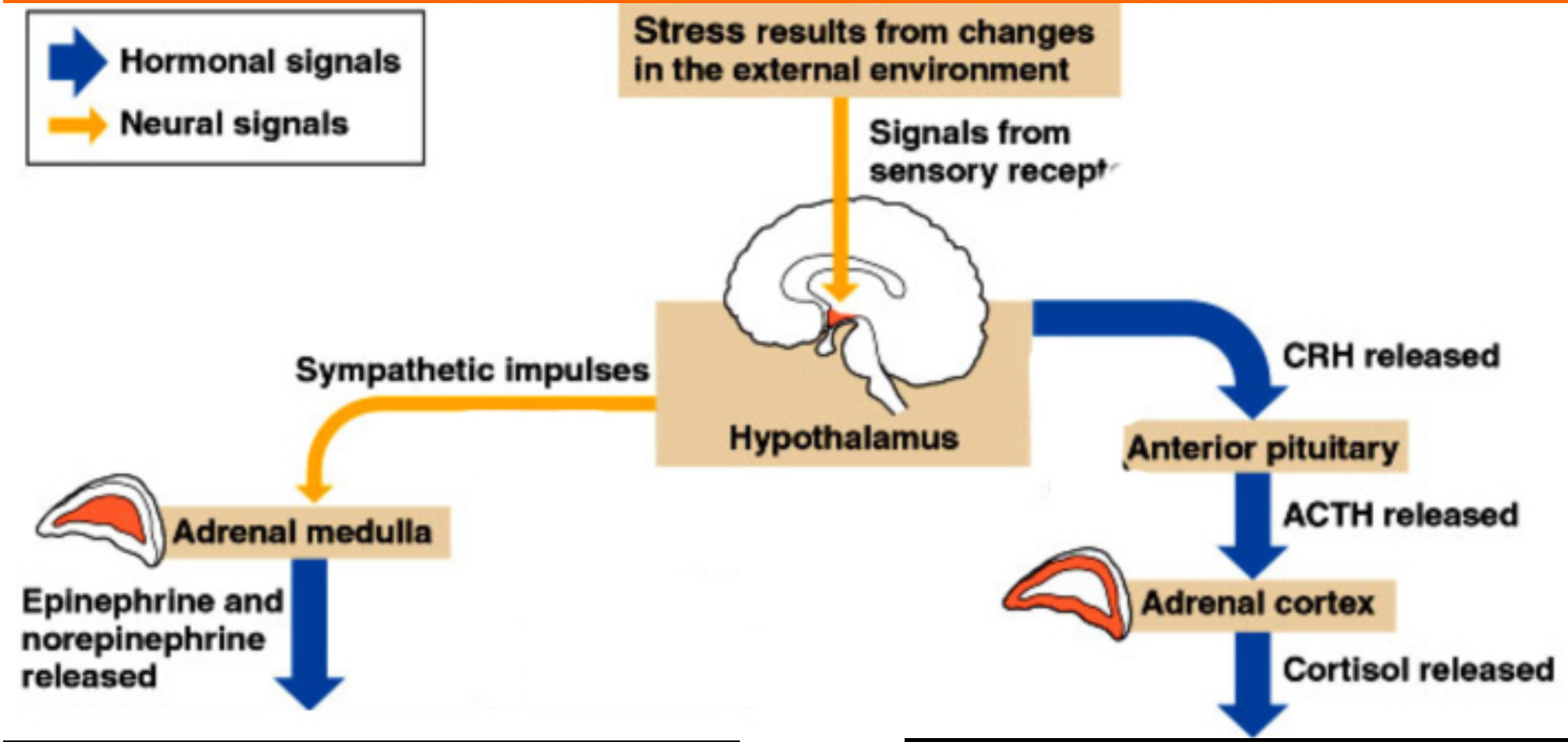


Figure 4-18B, Page 4.10

Moon face

Red striae

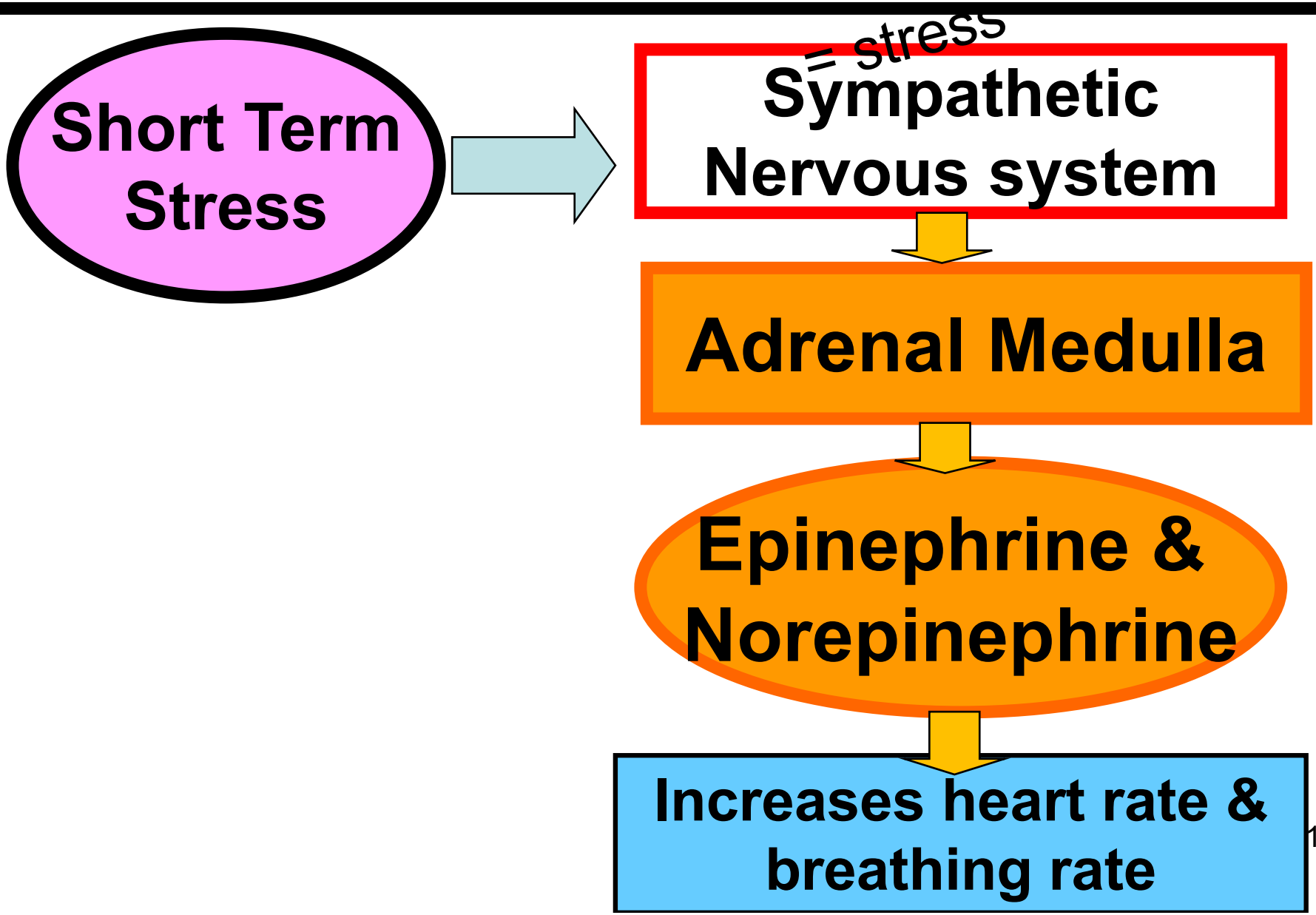
ADRENAL: Cortex vs Medulla



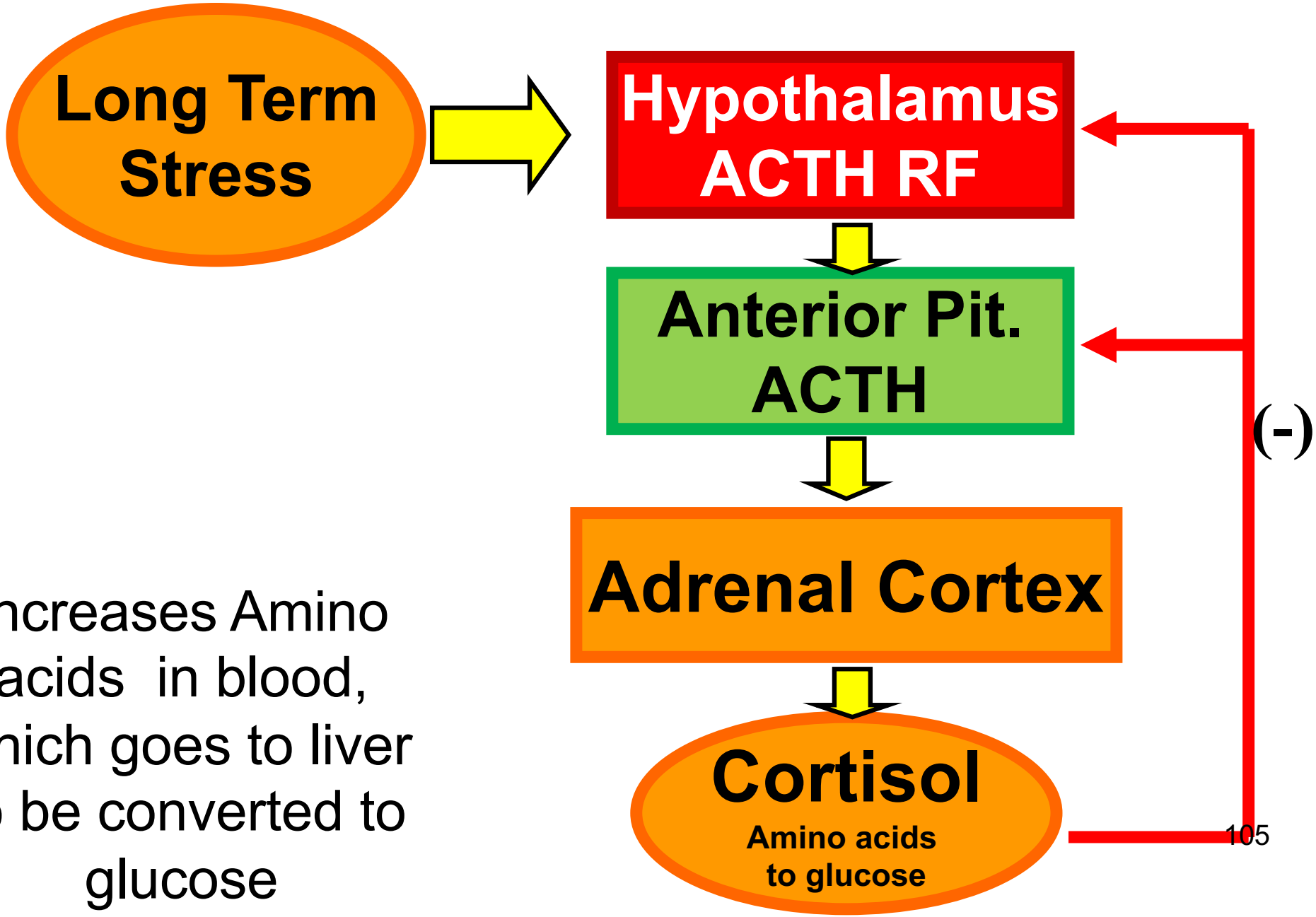
SHORT TERM STRESS
"fight or flight"

