YOUR HORMONES

ENDOCRINE SYSTEM

Endocrinology: study of **ductless glands**

- Release secretions (hormones): **directly** into blood
- **Hormone**: chemical messenger
- Secreted → blood → "effect" on other (**target**) cells
- Hormone: attaches to cell receptor → brings about "effect"

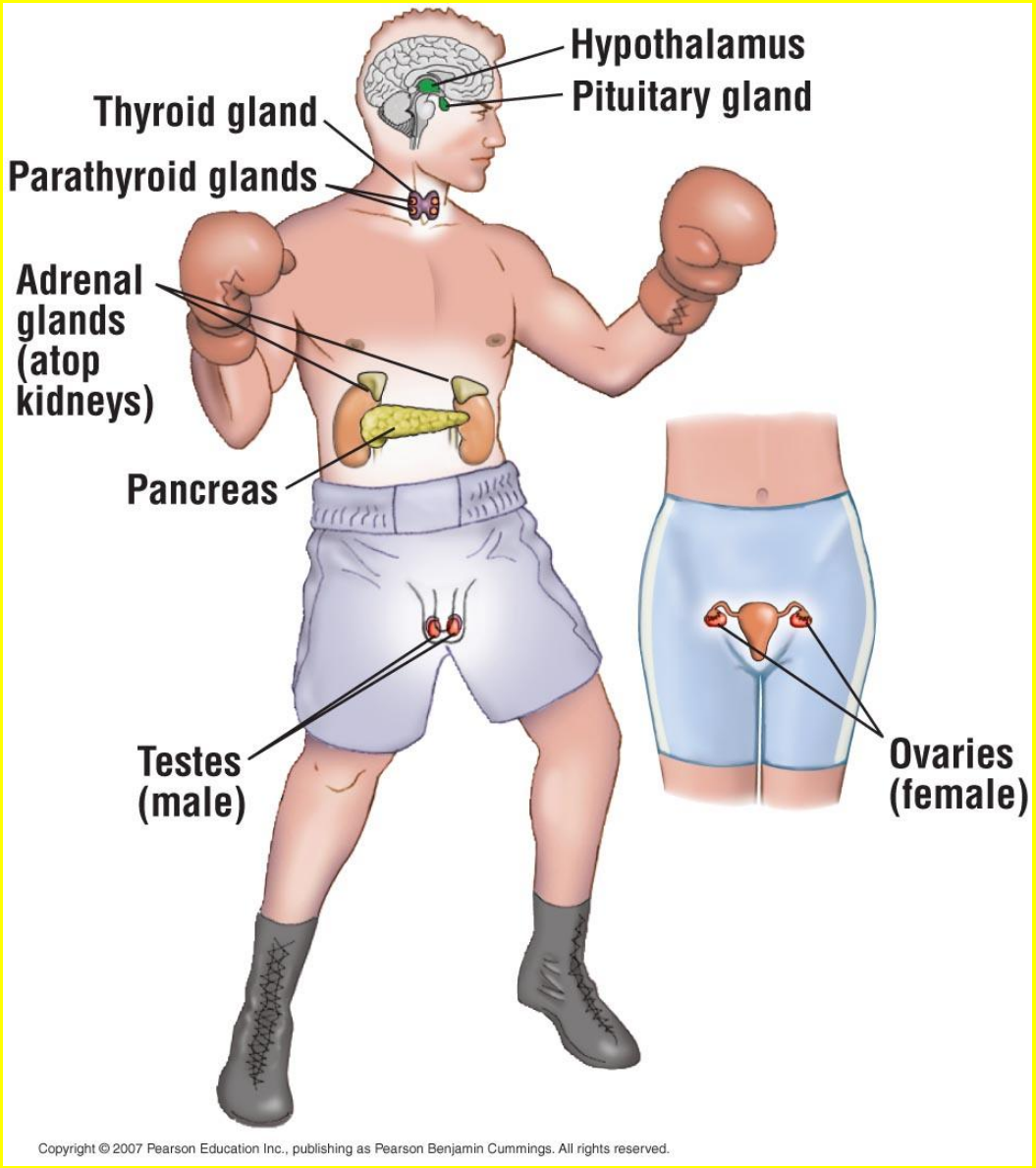
Nervous Impulses	**Hormone Action**
1. Fast	**1. Slower**
2. Rapid effect	2. Longer effect

Nervous ⟷ Endocrine Systems

Closely linked

Mind → Body (Bad/Good effects)

Major Endocrine Glands



Types of Hormones

1. Amino-acid based: made from an amino acid

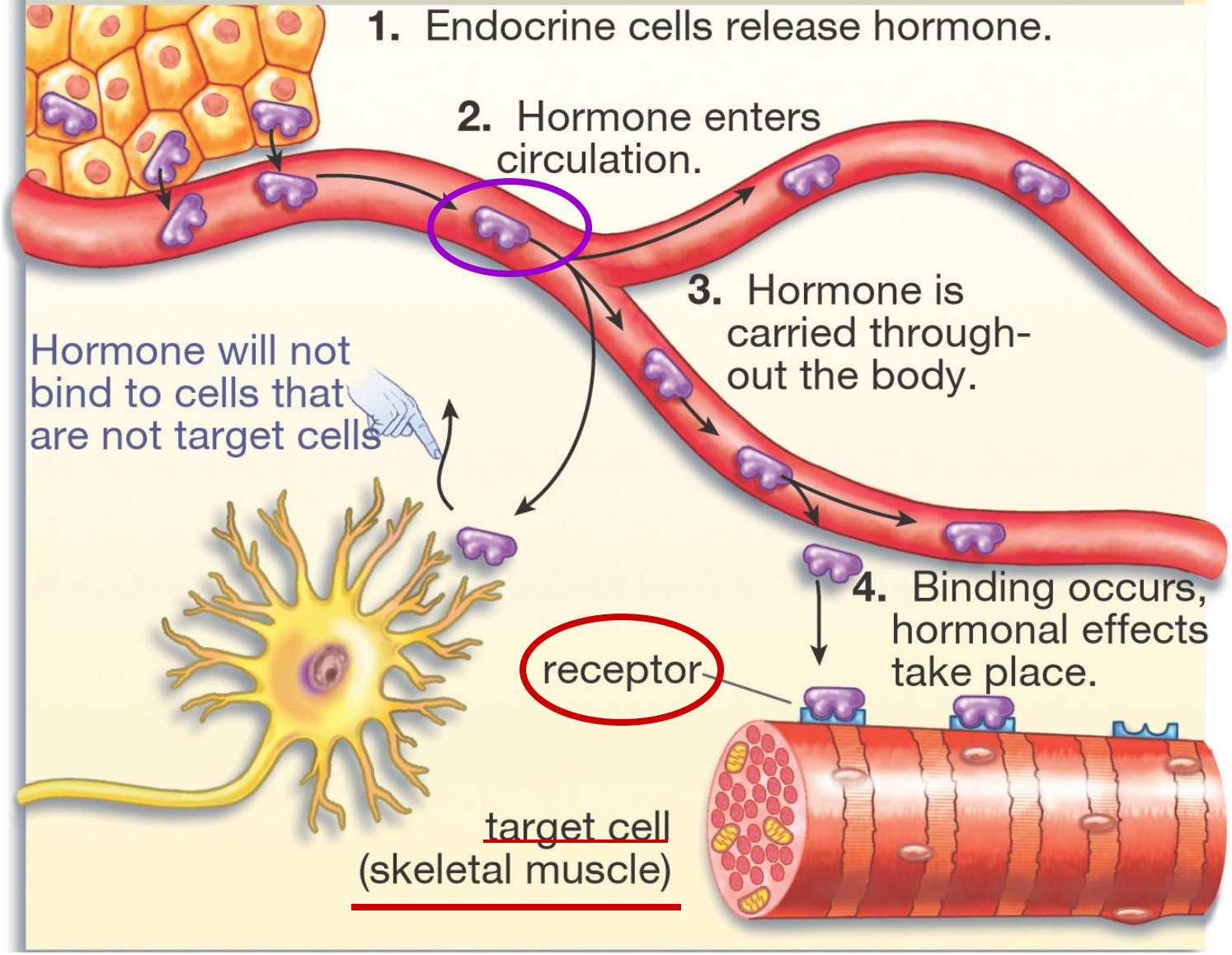
   Example: adrenaline, dopamine

2. Peptide Hormones

   Example: Growth hormone, insulin

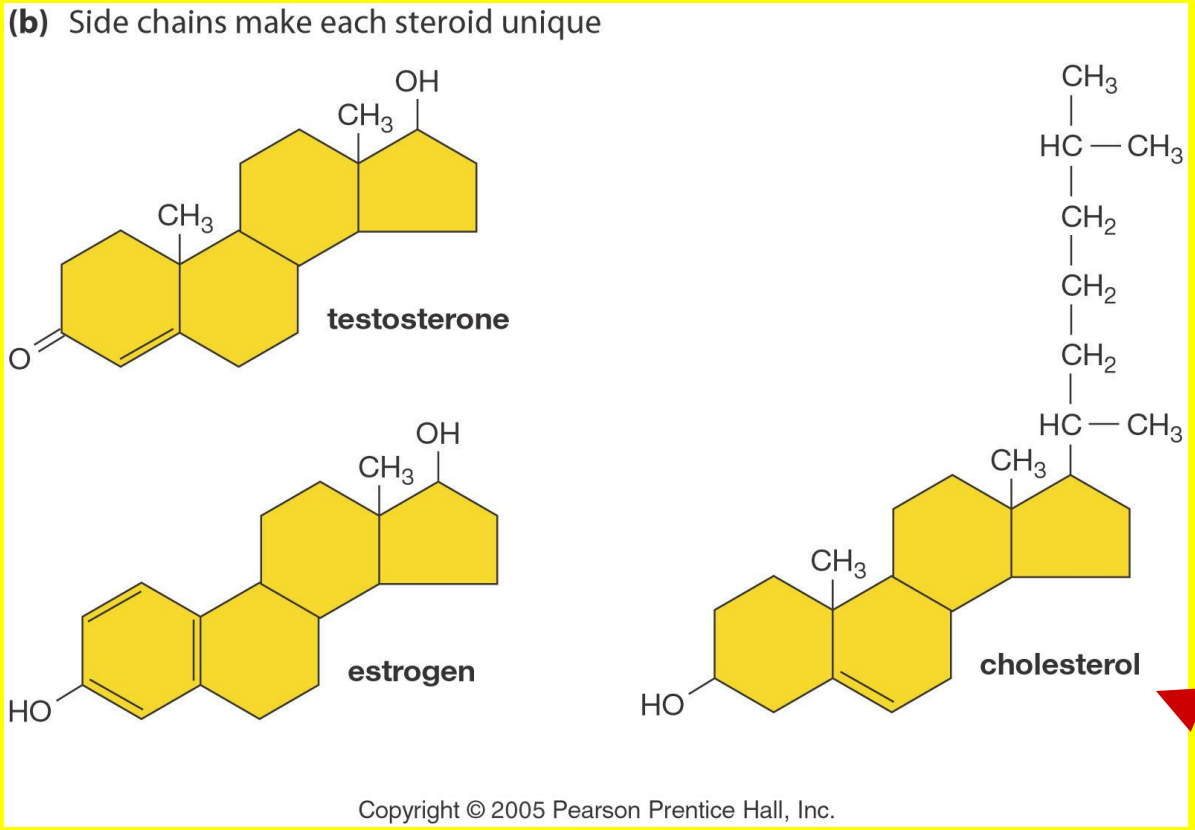
1 & 2 bind to **receptor** on cell membrane ⟶ change cell activity