LONG TERM STRESS
-increased glucose from amino acids

Flow Chart For Epinephrine
(and norepinephrine)



Feedback Loop For Cortisol



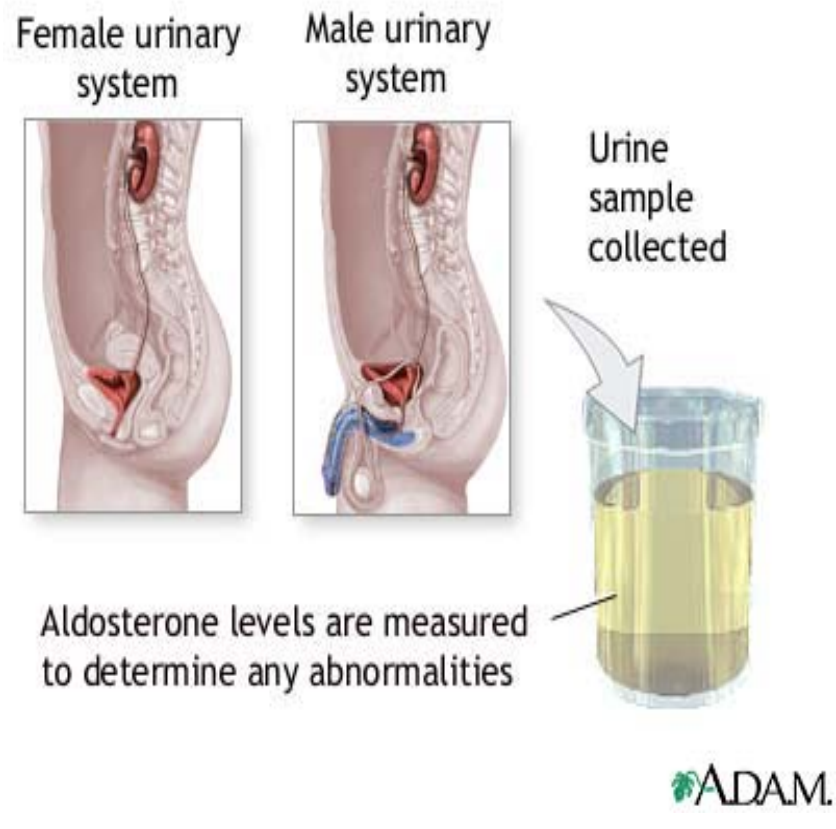
Increases Amino acids in blood, which goes to liver to be converted to glucose

Adrenal CORTEX -Aldosterone-

WATER RETENTION

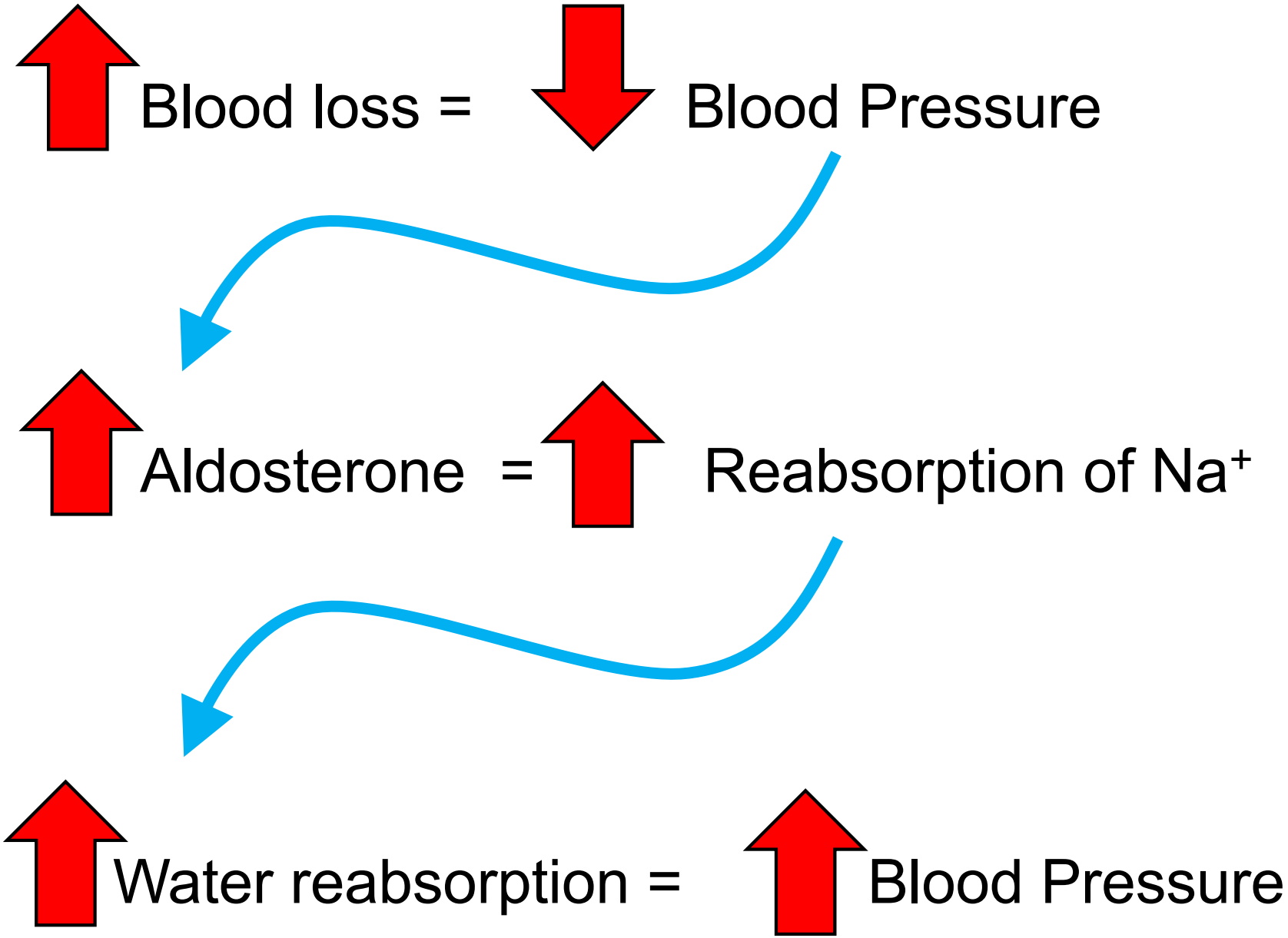
- Production site: adrenal cortex
- **Target:** the kidneys
- **Function**: increases sodium (Na^+) retention **and with it water** though osmosis
- -essentially increases blood volume and therefore blood pressure

(similar to ADH → Increases blood pressure)



- **Hyposecretion:** water loss or dehydration
- **Hypersecretion:** increased water retention

Aldosterone and blood pressure



Aldosterone vs. ADH

ADH released in response to **dehydration (lack of water)**

Aldosterone is released in response to low **blood pressure or low volume (loss of fluid like diarrhea or hemorrhage)**.

What happens if you stop drinking water?

http://www.youtube.com/watch?v=zCheAcpFkL8&safe=active&safety_mode=true

Check your understanding…

How does Calcitonin get its job done?

It lowers blood calcium levels by placing calcium in bones, lowering calcium resorption in kidneys and intestines

What will an increase of thyroxine do?

Increase glucose use which increases metabolism

A Goiter is formed by too much TSH present. Why did the body not stop the production of TSH?

Not enough iodine is present so no thyroxine can be produced. Although the hypothalamus directed metabolism to increase, metabolism is not increasing (b/c of no thyroxine. Hypothalamus keeps directing the thyroid with TSH but nothing keeps happening.

A rare disorder is artificially lowering the amount of calcium in the blood. 5How would the body correct this low amount of calcium?

PTH secreted to increase levels

What are 3 ways the body is able to increase calcium levels through the use of PTH?

Absorb more in intestines from food, kidneys retain more, extract from bones

You nearly get into a car accident. Your heart rate goes up sharply. What part of the adrenal gland was just activated?

Adrenal MEDULLA

How is the adrenal cortex different from the adrenal medulla as far as how they are controlled?

It medulla controlled by nerves…cortex controlled by hormones(ACTH)

Which hormone increases the amount of sodium? Aldosterone

Which of the following rows identifies the source of cortisol, the hormone that stimulates the release of cortisol, and an effect of cortisol?

Row	Source	Hormone	Effect
A.	Adrenal gland	ACTH	Increased conversion of amino acids to glucose
B.	Pituitary gland	ACTH	Increased protein synthesis
C.	Adrenal gland	ADH	Increased conversion of glycogen to glucose
D.	Pituitary gland	ADH	Increased water reabsorption

Use the following information to answer the next two questions.

Thyroid cancer can develop slowly over many months or even years. Because the symptoms are frequently overlooked, diagnosis is often delayed. However, thyroid cancer is usually treated successfully with a combination of surgery, radioactive iodine, and thyroid medication.

Surgical removal of the thyroid gland results in

A. a decrease in thyroxine levels and TSH levels
B. an increase in thyroxine levels and TSH levels
C. an increase in thyroxine levels and a decrease in TSH levels
D. a decrease in thyroxine levels and an increase in TSH levels

The release of thyroxine from the thyroid is directly regulated by

A. TSH
B. TRH
C. iodine
D. thyroxine

A characteristic symptom of hyperthyroidism is

A. lethargy
B. weight loss
C. intolerance to cold
D. slowed mental processes

BOOKLET 3

TARGET GLANDS

1) Pancreas
2) Estrogen
3) Progesterone
4) Testosterone

Learner outcomes…
What you need to know!

- describe, using an example, the physiological consequences of hormone imbalances; i.e., diabetes mellitus *(e.g., diabetes insipidus, gigantism, goitre, cretinism, Graves' disease).*

Terms you need to know

Endocrine

Exocrine

Islets of Langerhan

Insulin

Glucagon

Permeability

Terms you need to know

Glycogen

Alpha Cells

Beta Cells

Diabetes Mellitus Type I

Diabetes Mellitus Type II

Prostaglandin

Terms you need to know

Estrogen

Progesterone

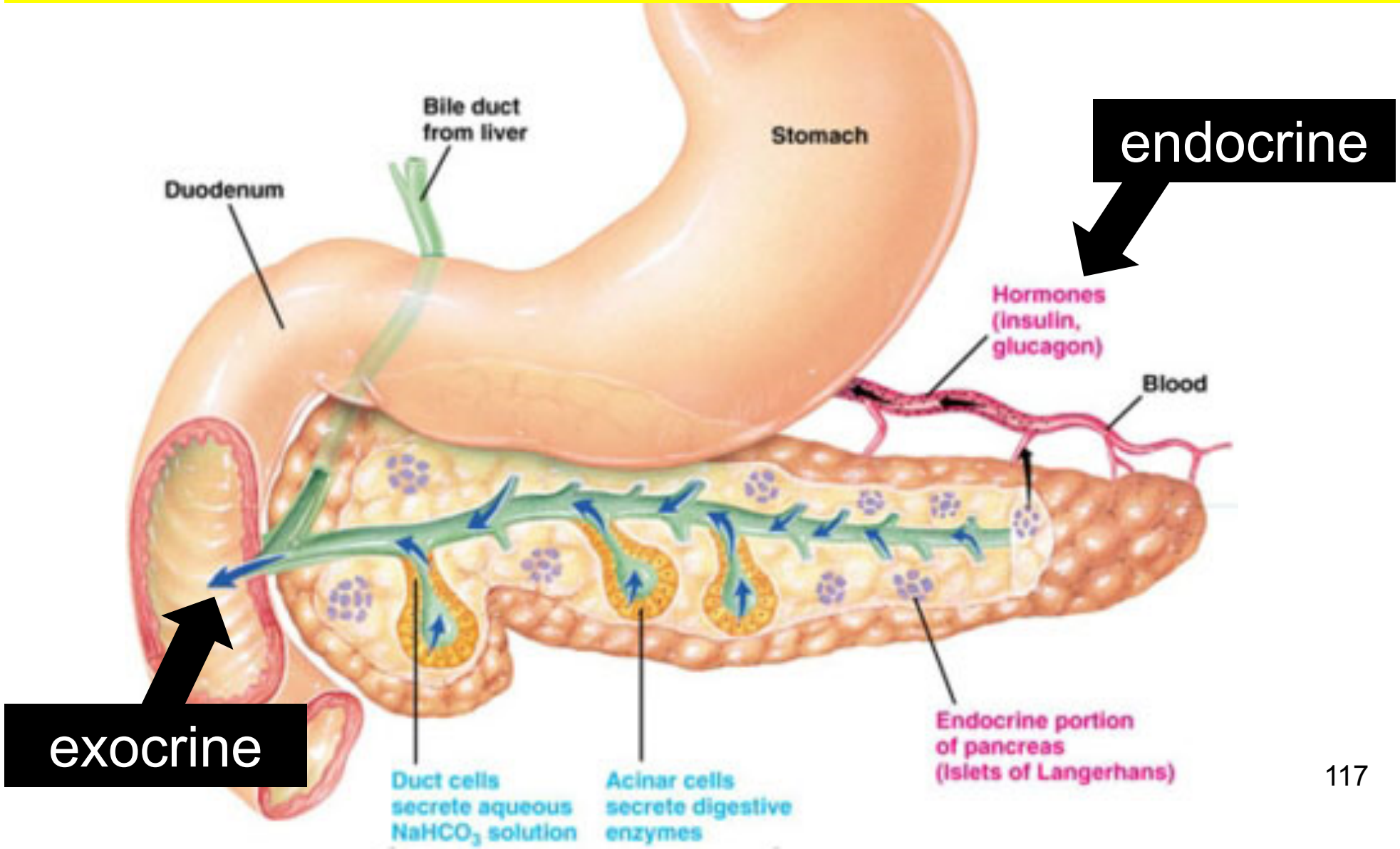
Testosterone

Synthesis

Secretion

Inhibit

THE PANCREAS
Islets of Langerhans



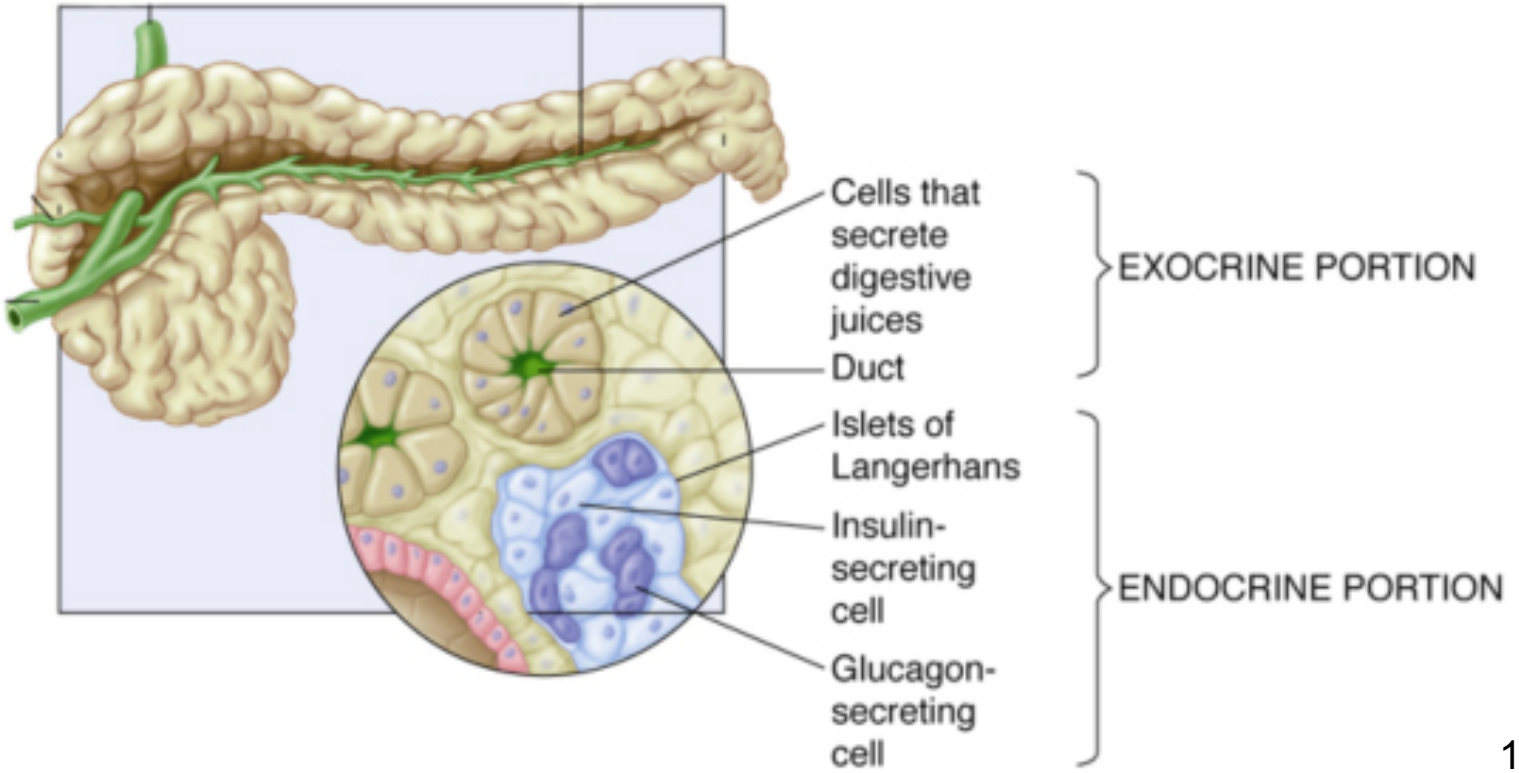
Pancreas

The pancreas is an endocrine and an exocrine gland.