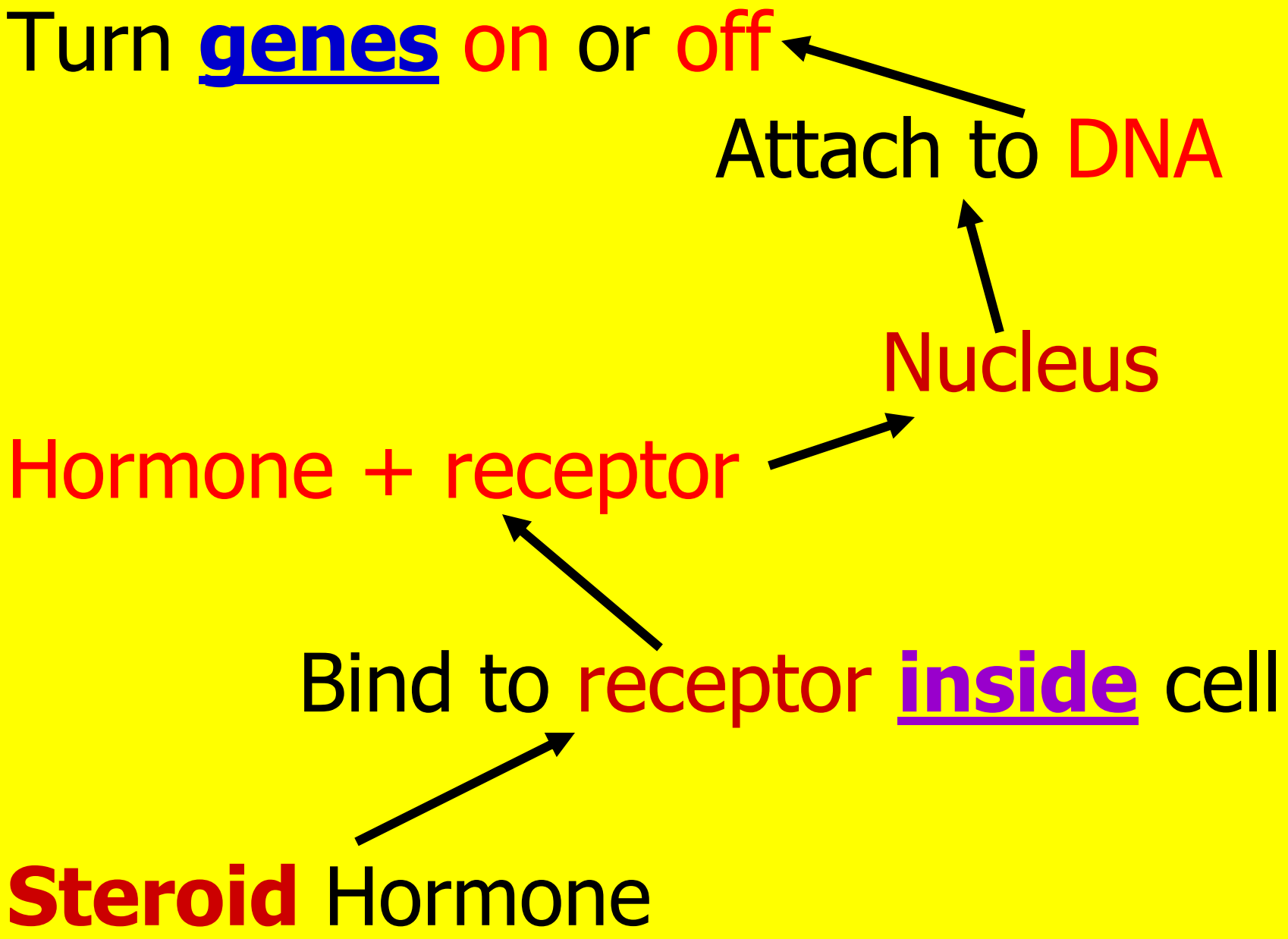
Hormones and Target Cells

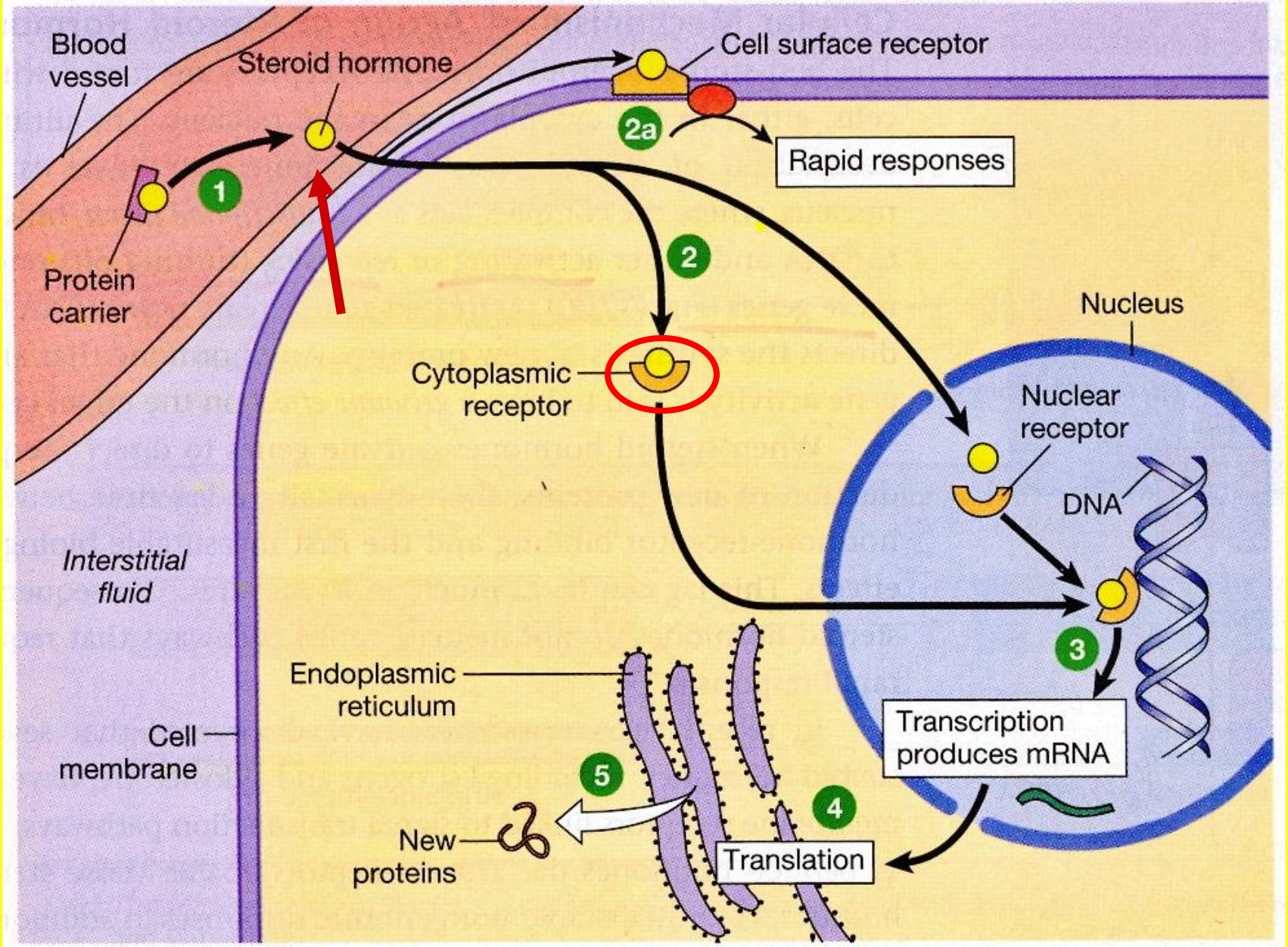


3. **Steroid** Hormones: made from **cholesterol**

Example: testosterone, estrogen

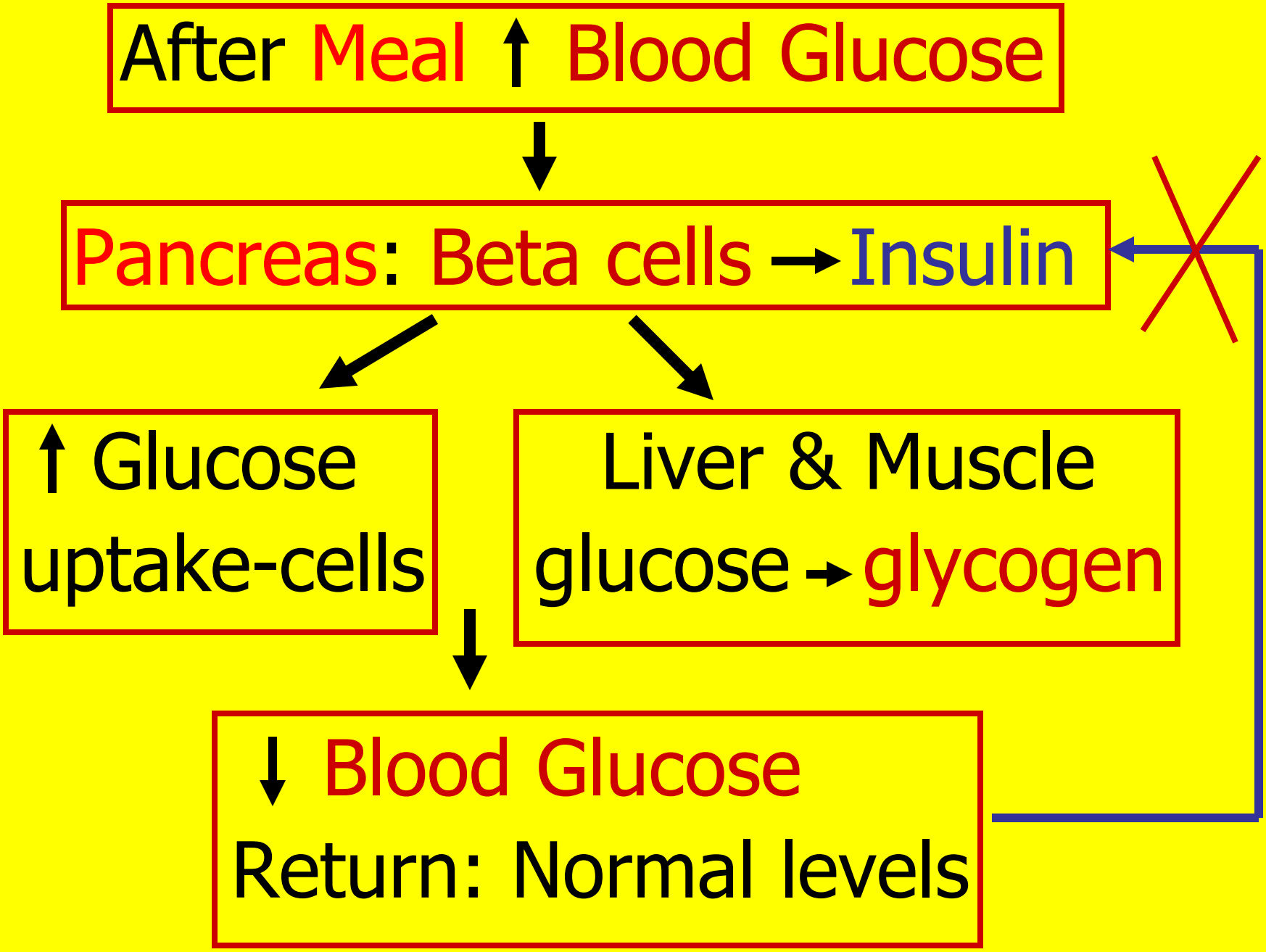


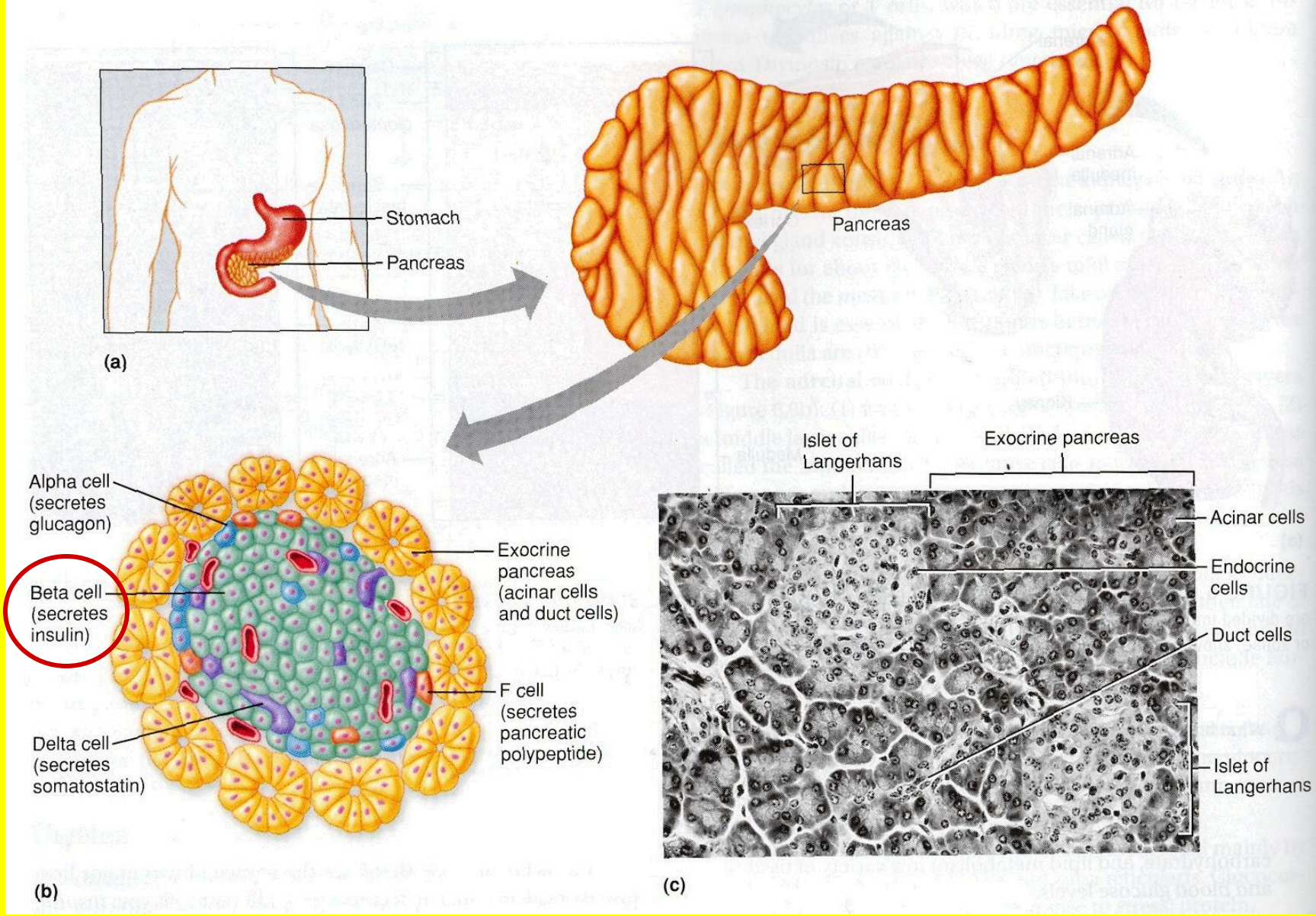

Turn genes on or off
Attach to DNA
Nucleus
Hormone + receptor
Bind to receptor inside cell
Steroid Hormone


Blood vessel
Steroid hormone
Cell surface receptor
2a
Rapid responses
1
Protein carrier
2
Nucleus
Cytoplasmic receptor
Nuclear receptor
DNA
Interstitial fluid
3
Endoplasmic reticulum
Transcription produces mRNA
Cell membrane
5
4
New proteins
Translation

How is Most Hormone **Secretion** Controlled?

NEGATIVE FEEDBACK

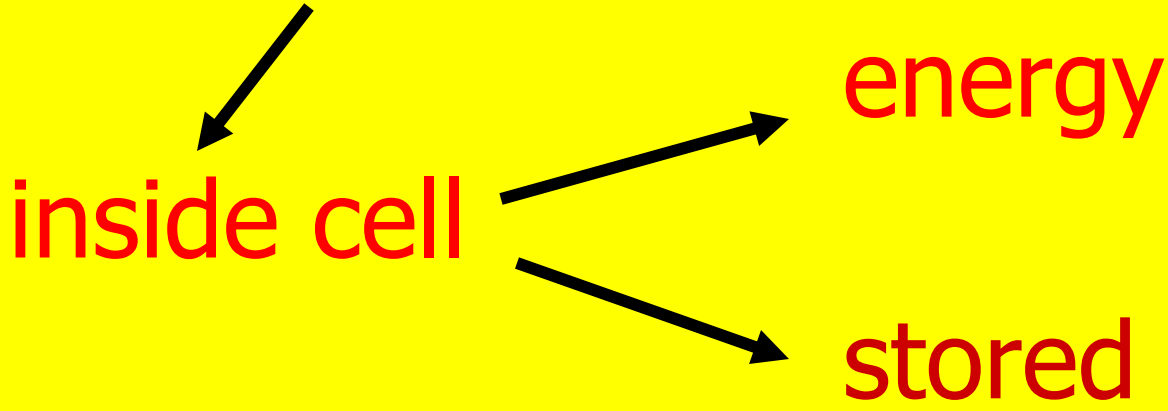

After Meal ↑ Blood Glucose
Pancreas: Beta cells → Insulin
↑ Glucose uptake-cells
Liver & Muscle glucose → glycogen
↓ Blood Glucose
Return: Normal levels


Stomach
Pancreas
(a)
Pancreas
Alpha cell (secretes glucagon)
Beta cell (secretes insulin)
Delta cell (secretes somatostatin)
Exocrine pancreas (acinar cells and duct cells)
F cell (secretes pancreatic polypeptide)
(b)
Islet of Langerhans
Exocrine pancreas
Acinar cells
Endocrine cells
Duct cells
Islet of Langerhans
(c)

Insulin ⟺ receptor- cell membrane

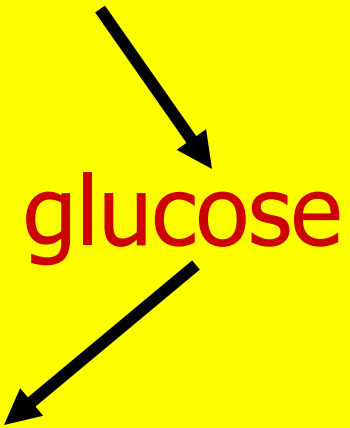
"key" opens door:

Glucose outside cell

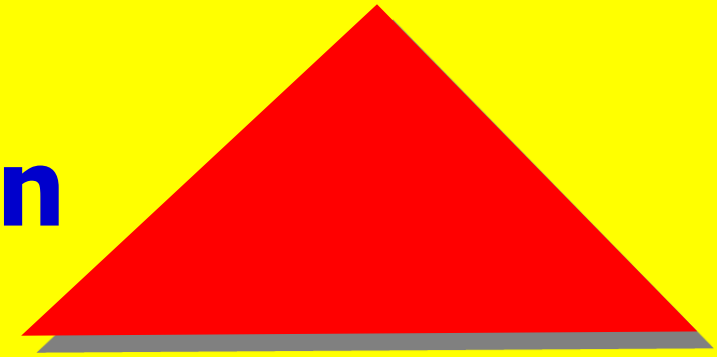


After few hours **without** food……

1. ↓ **Blood Glucose**
2. **Alpha** cells-pancreas → **glucagon**
3. Does opposite of insulin
4. **Glucagon**: liver glycogen



Insulin & glucagon **balance** each other

Insulin  **Glucagon**

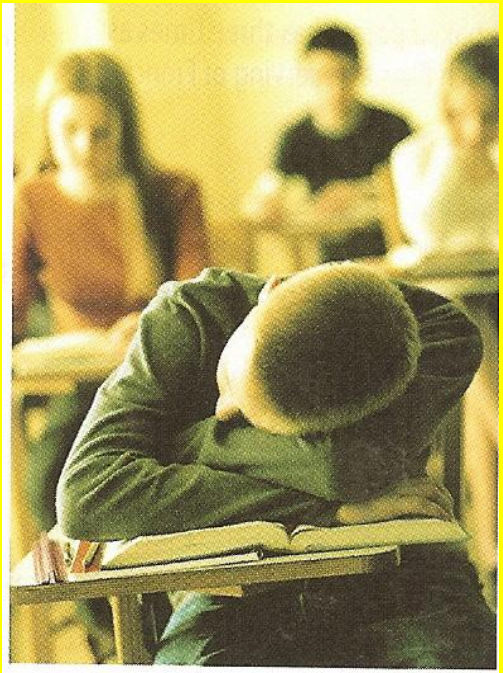
Keep blood glucose- normal levels

Why do you need to **shut off** insulin secretion after blood glucose reaches normal levels?

Answer:

Hypoglycemia

(low blood sugar)



Our red blood cells, brain, and nerve cells primarily rely on glucose. This is why you get tired, irritable, and shaky when you have not eaten for a prolonged period of time.

Extreme case: Diabetic

- **Inject** self with **insulin**
- Very little to eat
- Exercise actively: muscles use glucose

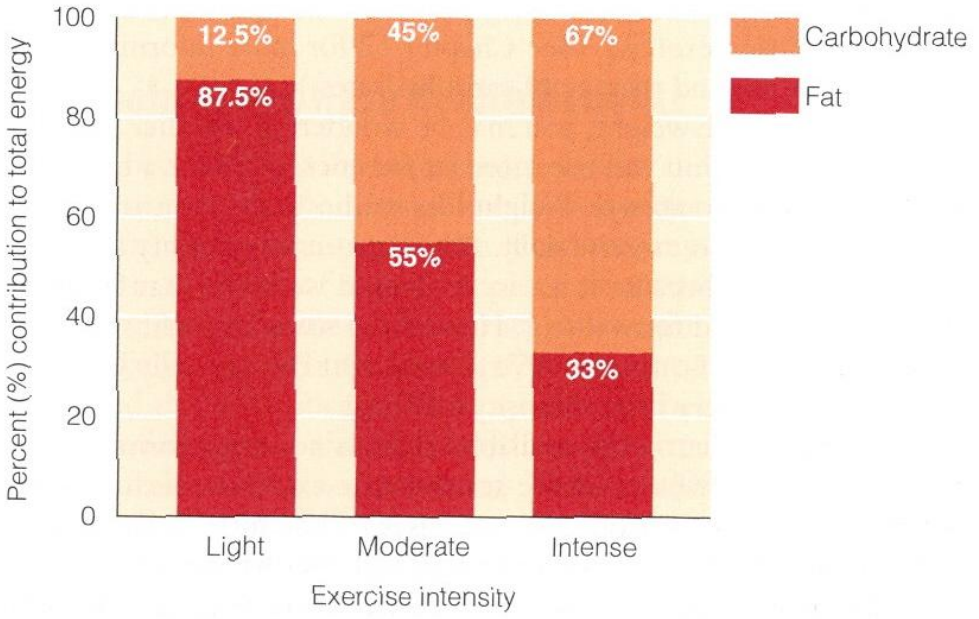


Figure 4.9 Amounts of carbohydrate and fat used during light, moderate, and intense exercise. (Adapted from J. A. Romijn, E. F. Coyle, L. S. Sidossis, A. Gastaldelli, J. F. Horowitz, E. Endert, and R. R. Wolfe. Regulation of endogenous fat and carbohydrate metabolism in relation to exercise intensity and duration. *Am. J. Physiol.* 265 (*Endocrinol. Metab.* 28) (1993): E380–E391.)

Result: Rapid drop in blood glucose

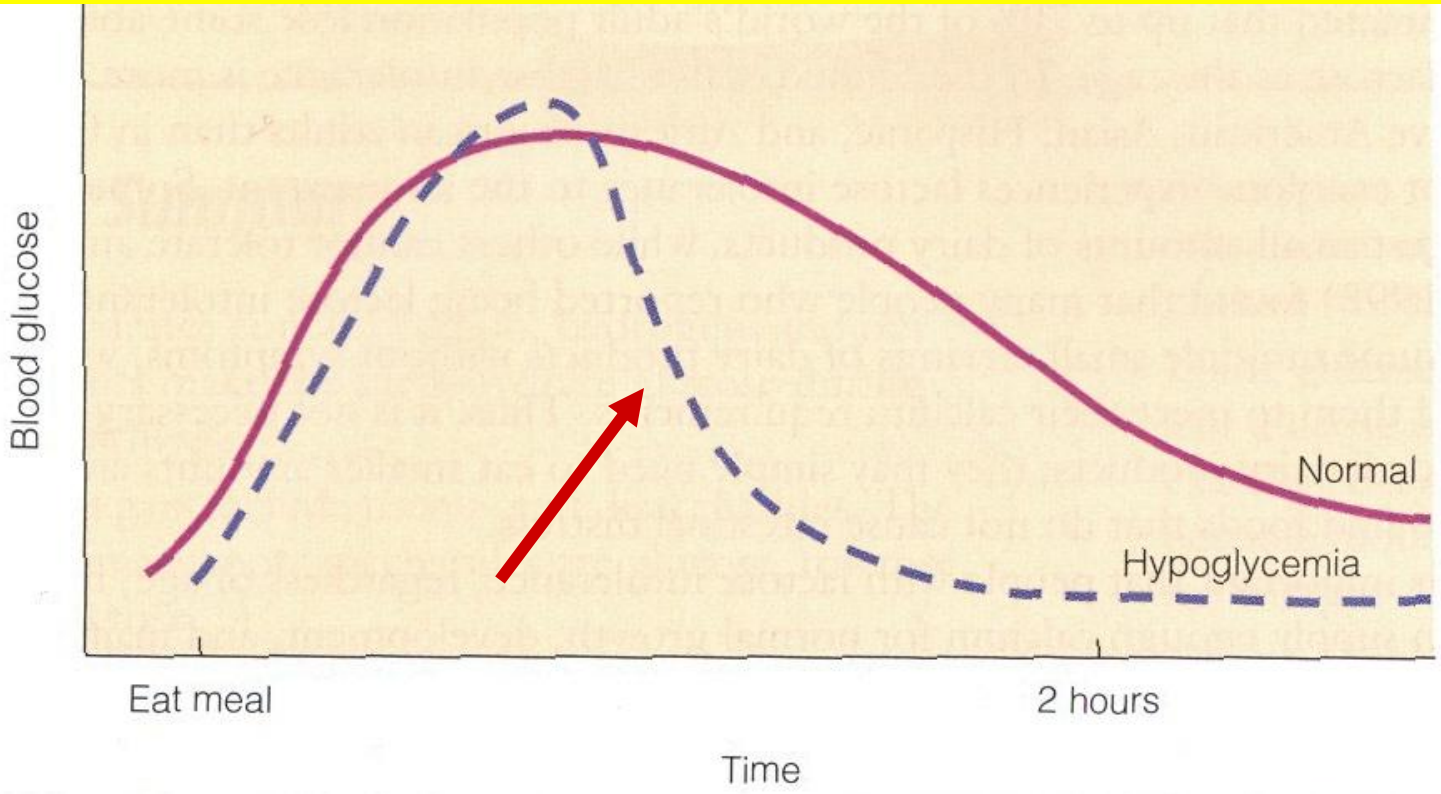


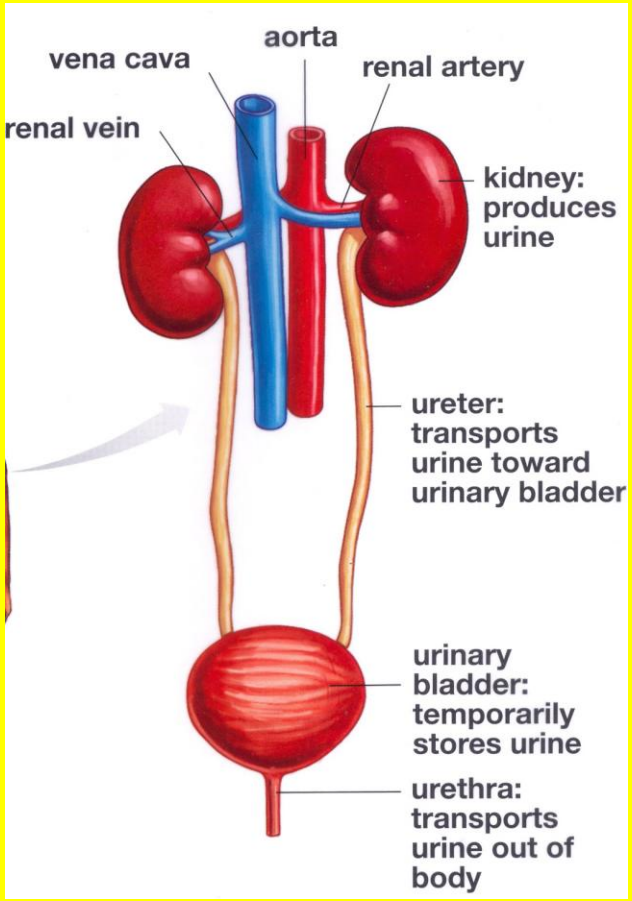
Figure 4.17 Changes in blood glucose after a meal for people with hypoglycemia and without hypoglycemia (normal).

Blood Glucose Levels

- Normal glucose narrow range: **80-100** milligrams/100 ml of blood (homeostasis)
- Uncontrolled diabetic: **200** milligrams or much higher **(600)**

Why does your body keep blood glucose in this narrow range?

- Kidney threshold: **160-180** milligrams
- Above this level: glucose spills- **urine**
- **Lost energy**

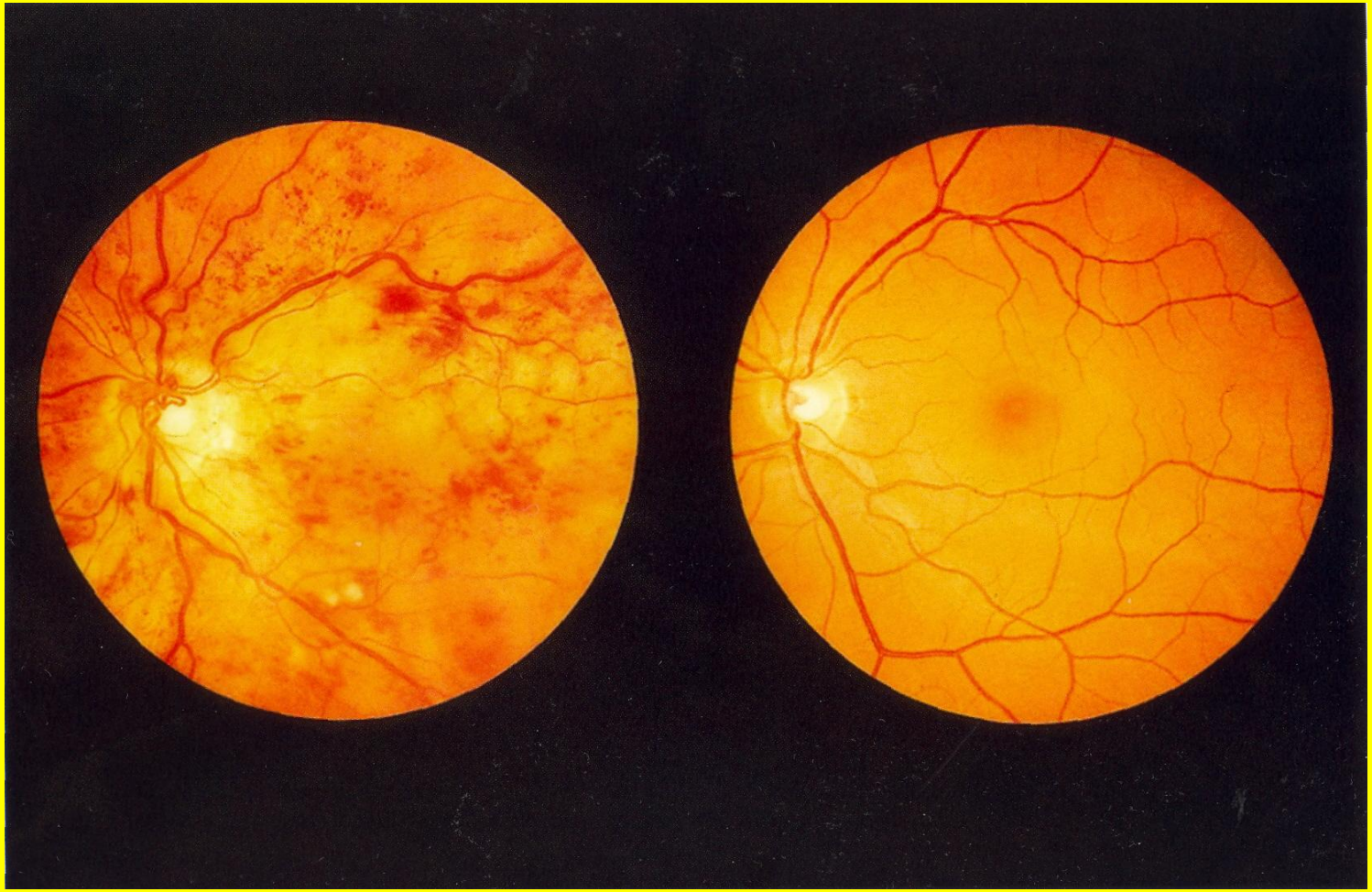


Why is **high blood glucose so bad?**

- **Glucose**- sticky: damages small blood vessels in body
- ↑ **Risk heart attack/strokes**
- ↑ Risk **kidney failure**
- **Nerve** damage- feet
- Damage- blood vessels eye **retina**

  (Diabetes: leading cause blindness)

Damaged blood vessels- diabetic retina (left)



- Infections (gangrene)/amputations: toes, feet, legs

Vincent Laforet for The New York Times

Diabetes, soaring among New Yorkers, has already left a mark on Diane and Aniello Discala of the Bronx. She lost a leg to its complications.