Exocrine - Secretion of digestive enzymes into small intestine

Endocrine - Secretion of hormones

(eg. insulin and glucagon) directly into blood.

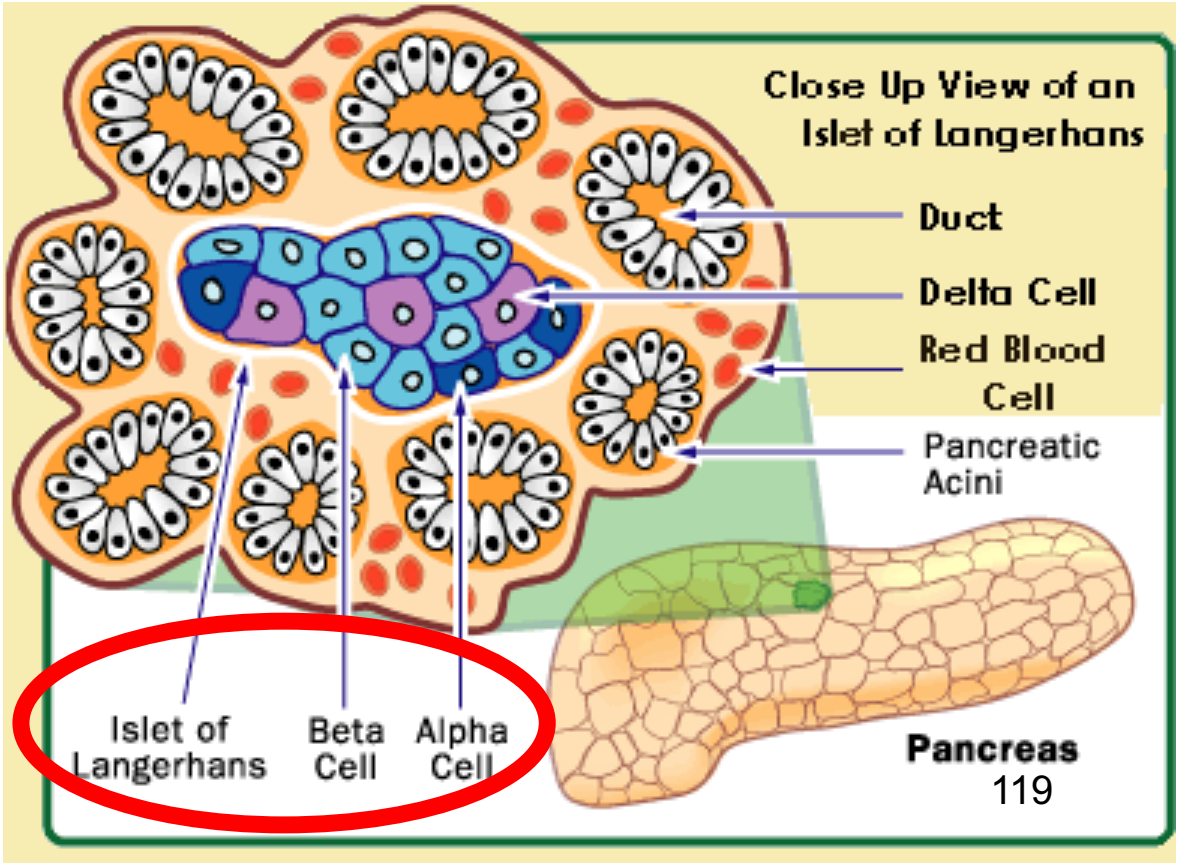


Islets of Langerhans

Produced inside the **Islets of Langerhans**

1) insulin- produced by BETA cells(vowel "I" goes with consonant "B")

2) glucagon- produced by ALPHA cells (consonant "G" goes with a vowel "A"



Insulin and Glucagon

Glucose is gone!

Insulin

- **Production site: BETA cells** of the **islets of Langerhans**
- **Target: liver, muscles and all other cells**
- **Function:** released after a meal to
  - **A. lower glucose levels in the blood**
  - **B.** Increase all cells **permeability** to glucose
    (makes it easier for glucose to be absorbed by cells)
  - **Excess Glucose** converted to **glycogen in liver and muscle cells**

Glucagon

- **Production site: ALPHA cells** of the **islets of Langerhans**
- **Target**: liver and muscles and all other cells
- **Function:** released after long periods of fasting to
  - **A. raise glucose levels in the blood**
  - **B.** Decrease cell **permeability to glucose**
    (makes it more difficult for glucose to be absorbed by cells)
  - – Glycogen converted to **glucose**

These two are antagonistic

How can I remember these terms?

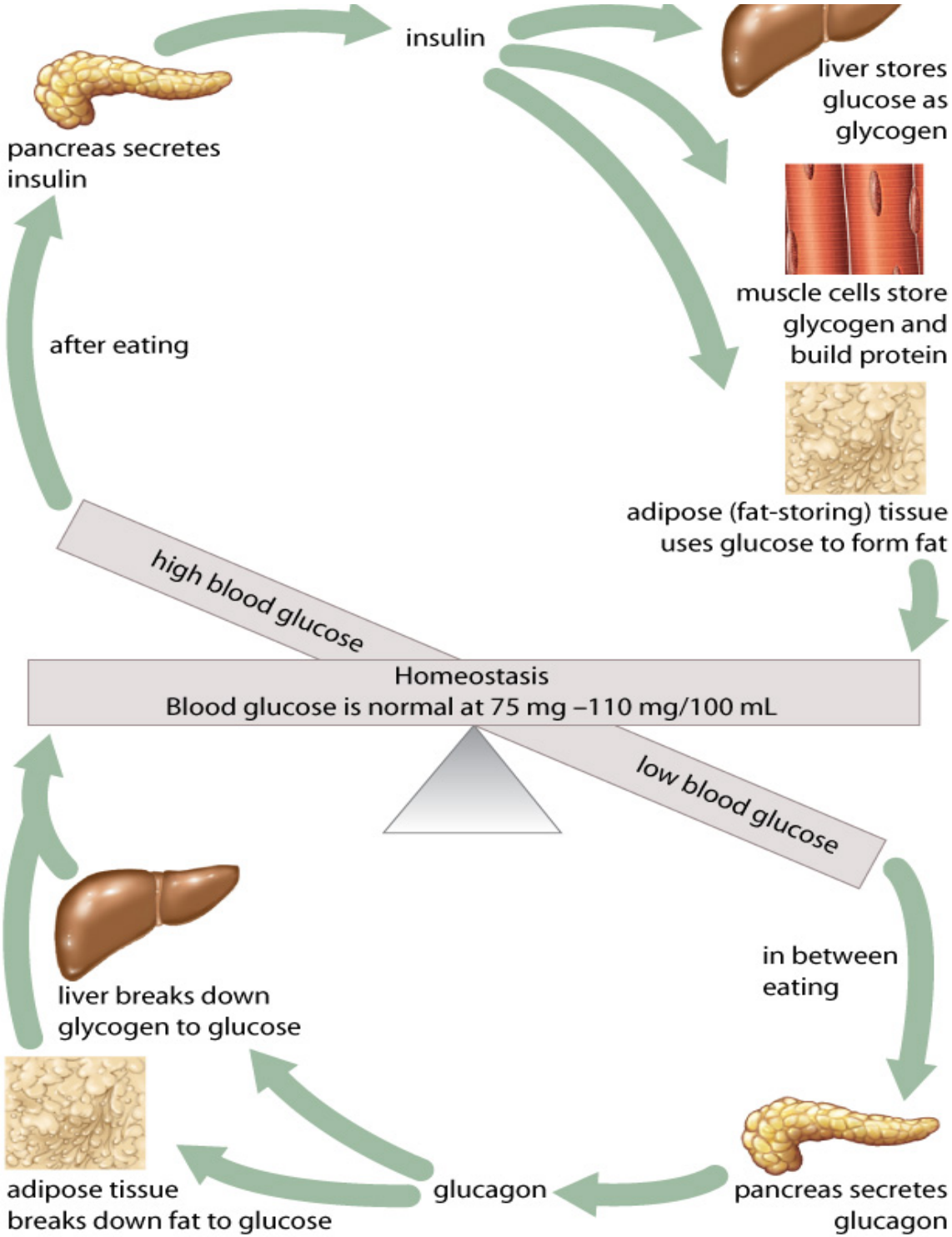
Insulin and Glucagon youtube video

Glucose – sugar

Glucagon – "glucose is GONE" from blood so glucagon gets glucose back into the blood