Who gets diabetes? Children, teens, young, old

Diabetes: uncontrolled, **high** blood glucose

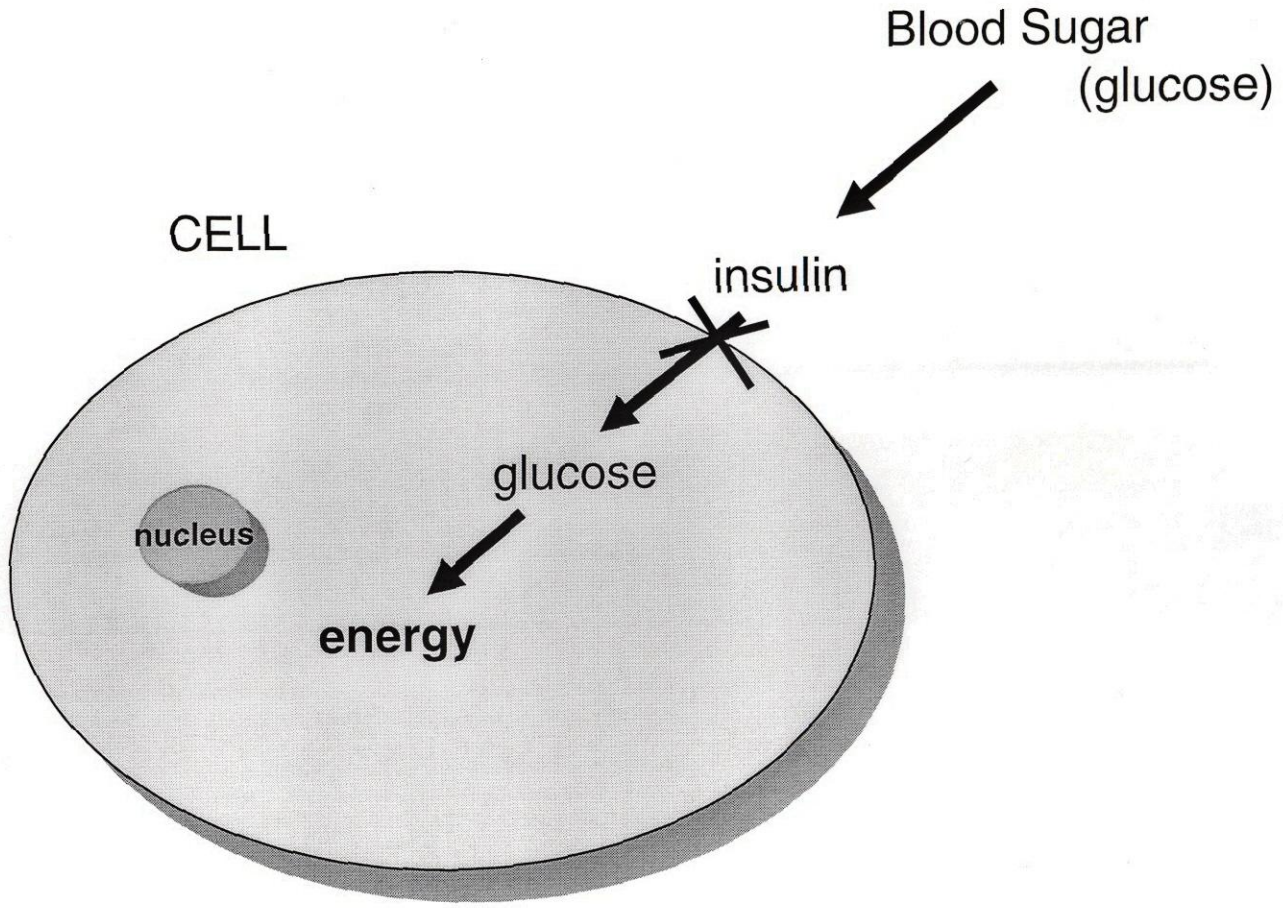
Type 1: **Insulin deficiency**

- Glucose can't get into cells
- "Starvation in the midst of plenty"
- Glucose spills- urine (wasted)
- **Causes**: genetics, viral infection, toxin exposure, autoimmune disease

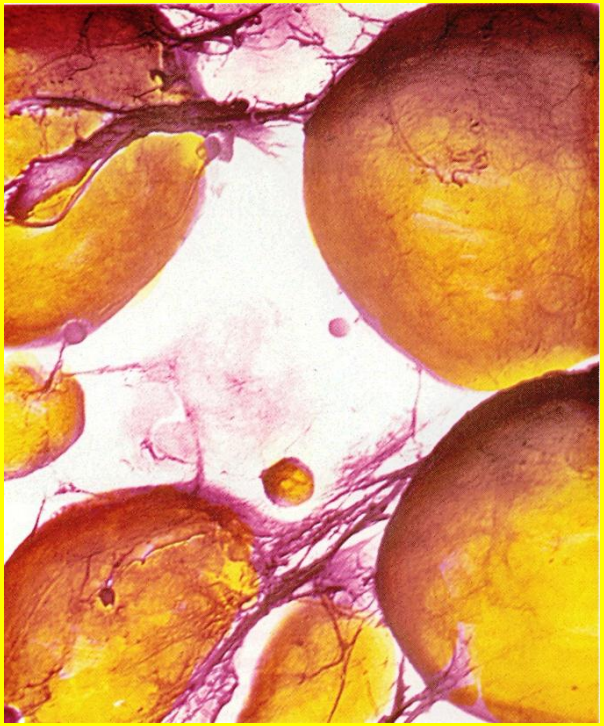
Type 2 Diabetes

- **Insulin** at high levels
- Trying to get glucose into cells
- Muscle & adipose tissue cells **not** responding: **"insulin resistance"**
- Result: ↑ blood glucose
- **Causes**: genetics, overweight/obese, at risk: African, Native, Hispanic, Asian Americans

Diabetic



- Overstuffed fat cells: leak fat & hormones (trigger inflammation): blood
- Fat → liver (fatty)
- Fat → muscle cells
  insulin resistance
- Fat → toxic: Beta cells



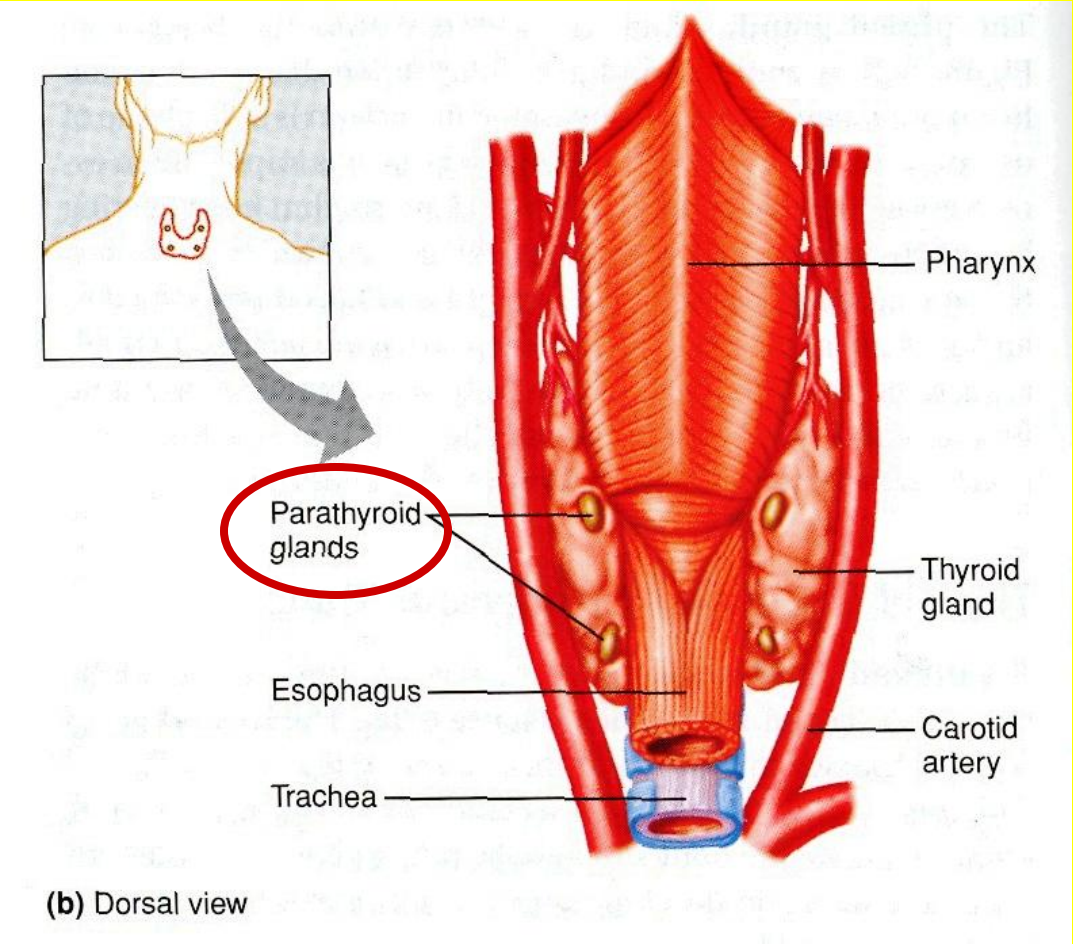
Parathyroid Hormones

Behind thyroid:

regulate

blood

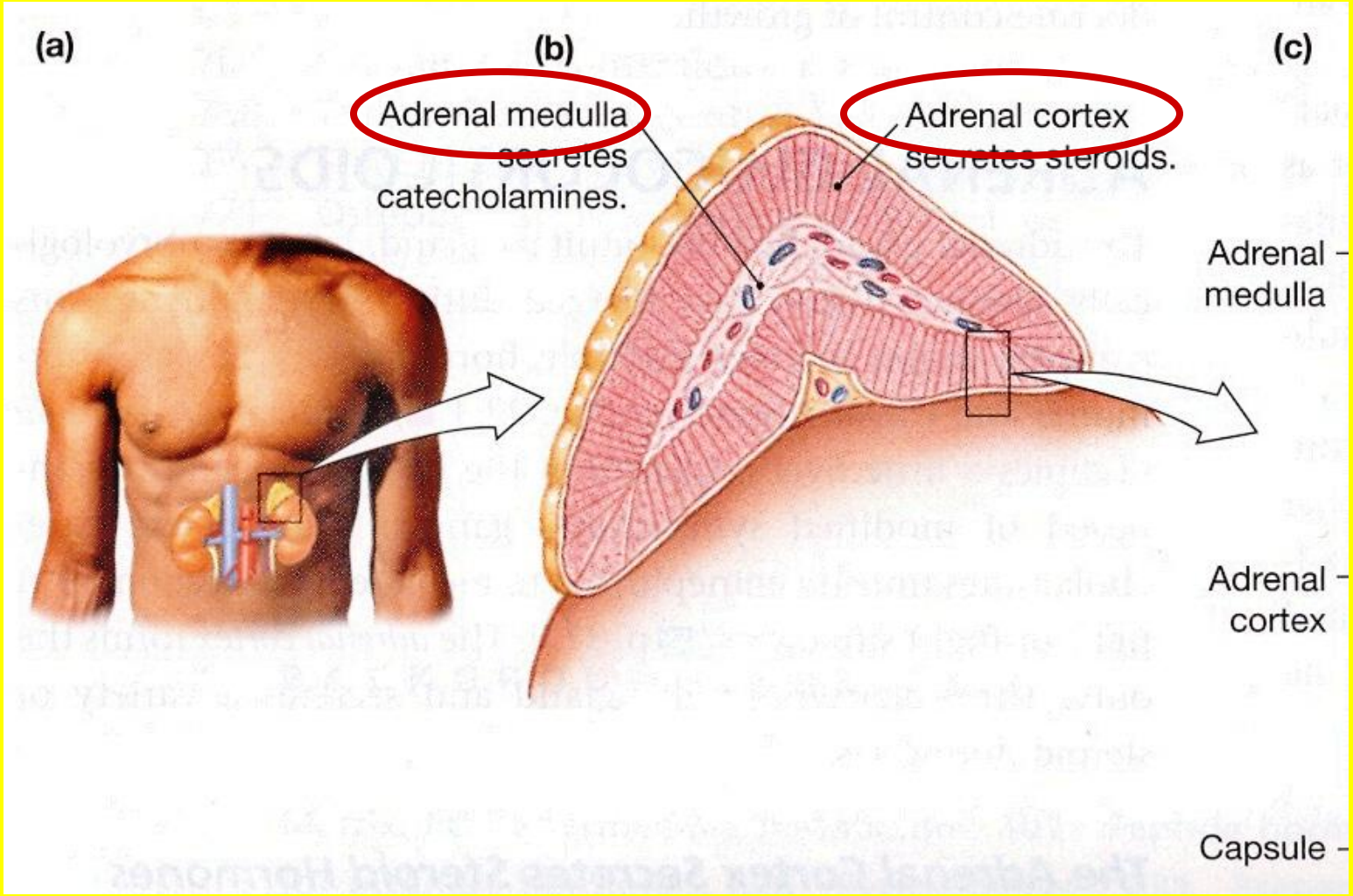
calcium



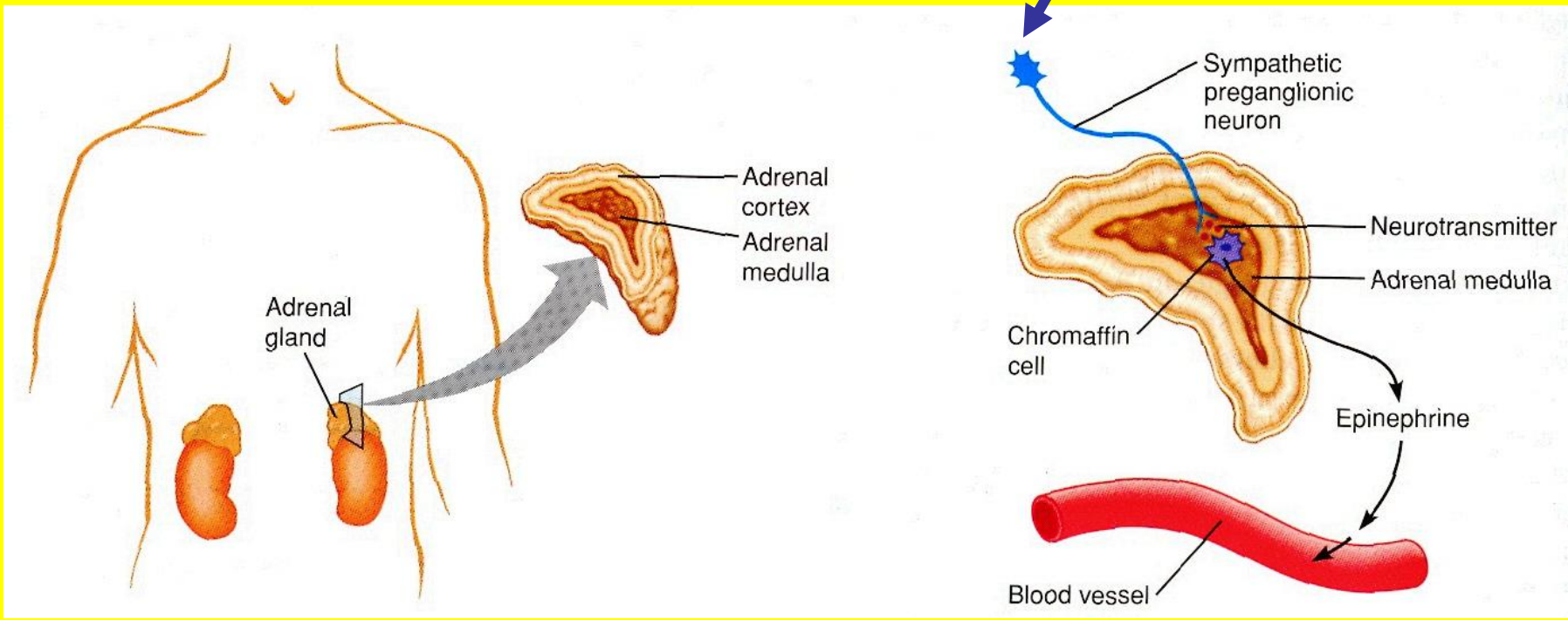
Blood calcium: important: blood clotting, stabilize: nerve & muscle membranes

- ↓ Blood calcium
- ↑ Parathyroid hormone
- **Bone calcium ⟶ blood**
- ↑ Blood calcium
- ↓ Shuts off parathyroid hormone
- **Negative feedback**

Adrenal Glands: on top of kidneys



Connected to brain (hypothalamus)



Hypothalamus

Sympathetic nerves

Impulses

Adrenal glands

Inner portion **(medulla)**

Adrenaline & noradrenaline

Blood: **Fight or Flight** response

(emergencies)

Fight or Flight Response

- Liver/muscle: glycogen → glucose
- ↑ **Blood glucose**
- Adipose fat → blood → energy
- ↑ **Heart rate/blood flow**
- Pupils/respiratory passages- dilate
- Blood vessels- muscle dilate

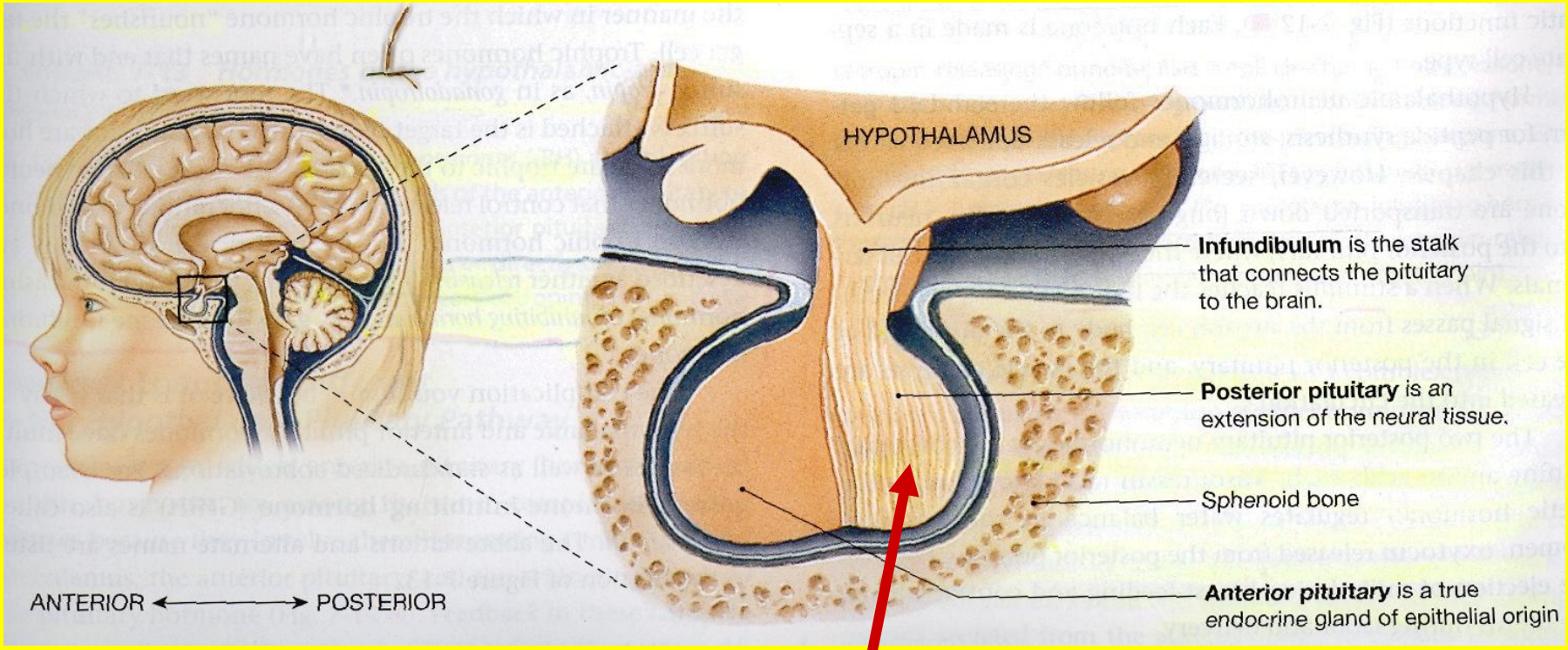
Hypothalamus

close link

Pituitary

“ master gland”

- Size: lima bean
- Attached by stalk
- Surrounded- bone
- 2 lobes: anterior (front), posterior (back)



Posterior: extension of **hypothalamus**

Posterior Pituitary

2 hormones:

1. **Antidiuretic Hormone (ADH)**
2. **Oxytocin**

Made in hypothalamus → neuron → (stored) posterior pituitary

3. Brain **nervous impulse** → **pituitary** → hormones → blood

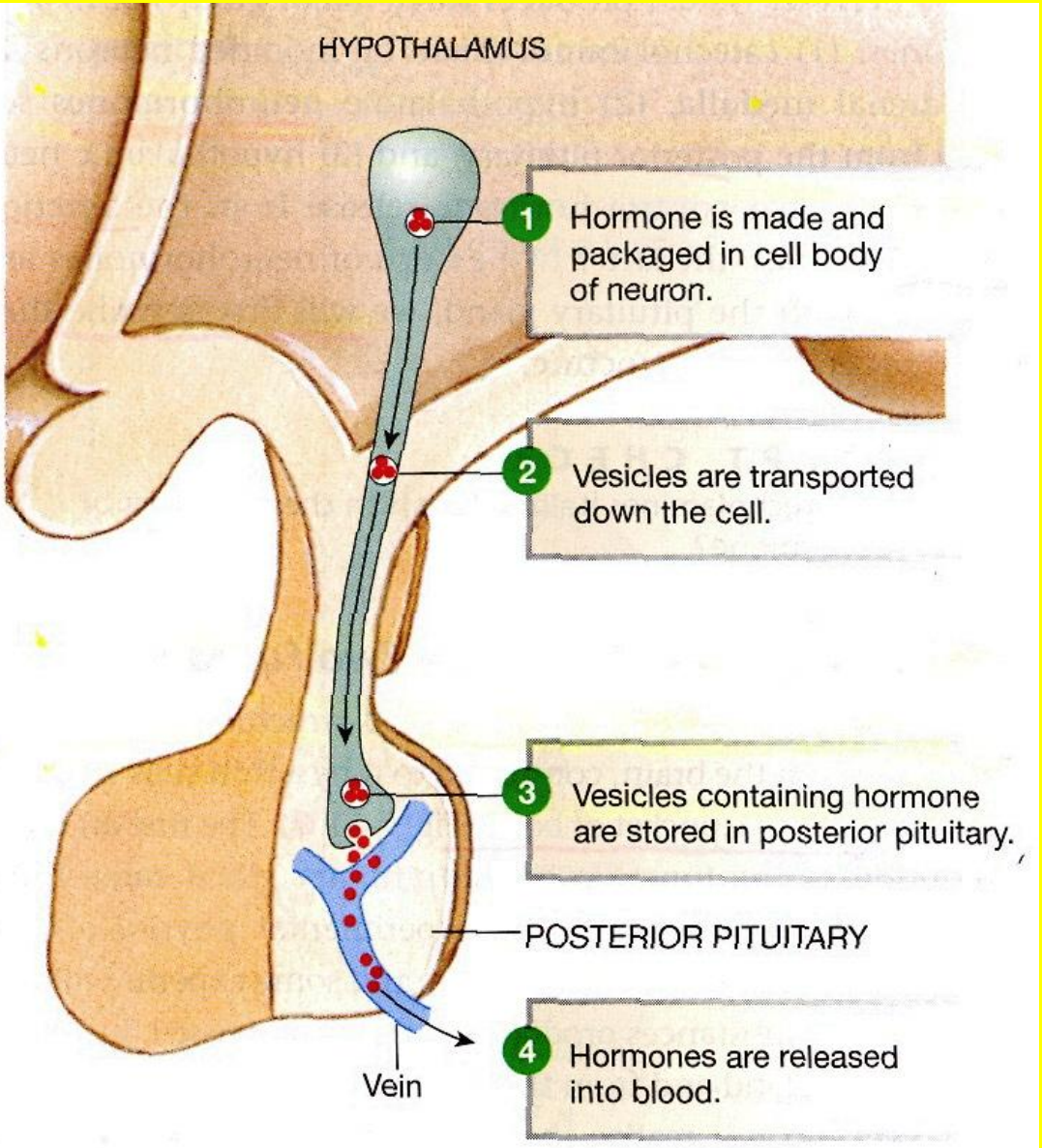


FIGURE 7-12 *Synthesis, storage, and release of posterior pituitary hormones*

ADH: regulates **H20**

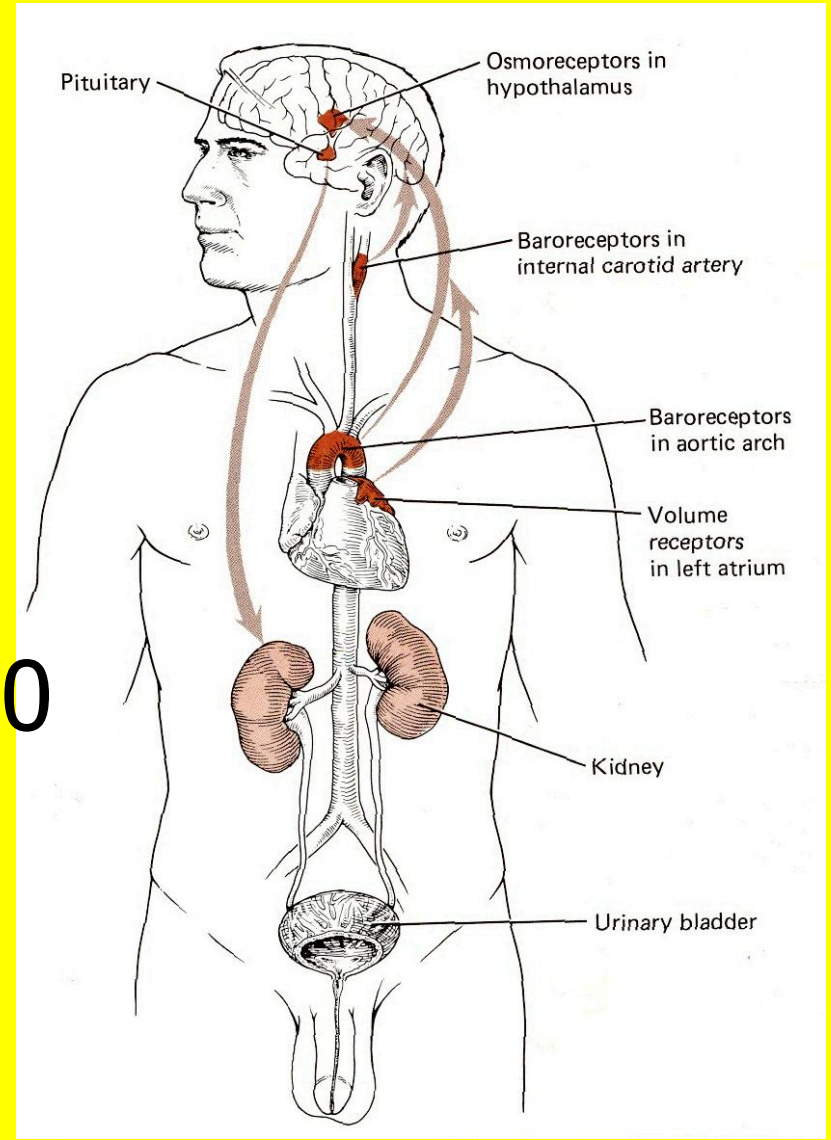
Balance:

Low H20 intake

- Concentrated blood
- ↑ ADH
- Kidneys reabsorb H20

High H2O intake

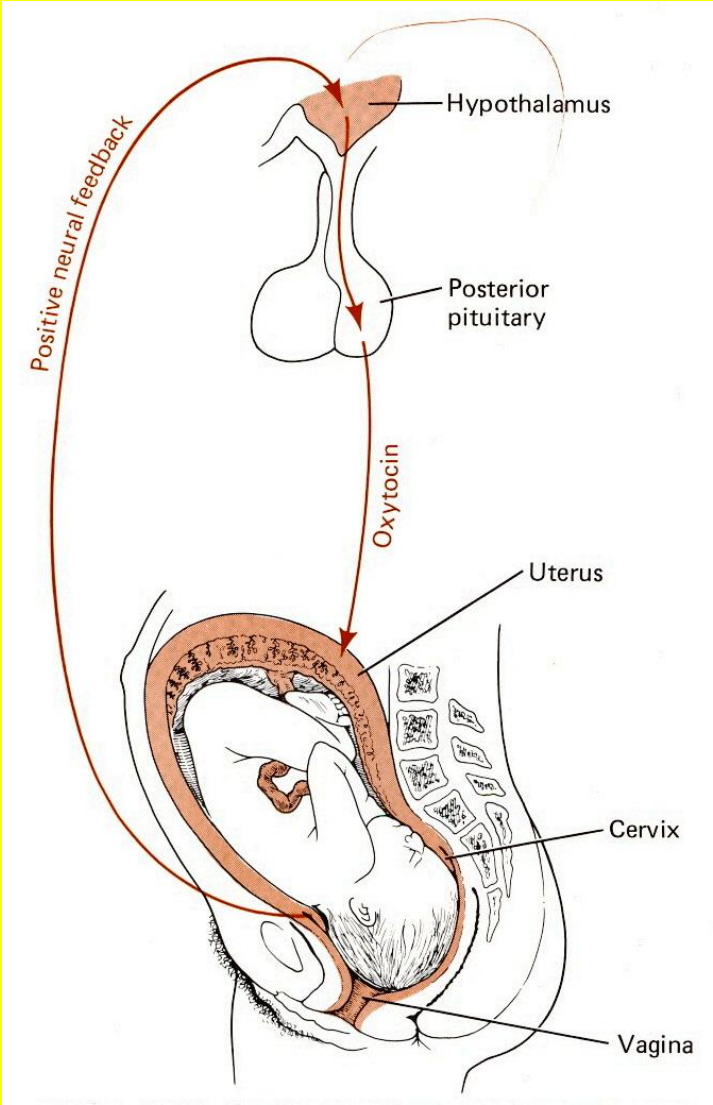
- ↑ Blood volume
- ↓ ADH
- ↑ Urine



CHILD BIRTH

Oxytocin:
Birth of baby

- Baby drops lower- uterus
- Pressure- **cervix**
- Nerve impulses- hypothalamus
- **Oxytocin**- pituitary to uterus ⟶ **contractions**