Glycogen – storage form of glucose

Insulin – lowers blood sugar



Circle the gland that is first responding to low blood sugar

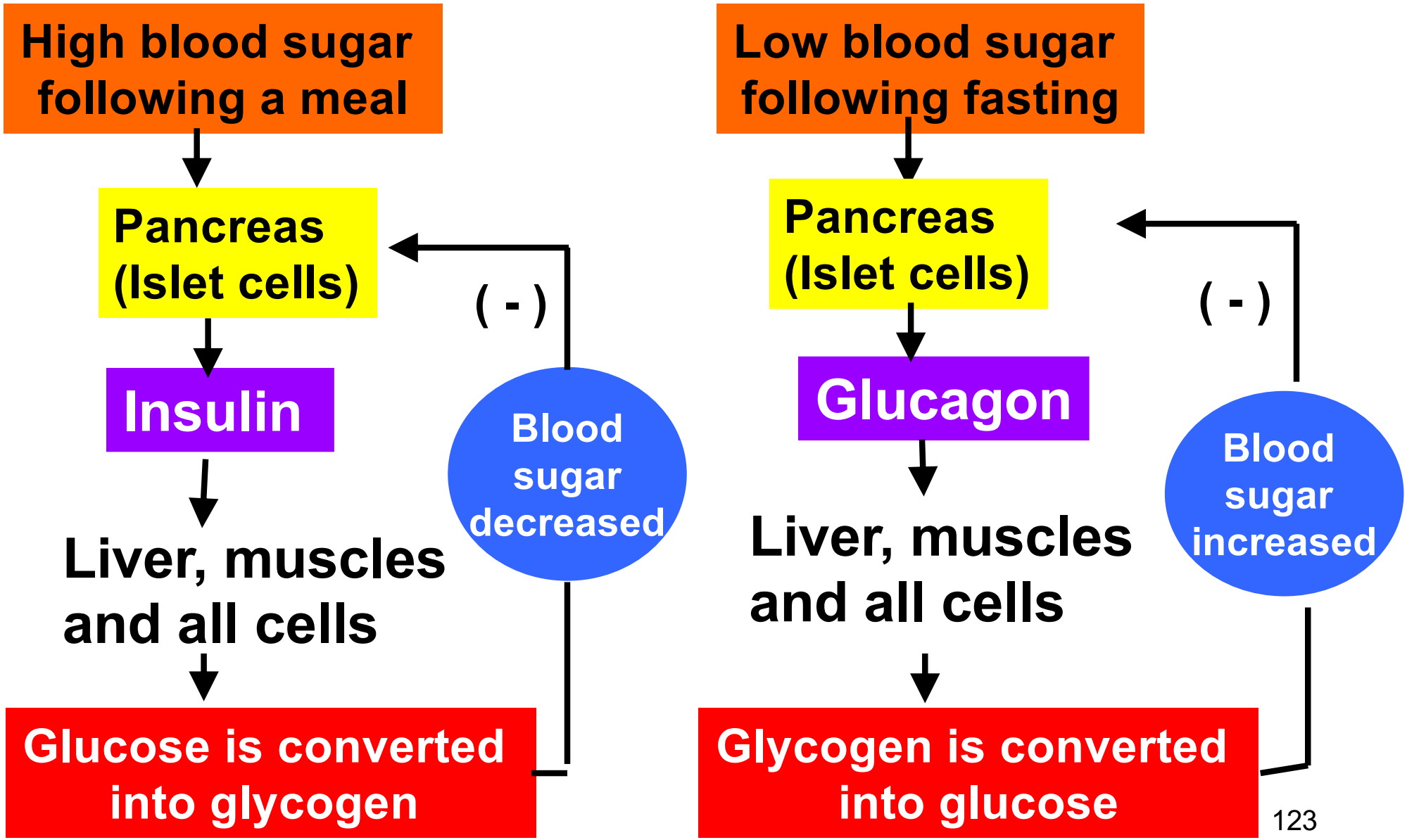
Put a box around the gland first responding to high blood sugar

Make a dashed circle around the organs that are removing glucose from the blood

Negative feedback loops

Insulin vs. Glucagon

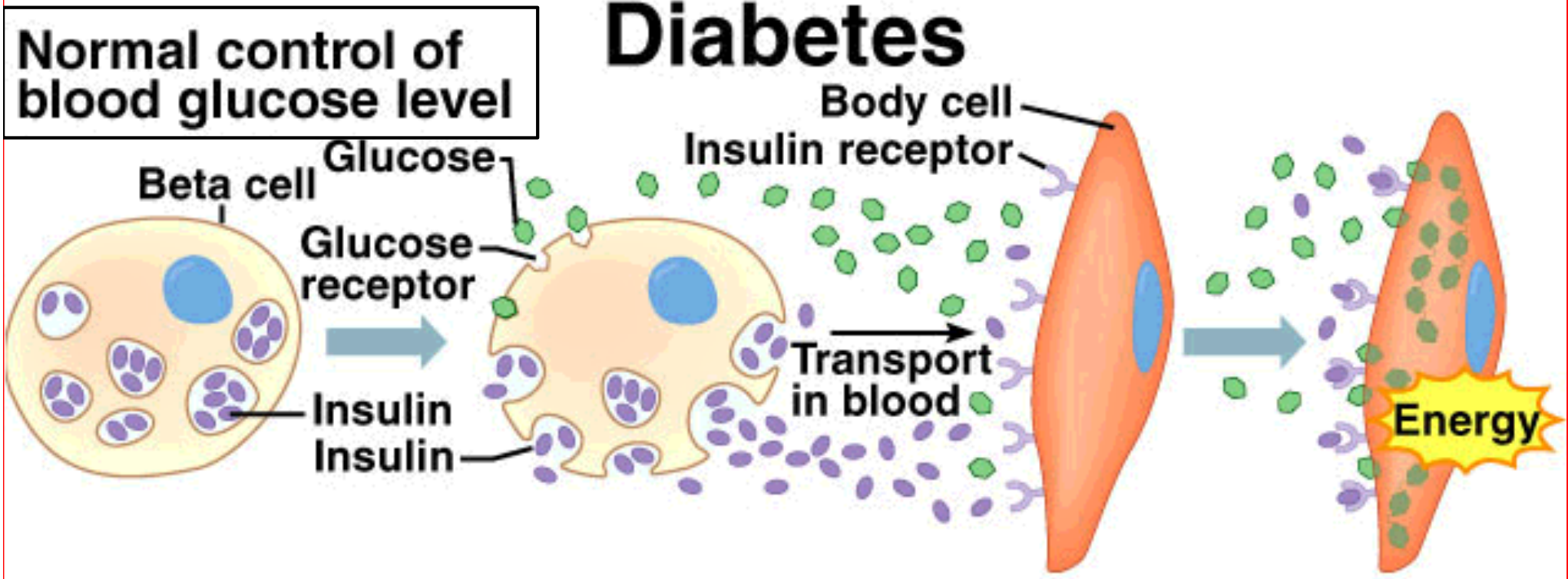
https://www.youtube.com/watch?v=eDm9hEOn8zc



Diabetes mellitus “mell-e-tus”

- Genetic disorder
- Not enough **insulin** production due to deterioration of **beta cells** within the islets of Langerhans
- **Result** = **high blood sugar levels after eating** **(hyperglycemia)**
- **Glucose** can appear in the **urine**
- **Normal urine contains NO glucose.**
- Glucose also draws water from the body = **large volumes of urine**

Diabetes



Disruption of control processes

- Type I: insulin-dependent diabetes
- Hypoglycemia
- Gestational diabetes
- Type II: non-insulin-dependent diabetes

Symptoms of Diabetes Mellitus

- Frequent urination & constant thirst
- Diabetics experience **low energy levels**
- Lots of sugar in the blood, but little move into cells
- Break down fat and proteins for energy
- **"acetone breath"** due to fat metabolism

Boy before and after Insulin Treatment

Diabetes Mellitus 2 types

Juvenile (early-onset) (TYPE 1)

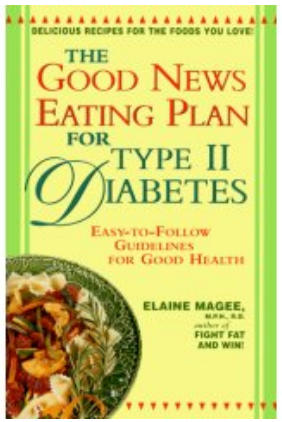
- Due to early **degeneration** of **beta cells**
- Treatment: **insulin injections**

Adult (maturity-onset) (TYPE 2)

- Due to **decreased effectiveness of insulin**
- Less effective beta cells
- Treatment: oral drugs such as can be controlled with diet and exercise and medications (**sulfonamides**)

Doctors: Type 1 vs. Type 2

https://www.youtube.com/watch?v=yENeJ70S5QE



CAUSES - Diabetes Mellitus

(TYPE 1)

Juvenile (early-onset)

-exact cause unknown

but…

Your immune system attacks and destroys your insulin producing cells

(TYPE 2)

Adult (maturity-onset)