- **Placenta** releases **prostaglandins**
- Cause contractions
- Baby pushes cervix harder
- More stretching
- More impulses
- Baby born
- **Positive feedback**

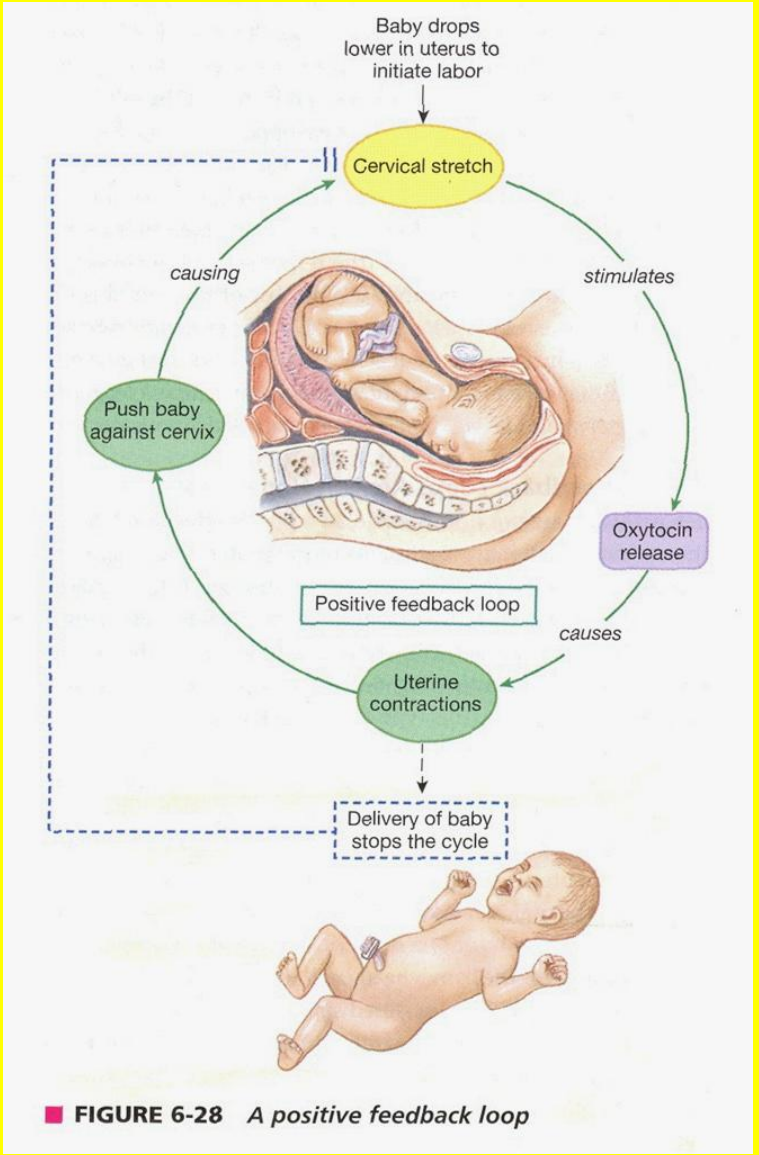


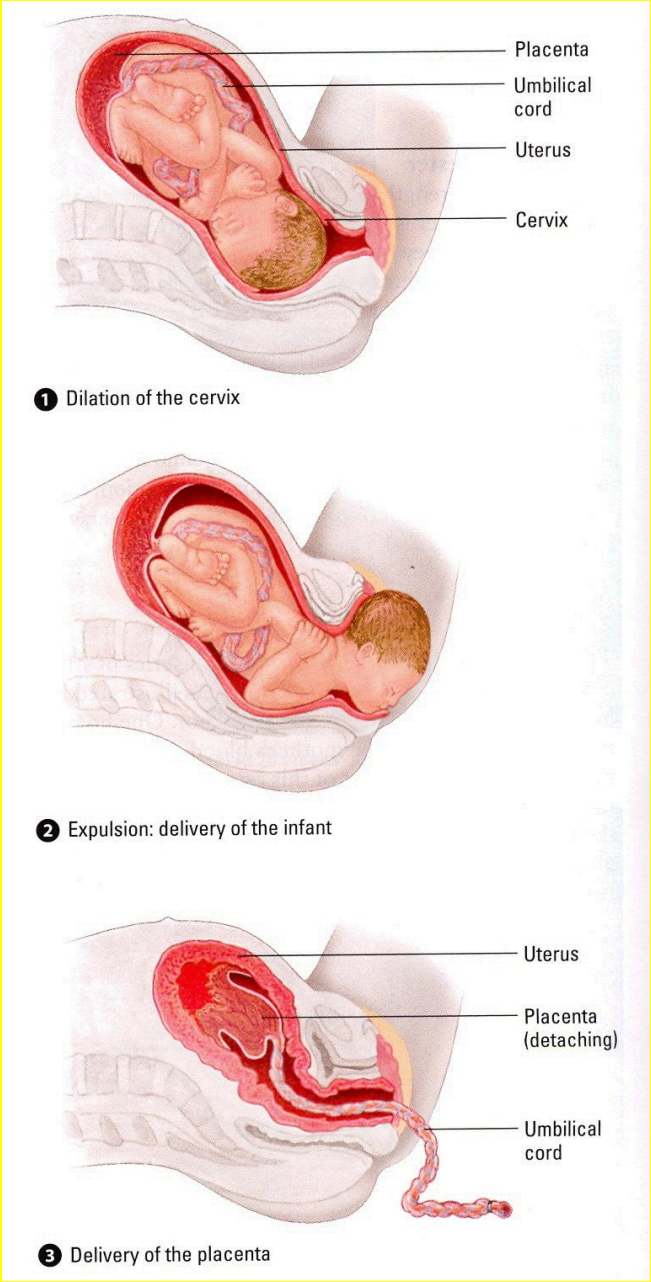
FIGURE 6-28 *A positive feedback loop*

- Prostaglandins:

Local tissue regulators

Stimulate **uterus**: muscle contractions

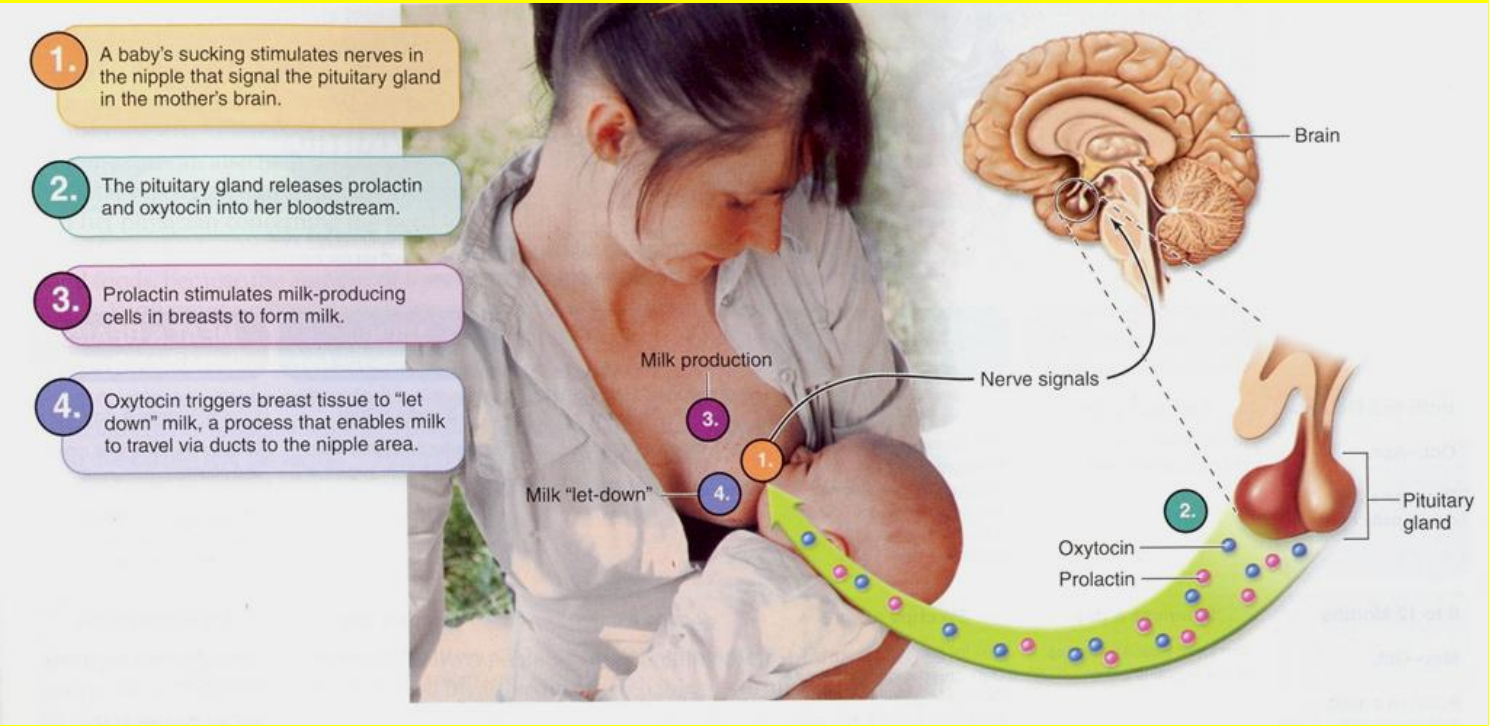
- Menstrual cramps
- Induce Abortions



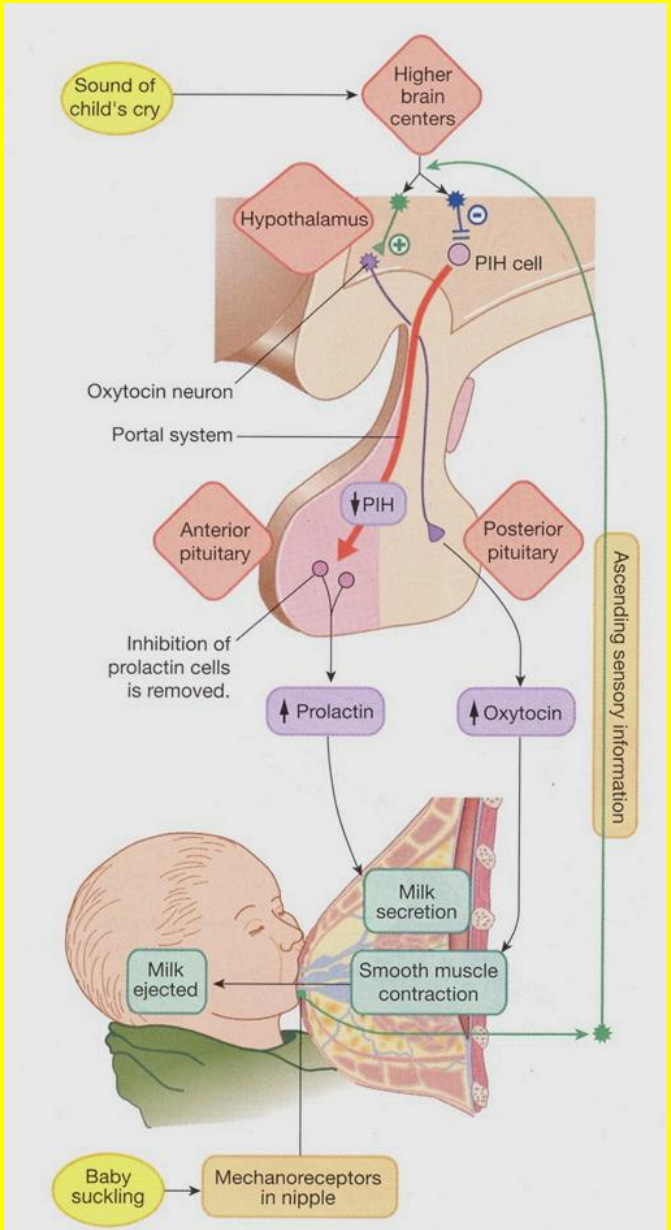
Oxytocin: Milk Ejection

mammary glands

After baby born: **Positive Feedback**



- Sound: **baby's cry**
- Mom's brain: Impulses from higher brain to **hypothalamus**
- Pituitary release **Oxytocin** ⟶ breast
- Muscles contract: milk **squirts**: baby's mouth



■ **FIGURE 26-23** *The hormonal control of milk secretion and release*

Baby's suckling

↓

Impulses

↓

Mom's brain

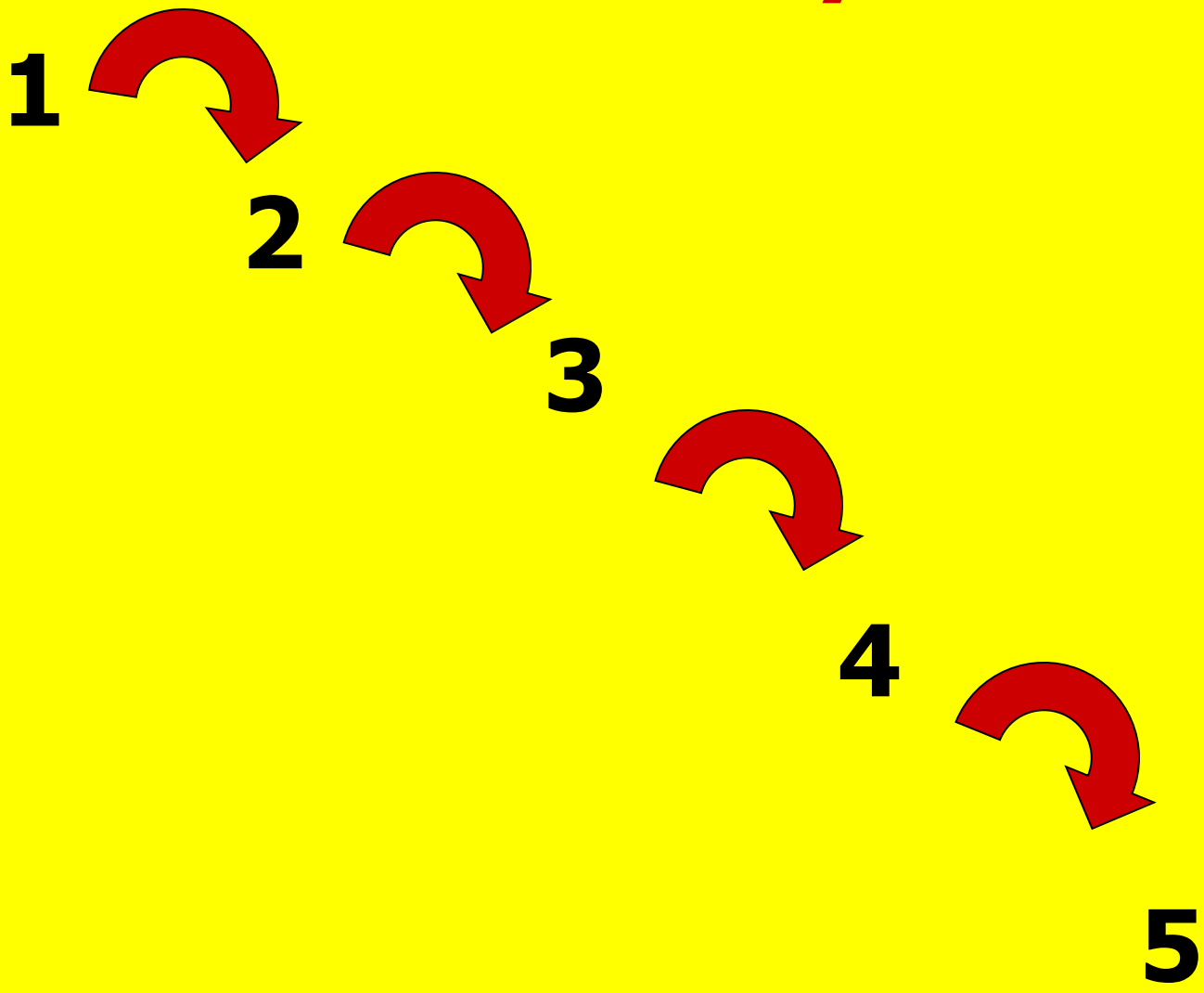
↓

Positive Feedback

Oxytocin: other actions

- Males: helps with **semen ejaculation**
- Men & women: ↑ blood oxytocin during **orgasm**

Anterior Pituitary: cascade effect



1. **Hypothalamus**: neurons produce: **releasing** (+) or **inhibiting** (-) hormones: blood vessels ⟶ anterior pituitary
2. Anterior pituitary: **+/-** (release/inhibition) **6** hormones
3. Blood→another endocrine gland
4. Another hormone released
5. Finally: to **target cells**

Anterior Pituitary Hormones

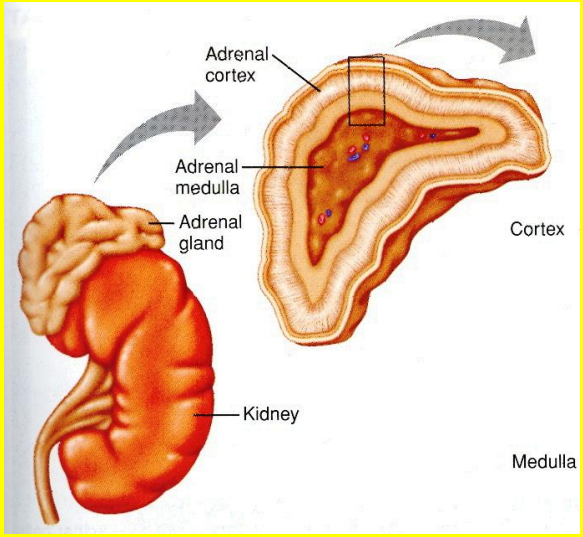
1. ACTH
2. Thyroid Stimulating Hormone
3. Growth Hormone
4. Prolactin
5. Follicle Stimulating Hormone
6. Luteinizng Hormone

#1 ACTH →

Adrenal gland **cortex**

(outer portion)

↓



Cortisol

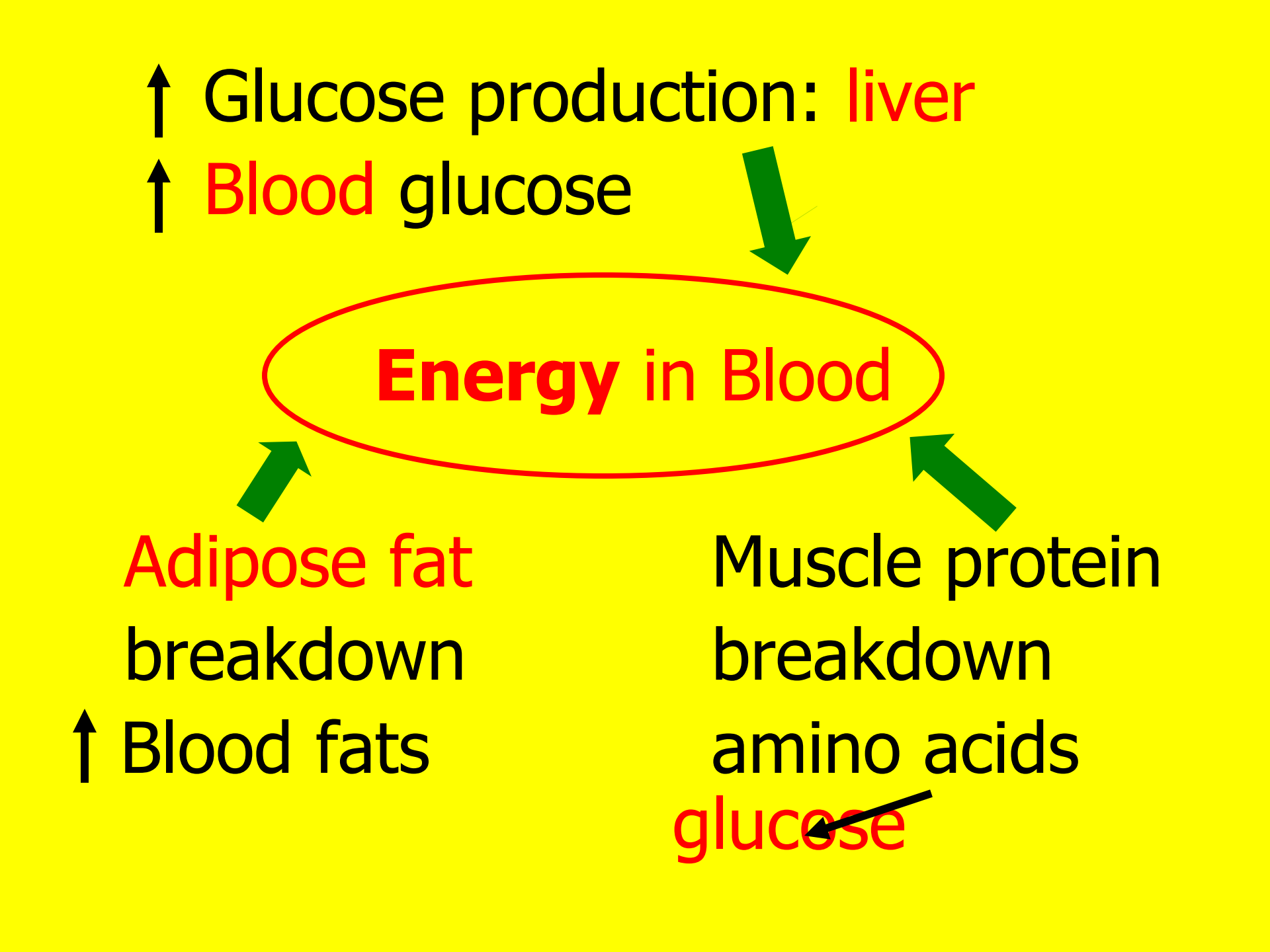
Helps body cope with **stress**

"stress response hormone"

Cortisol actions **overlap** with **adrenaline "fight or flight"** response

Cortisol: short-term (**daily**) stress

- Getting ready for **exams**
- Cortisol gets **"energy"** ready for you (energy mobilization)


↑ Glucose production: liver
↑ Blood glucose
Energy in Blood
Adipose fat
breakdown
↑ Blood fats
Muscle protein
breakdown
amino acids
glucose

Cortisol Release

- In bursts
- ↑ Morning ↓ Night
- Related: **Sleep/wake cycle (circadian rhythms)**
- **Reversed**: People awake at night, sleep during day

Problem: Long-term stress & **cortisol** release

Side-effects

- **Weakens immune system**
  (↓ # immune cells)
- ↑ Chances getting **sick**
- ↑ Atherosclerosis (arteries): heart attacks ?
- ↓ Insulin sensitivity: diabetes ?

Stress: condition- actual or potential- challenge to **homeostasis** ⟶ stress response

Stressors:

Physical: dehydration, hemorrhage, infection, extreme temperatures, severe exercise **(marathon)**

Psychological: pain, fear, anxiety

Stressor: for 1 person, no effect on another

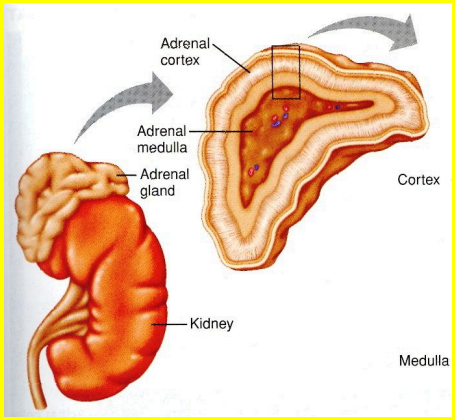
Stress: adrenal gland

Cortex

Cortisol

Daily/

long-term



Medulla

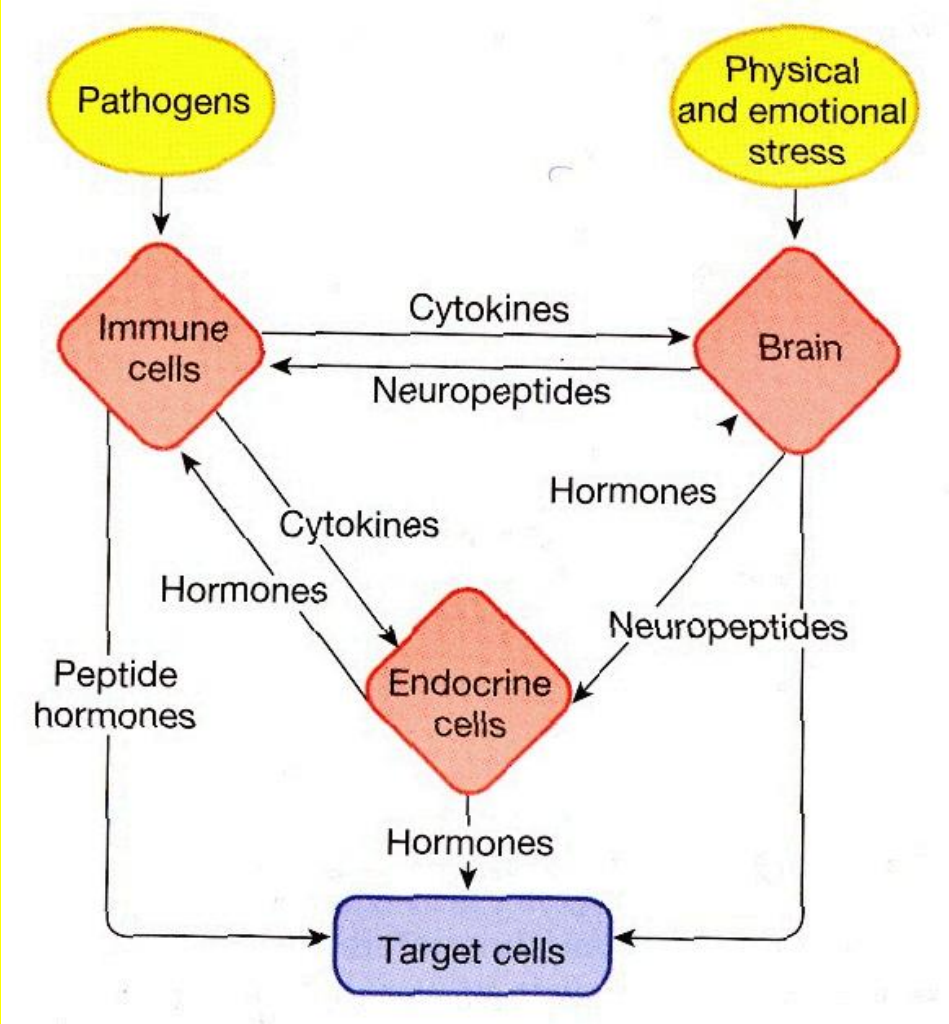
Adrenaline

Emergency

Nervous ⟷ Endocrine ⟷ Immune

All **linked** together

Share **Common** Chemicals/ Hormones & Receptors



Psychosomatic Illnesses

Mind → Body

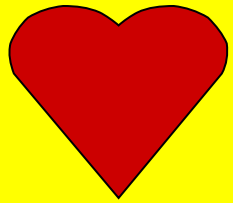
Examples:

- People in hospital: depression, ↓ immunity
- Caregivers (husband or wife) of Alzheimer's patient: ↓ immune cell activity

Associated Press/mtvU survey-2008: **4/10** college students **"stressed often"**

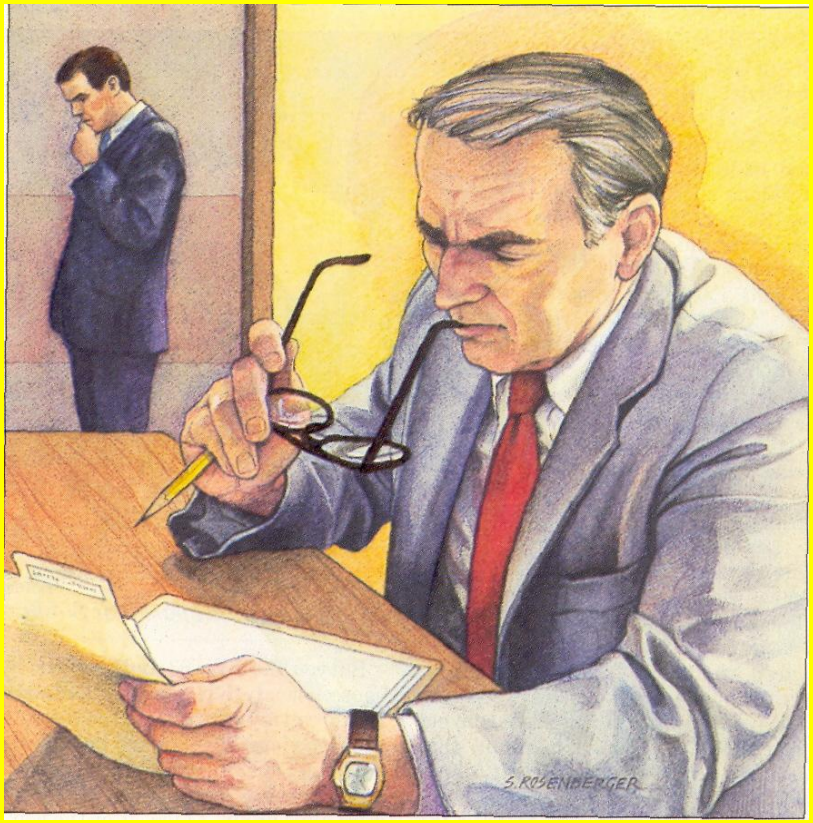
- **"Broken heart syndrome"**

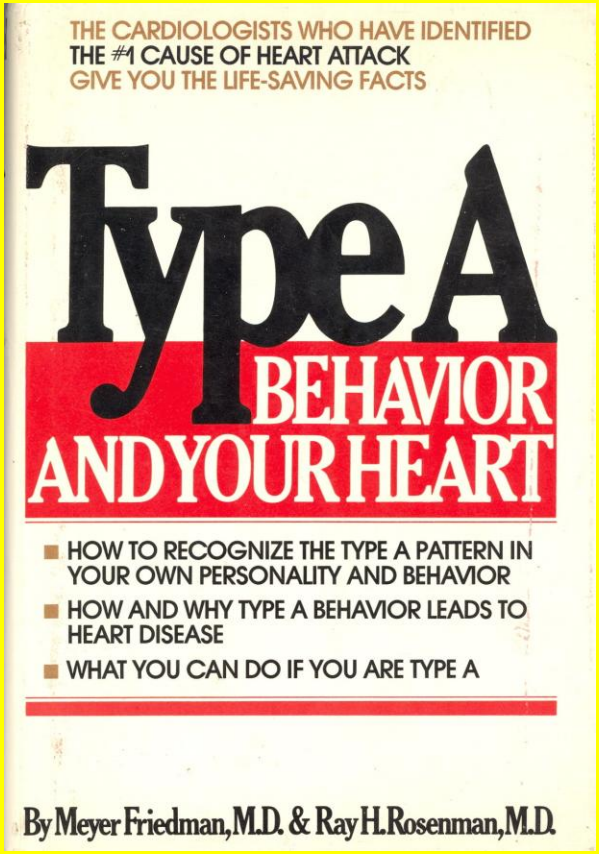
1. Emotional trauma (sudden death husband or wife)
2. Rapid **blast** of stress hormones
3. Paralyzes heart muscle/drop blood pressure/ decreased 02
4. Heart fails- some people die
5. No blockage, no heart attack
6. More common: post-menopausal women



Personality Type

- **Type A: Coronary prone**





Type A:

Time urgency, impatient, competitive, aggressive

Subtype: hostile, cynical, increased adrenaline stress response: ↑ heart disease risk

Type B: more relaxed, less time conscious: ↓ risk

World Health Organization 2008:

Night Shift: a "probable" **carcinogen**

↑ Breast & prostate cancer: people working-night

Cause? Effect?