-obesity

-lack of physical activity

-genetic factors

-high fat and carbohydrate (sugar) diet

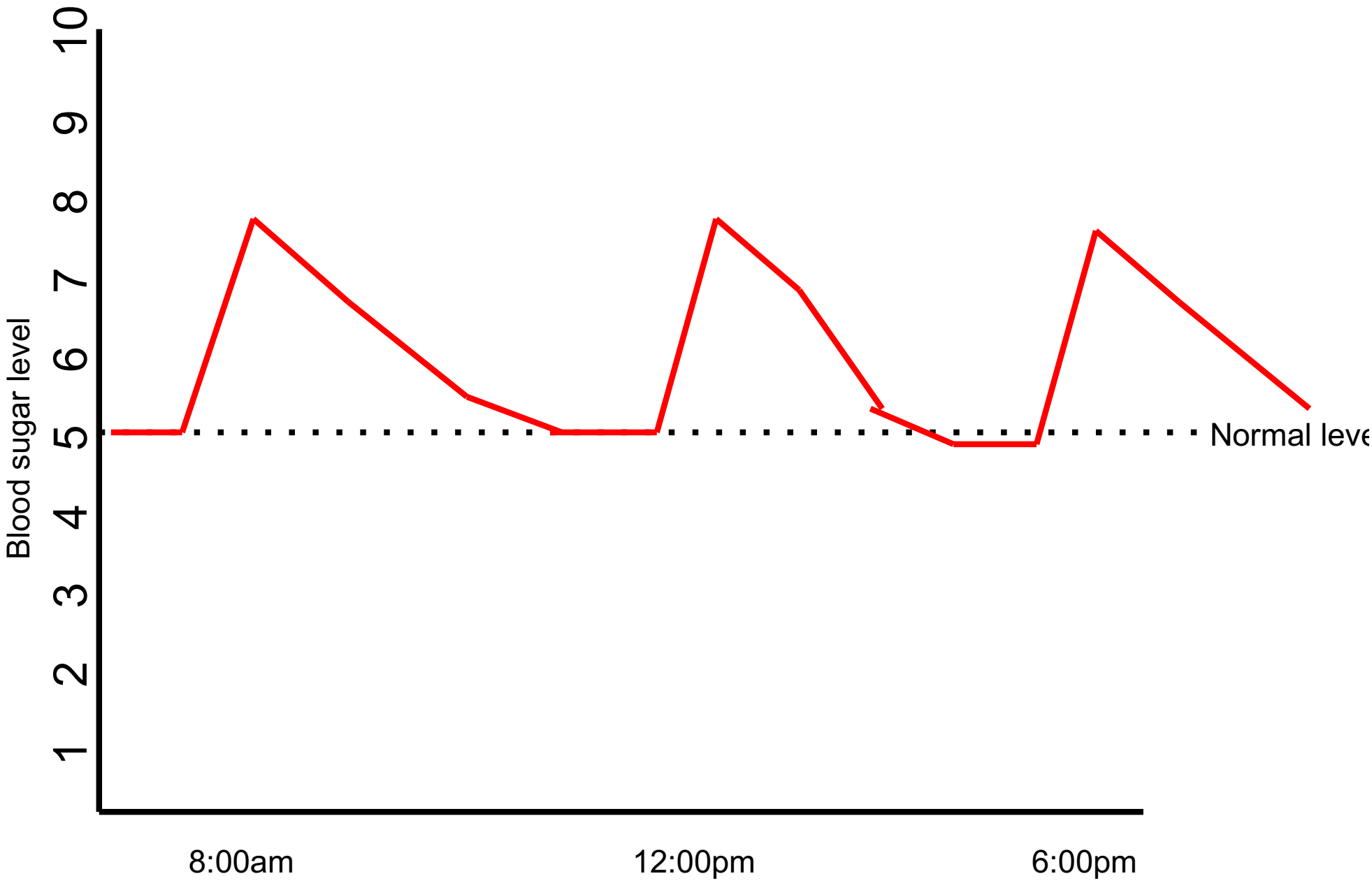
-high alcohol intake

-age

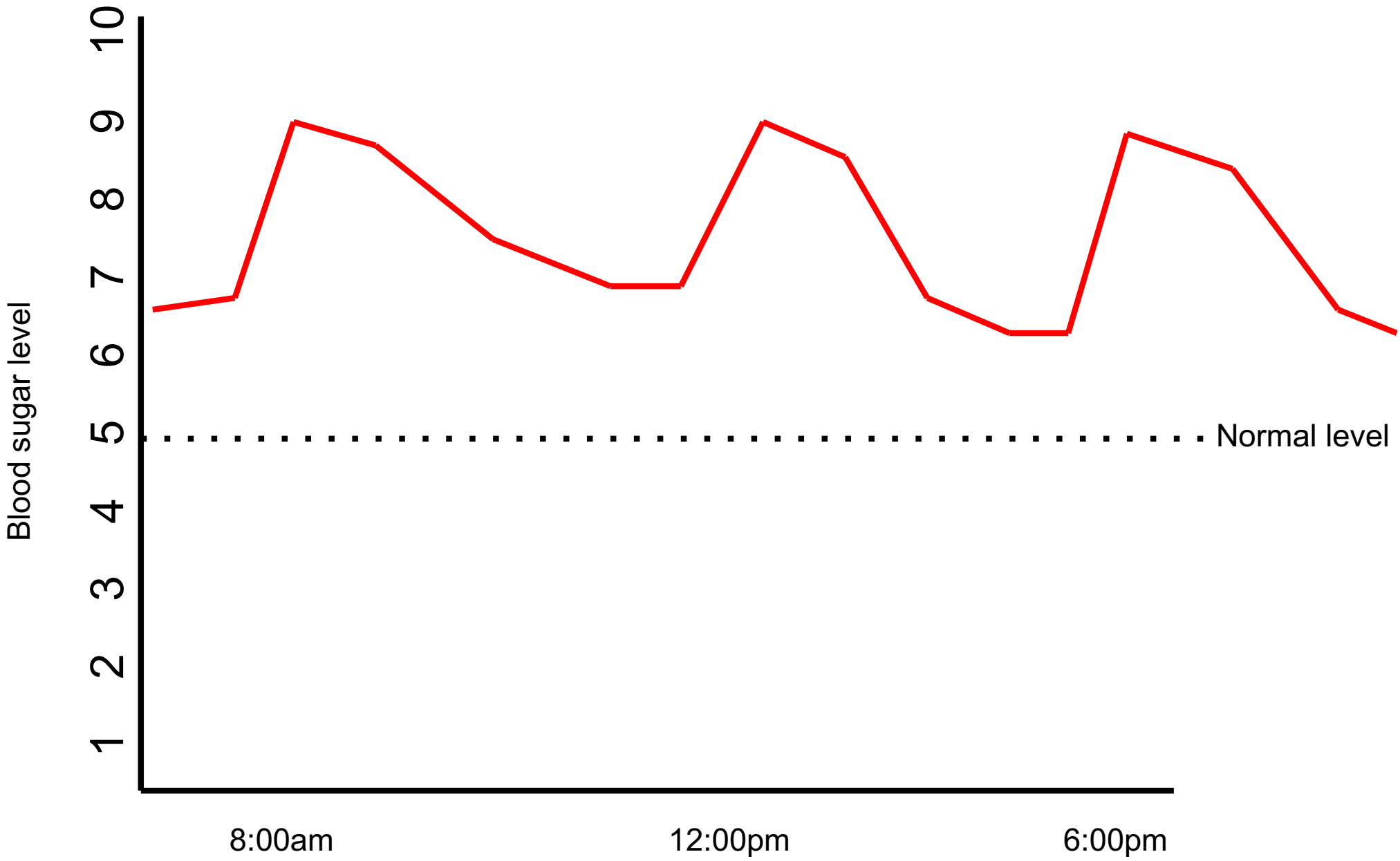
What would the blood sugar level on a graph look like if?

a) A normal person ate a meal at 8:00, 12:00 and 6:00.

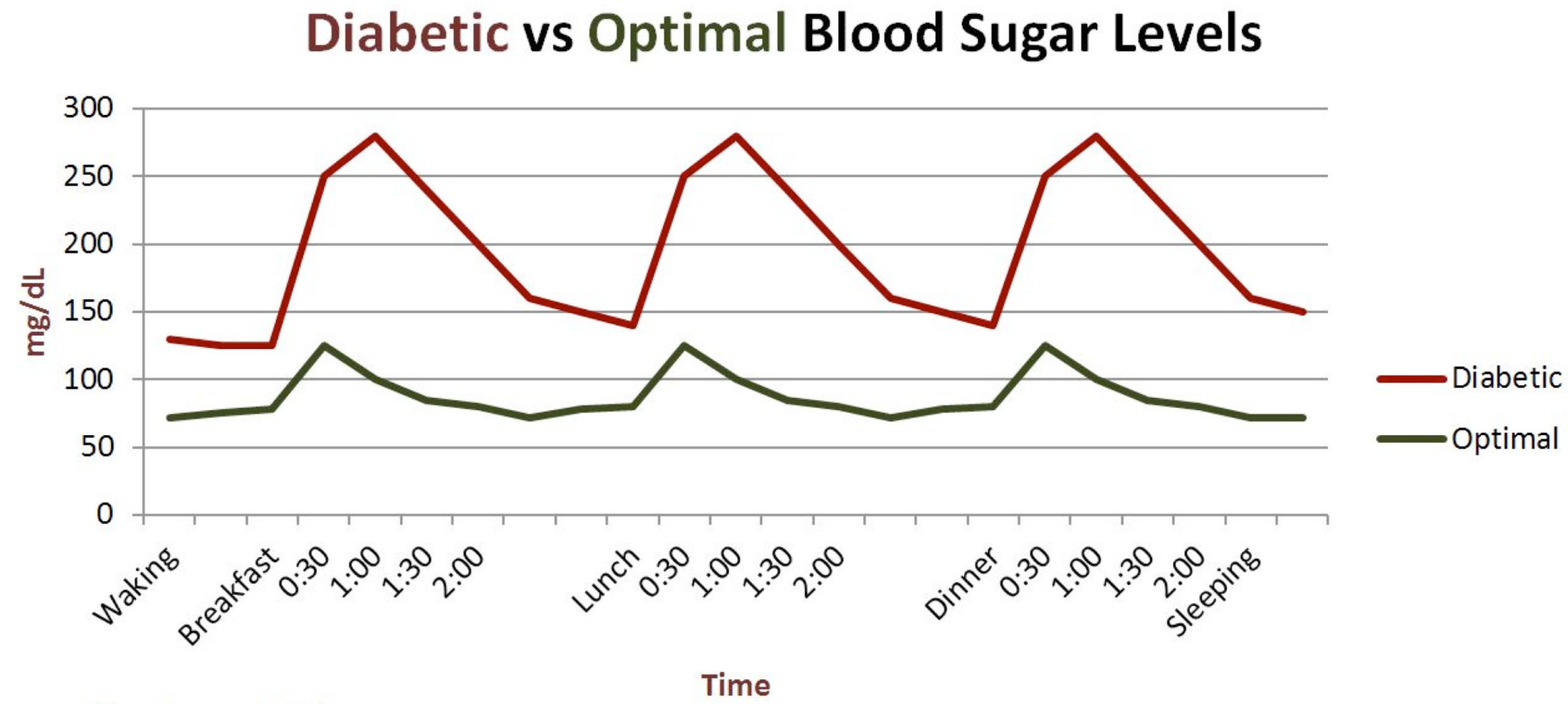
b) A diabetic TYPE 2 person ate meals at the same time.



Normal Blood Sugar Regulation

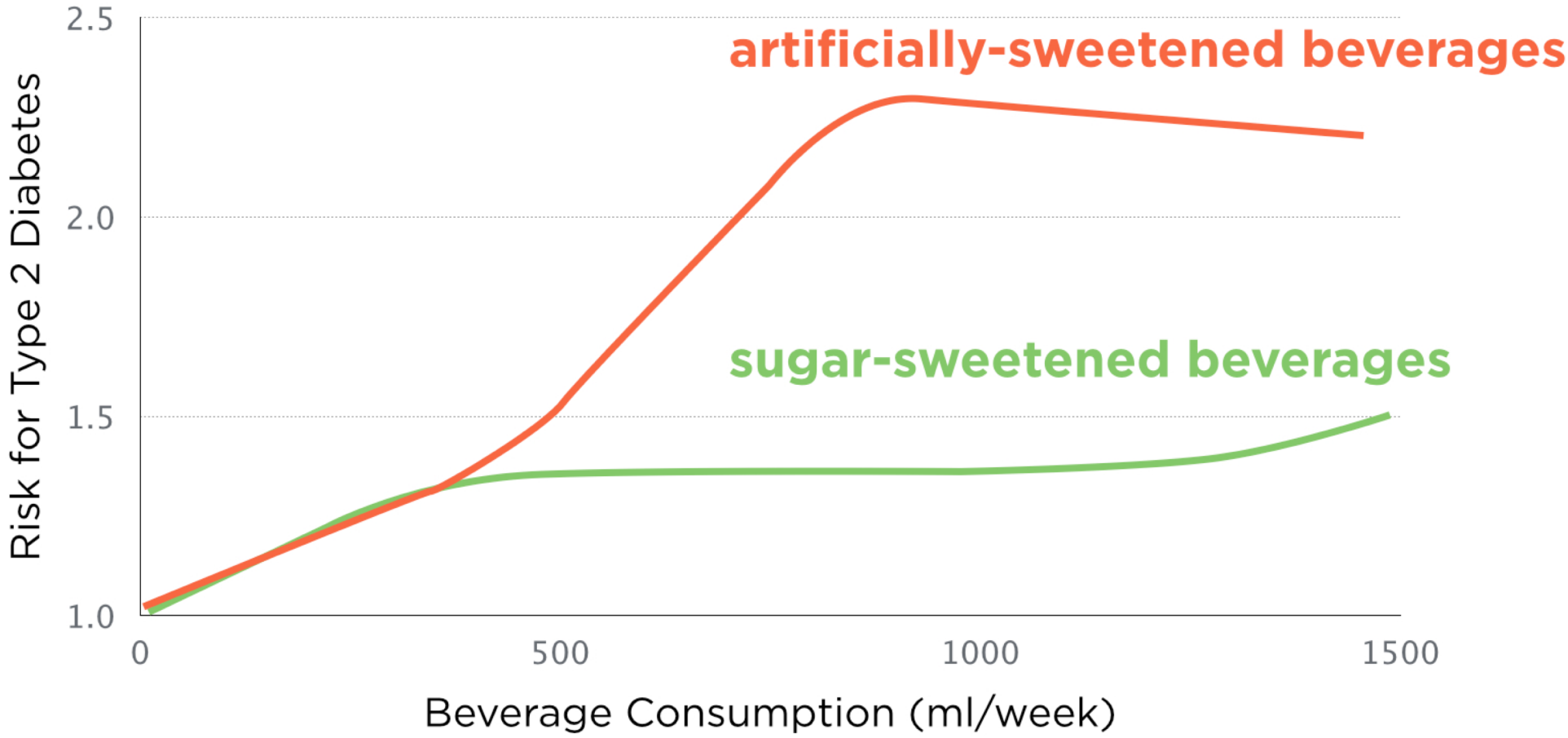


Diabetic Type II



www.bloodsugarbattles.com

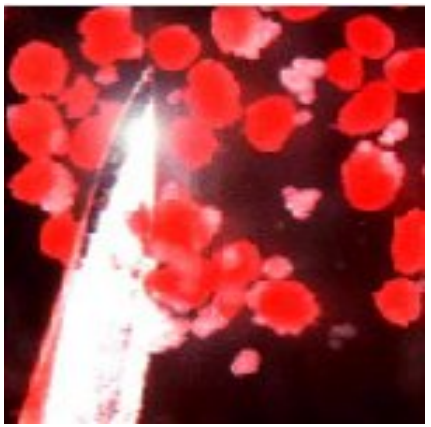
FYI- some studies find…



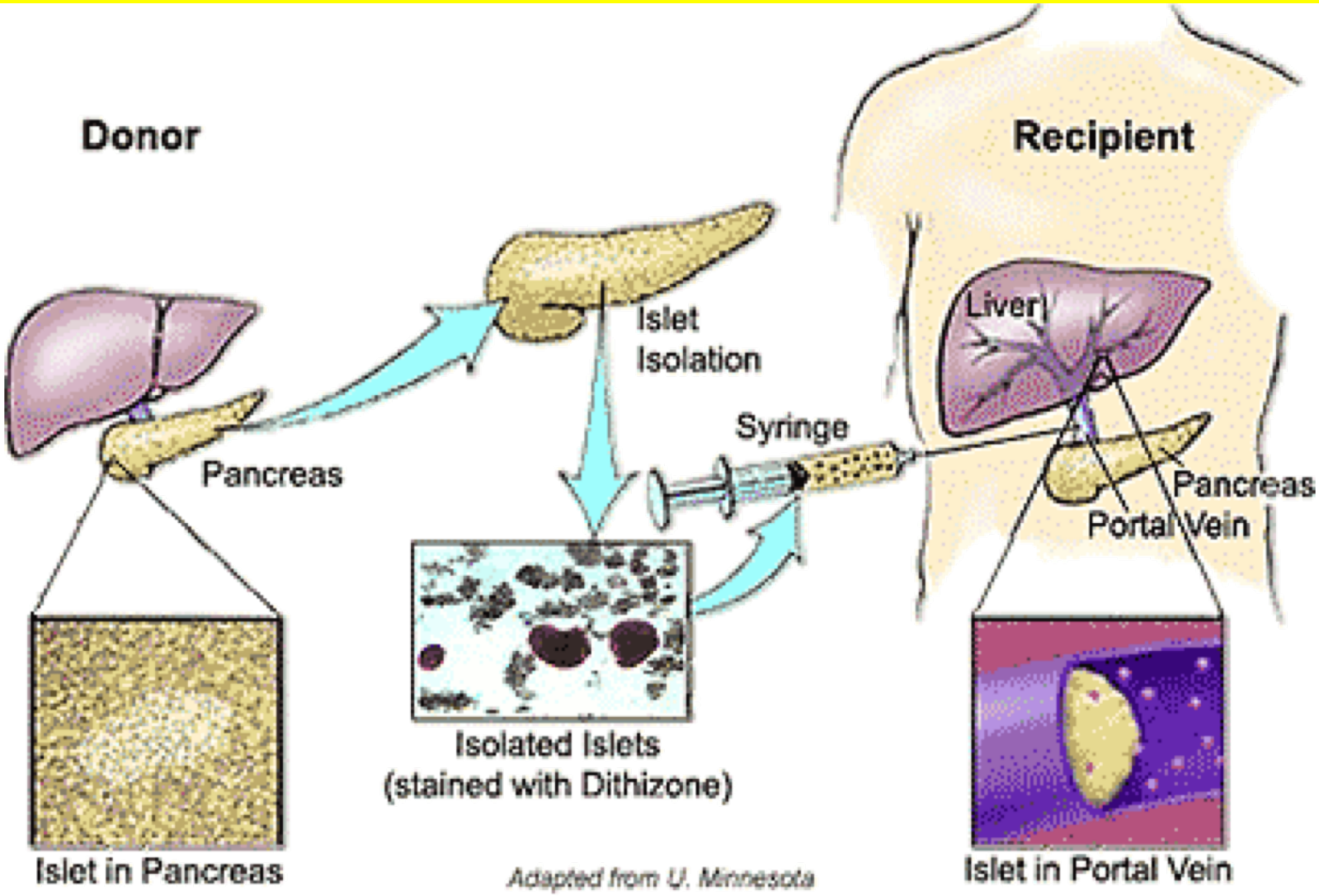
NO!! This does not give you permission to drink as much sugar as you want!

Islet transplants

- Islet transplants can reverse the effects of diabetes
- The **U of A** is a leader in islet transplants
- U of A hospital was the **first to successfully transplant** islets of Langerhans cells into a patient
- **Islet cells are taken from two cadavers and transplanted by injection into the patient.**
  - Patients are required to take immunosuppressant drugs.
- Need to have **2 pancreas** donations **per operation!** **(From 2 separate people)**



Islet transplants



Islet transplants

Challenges and Controversies:

- Who receives islet cell transplants?
- Where do we get adequate donor tissues?
  - Xenogenic (neonatal pigs)
  - Stem Cells
  - Engineered beta cells
- Can we improve the survival rate of transplanted cells?
- How do we reduce/eliminate the need for immunosuppressants and related side effects?

- COMPLETE WORKBOOK

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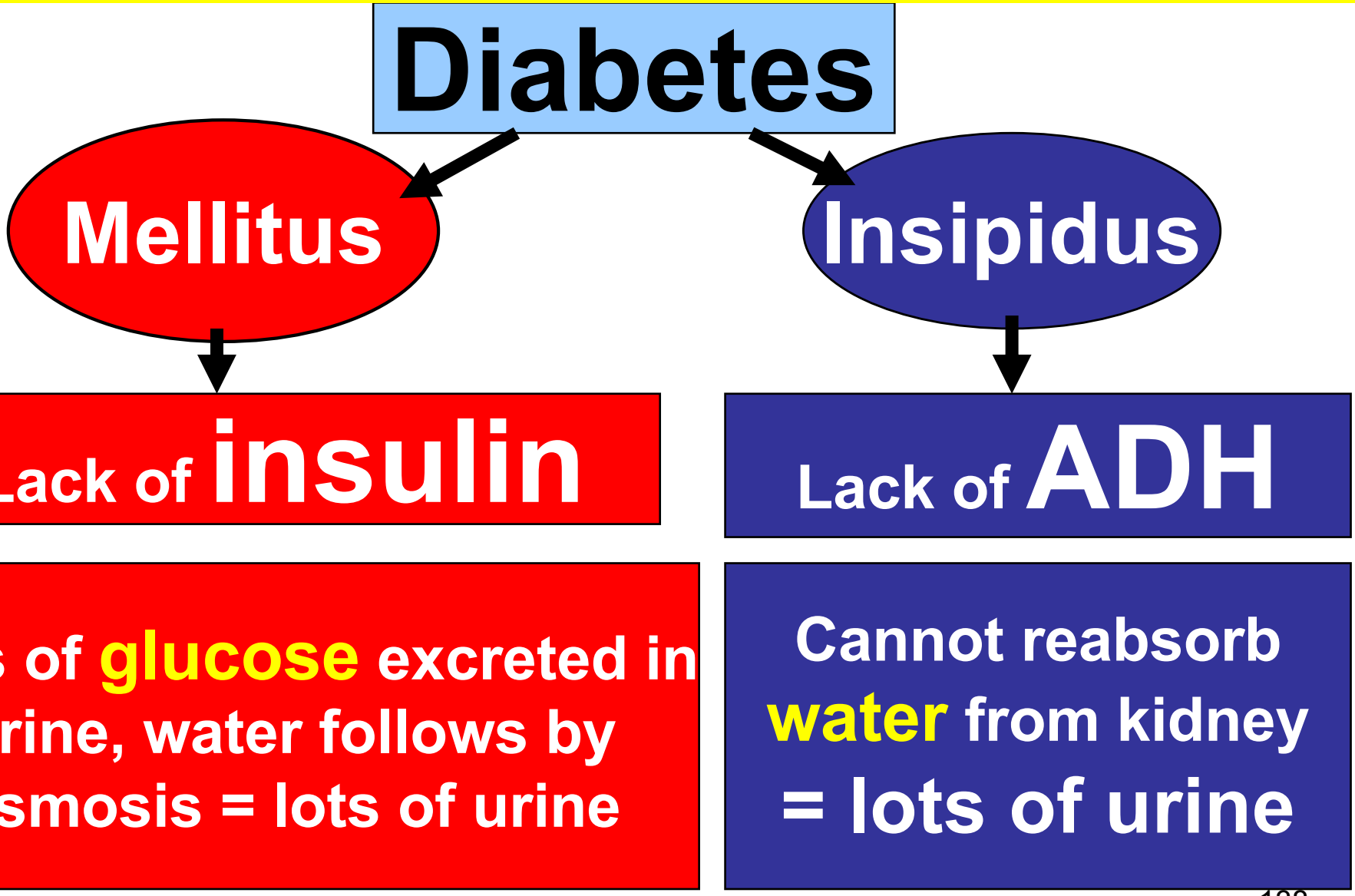
COMPLETE VOCABULARY

Don’t confuse Diabetes Mellitus and Diabetes Insipidus!



Control of Blood Glucose

1. **Pancreas**
   - **Insulin** glucose → glycogen — ⇩BG
   - **Glucagon** glycogen→glucose — ⇧BG
2. **Adrenal Cortex**
   - **Cortisol** ⇧aa in blood →liver → glucose — ⇧BG
3. **Thyroid**
   - **Thyroxin** cellular respiration — ⇩BG
   - $Glucose + O_2 \rightarrow CO_2 + H_2O + ATP$
4. **Adrenal Medulla**
   - **Epinephrine** glycogen→ glucose — ⇧BG

Control of Metabolism

1 . Thyroid Gland

Thyroxine - increases metabolism

2. hGh

-Promotes protein synthesis (growth)
-used to change the “fuel” muscles use (fat used in times of fasting)

Control of Blood pressure / water balance

ADH released in response to **dehydration** **(lack of water)**

Aldosterone is released in response to low **blood pressure or low volume** **(due to loss of fluid like diarrhea or hemorrhage)**.

Prostaglandins

- Group of hormones that do not travel to sites in the body
- Have a pronounced effect in a small localized area

(eg) when tissue is damaged(stressed), the cells of the area release prostaglandins

- They stimulate inflammation, increase blood flow, and stimulate blood clotting in the area

Aspirin blocks prostaglandin from being released and this prevents blood from clotting which is why it is given to patients with heart disease

Estrogen and Progesterone

Estrogen

- **Production Site: follicles** within the ovary, and **corpus luteum** **(part of ovary)**
- **Targets: various cells**
- **Functions:**

-promotes development of **secondary sexual characteristics** (breasts, body hair);

-Initiates **thickening of uterine lining** in preparation for pregnancy each month

Progesterone

- **Production Site:** corpus luteum (part of ovary)
- **Target:** mammary glands for development
- **Target:** Endometrium (uterine lining)
- **Functions:** growth and maintenance of endometrium; inhibits ovulation and prevents **uterine contractions**

Testosterone

- **Produced in: testes**
- Production is regulated by **LH** from the anterior pituitary

- **Targets:** various cells

- **Function:**

-development of **primary** sexual characteristics
(penis, prostate, seminal vesicle development),

-development of **secondary** sexual characteristics
(facial hair, deepening voice, broadening shoulders);

-increases **sperm production**

- COMPLETE WORKBOOK
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Check your Understanding…

How does insulin affect the bodies cells?

Increases permeability to glucose

How does glucagon increase blood glucose levels? 2 ways

Decreases cell permeability to glucose, converts glycogen to glucose

How is glycogen different from glucose?

Glycogen is storage form of glucose in liver and muscles

How much glucose should normal urine posess?

NONE

How does insulin do its job?

Hooks up with receptors which then allows glucose to enter cell

Which type of Diabetes Mellitus requires life dependent injections of insulin?

Type 1

Why is Diabetes Type II not immediately life threatening?

They still produce insulin but in lower amounts and/or insulin is not as effective to allowing glucose into cells

Think about it!

- Blood glucose is reduced by medication, how does the body respond? Releases glucagon to increase glucose from glycogen
- Calcium levels go down because of a tumor, what does the thyroid do? Its not his problem. Parathyroid will increase calcium level with PTH
- PTH levels are unnaturally too high. How will the body respond? Thyroid will release calcitonin to deposit excess calcium into bones
- The Thyroid cannot produce any thyroxine because of a missing ingredient, what will happen to TSH-RH levels?

Increase because metabolism still not going up because no thyroxin being released

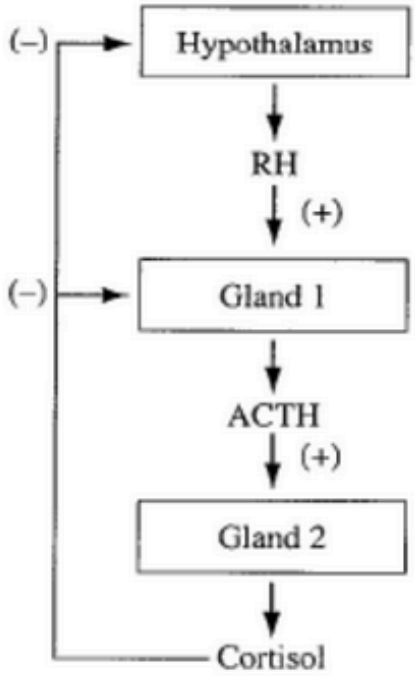
- You sweat and lose salt and water. You are so thirsty. How will your body respond to your dehydration?

Increase ADH release

Researchers suggest that the brain has a daily "internal clock" that is controlled by the endocrine and nervous systems. The hormone ACTH helps to regulate the nervous system and gives the body the ability to respond to changes in sleep patterns. The release of ACTH is suppressed during sleep but increases before a person awakes.

The feedback loop below illustrates part of the regulatory hormonal control of the internal clock.

Regulatory Hormone Feedback Loop



The secretion of ACTH is suppressed during sleep as a result of

A. increased activity of the pituitary gland
B. decreased secretion of RH by the hypothalamus
C. decreased secretion of cortisol by the adrenal cortex
D. increased nervous system input to the medulla oblongata

ANSWER B: If the hypothalamus does not release a "RH" (releasing hormone), then GLAND 1 will not release ACTH.

Diabetes insipidus is a disorder in which the body fails to produce sufficient ADH. One symptom of this disorder that is directly related to ADH secretion is

A. the production of large amounts of dilute urine
B. a decrease in the glucose concentration in the blood
C. an increase in the glucose concentration in the urine
D. the production of small amounts of concentrated urine

Parathormone and calitonin are hormones that work antagonistically. Two other hormones that work antagonistically are

A. TSH and thyroxine
B. insulin and glucagon
C. ADH and aldosterone
D. prolactin and oxytocin

Low levels of calcium ions in the blood cause

A. decreased secretion of PTH and increased depo
B. decreased secretion of calcitonin and increased bones
C. increased secretion of PTH and movement of calcium from the bones to the blood
D. increased secretion of calcitonin and movement of calcium from the bones to the blood

ANSWER C: PTH (parathyroid hormone) RAISES blood calcium by taking it out of bones(storage).

Which of the following hormones plays a role in returning the salt concentration in the blood to homeostatic levels following heavy exercise?

A. Cortisol
B. Thyroxine
C. Aldosterone
D. Epinephrine

As you sweat, water and salt(sodium) is lost from blood. Aldosterone retains sodium in kidneys and with it, water. So this sodium and water has been saved from being released out of bladder.

Chemicals found in alcohol and tea have a diuretic effect. Diuretics cause the body to produce greater-than-normal volumes of urine.

Diuretic chemicals counteract the effect of the hormone

A. ADH
B. insulin
C. cortisol
D. prolactin

ADH = anti-diuretic hormone which means it prevents water loss

Homework

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