Changes- Biological clock (circadian rhythm)

Positive Outlook on Life

- 2006 Dutch **"Outlook on life"** study: men 64-84 followed for 15 years

"I still expect much from life"

"I am still full of plans"

50% lower risk dying heart disease

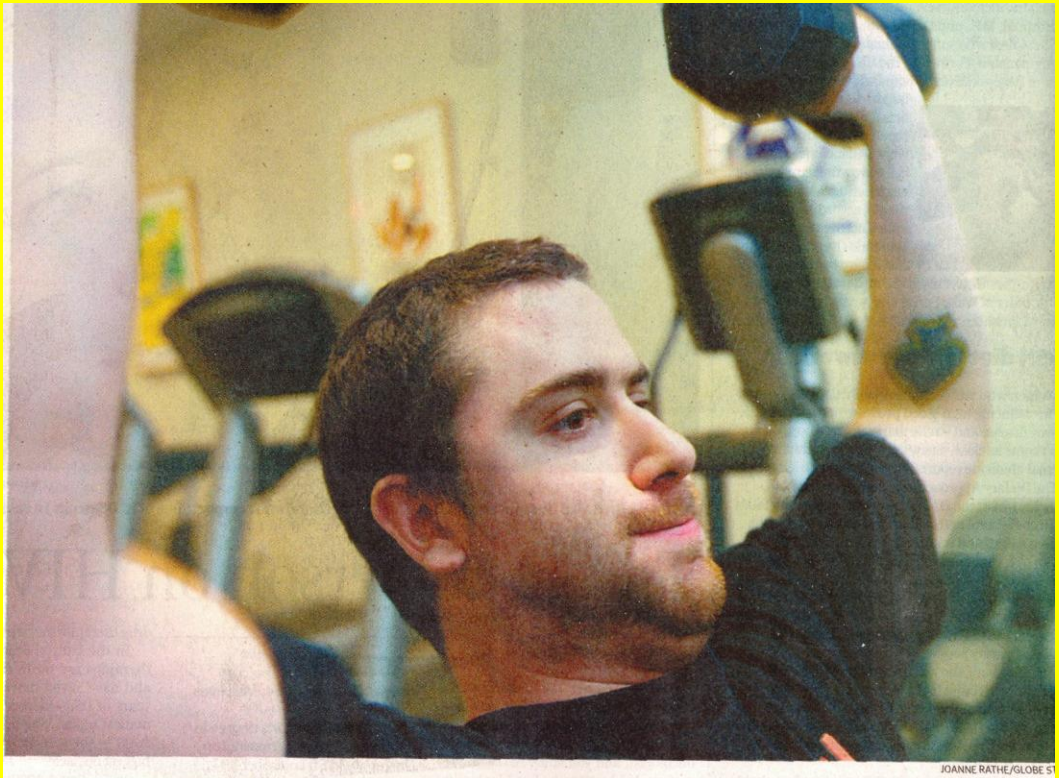
- Cancer & AIDS survivors- positive outlook: improved health

- Laughter Therapy (www.aath.org)

  People watching funny movies:

  ↑ immune cell activity
- Complementary medical therapy: meditation (? endorphins), yoga, hypnosis, biofeedback
- **Exercise** as stress reliever

2007 study: Exercise almost as good as anti-depressant in reducing depression



JOANNE RATHE/GLOBE ST

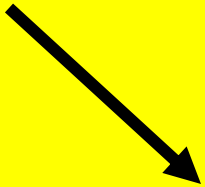
Theo Baars uses weights in the exercise room at the recreation center as part of his treatment for depression at McLean Hospital in Belmont.

Mood lifting

Growing evidence suggests that exercise is as good for your mental health as it is for your physical well-being

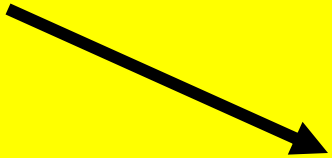
#2 Thyroid Stimulating Hormone (TSH)

TSH from anterior pituitary

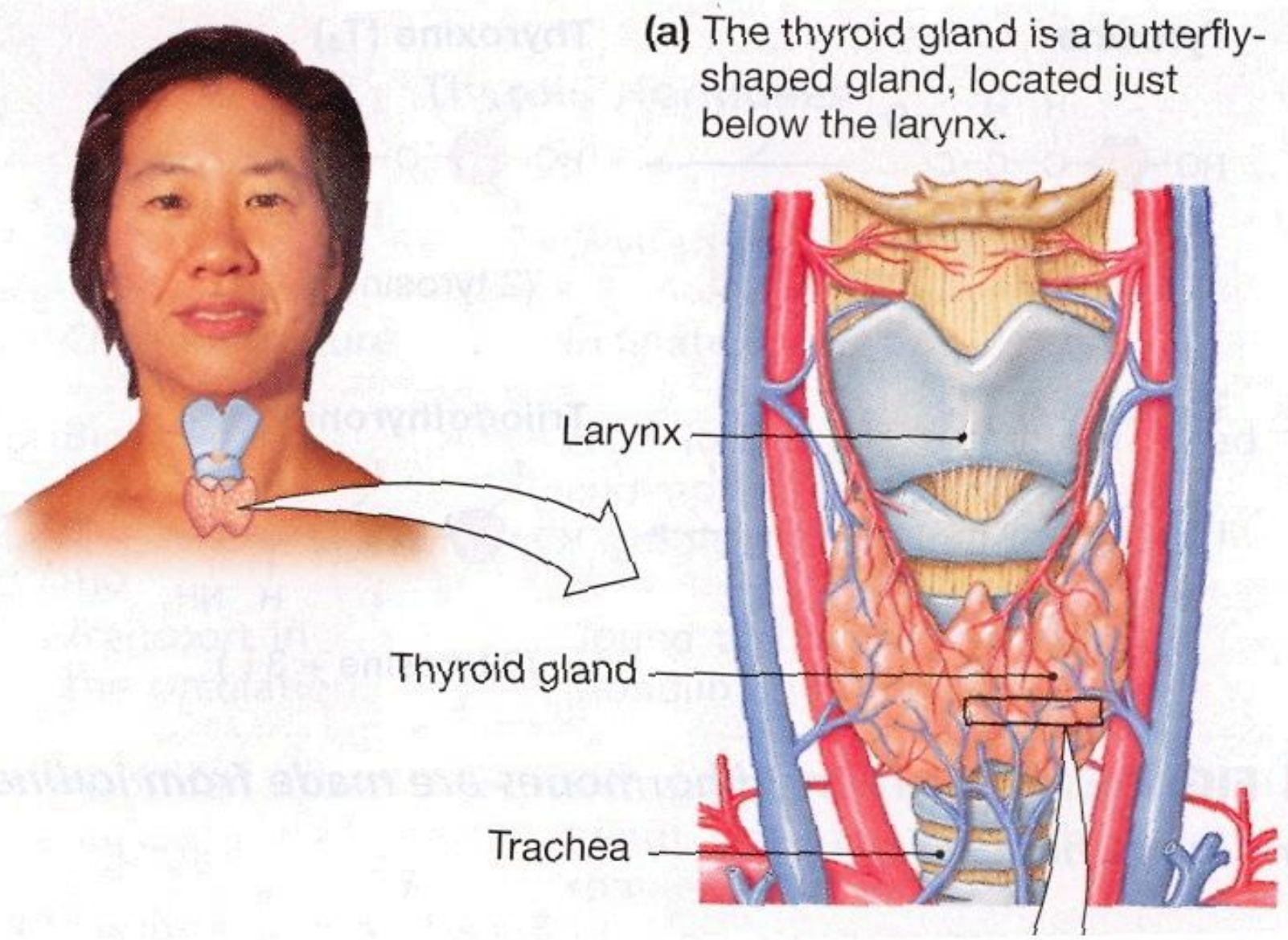


Thyroid hormones  Thyroid

Stable blood levels



Maintain normal metabolism


(a) The thyroid gland is a butterfly-shaped gland, located just below the larynx.
Larynx
Thyroid gland
Trachea

Thyroid hormones: made from an **amino acid** + **iodine**

Iodine concentrated in thyroid

Children, radioactivity exposure, and thyroid cancer

1986: **Chernobyl** (Ukraine): nuclear reactor **meltdown**

- Plume: radioactivity (Iodine 131)- taken up by thyroid

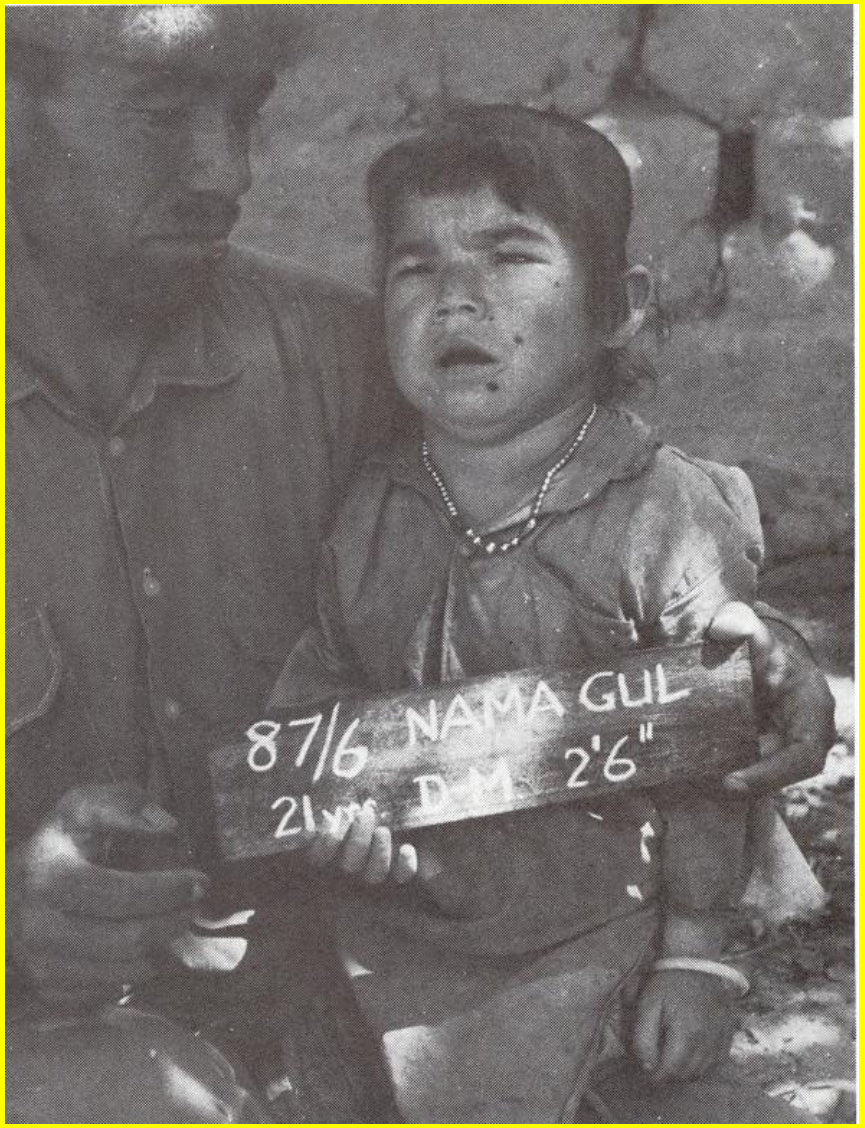
Children: thyroid hormones important: normal growth, body, nervous system development

Deficiency: **hypo**thyroidism= **cretinism**

- Mental retardation
- Growth stunted
- Brain damage

Cretinism: can be result of iodine deficiency

21 year old woman
2’ 6” tall



Thyroid Hormones: what they do

- ↑ O_2 use by most tissues
- Maintain your **Basal Metabolism**
  Oxygen used and heat produced at **rest**
- Heat helps maintain your body temperature

Basal Metabolism: energy needed- basic functions- just to keep you alive

- Breathing
- Circulating Blood
- Maintaining Body Temperature
- Making New Tissue
- Removing Waste Products
- Sending Nerve Impulses

Basal Metabolic Rate (BMR)

- Calories you burn every hour to keep you **alive**
- 60-70% of total calories you burn (energy needs)
- Does **not** include: physical activity/exercise
- Warm blooded animals: "Keep fires lit all night"

In General:

↑ BMR ↑ **Lean body mass**

(metabolically active vs. fat tissue)

↑ BMR ↑ **Men** vs.women

(more lean mass)

↓ BMR ↓ **Age**

(less lean mass)

↑ BMR ↑ Thyroid hormones

↓ BMR ↓ If calorie intake low **(starvation)**

Homeostasis: less energy needed to maintain weight

Frustration: Trying to lose weight

Adults- **Hyperthyroidism**

↑ Thyroid hormone secretion

- ↑ Oxygen use by cells
- ↑ Heat produced (warm/sweaty/heat intolerant)
- ↑ Weight loss, ↑ protein catabolism
- **Hyper excitable** nervous system
- ↑ Heart rate, irritability

Treatment

Remove part thyroid, destroy with radioactive iodine, drugs: block hormone synthesis

Exophthalmus: bug-eyed appearance- enlarged (↑ fluid) muscles/tissue eye socket

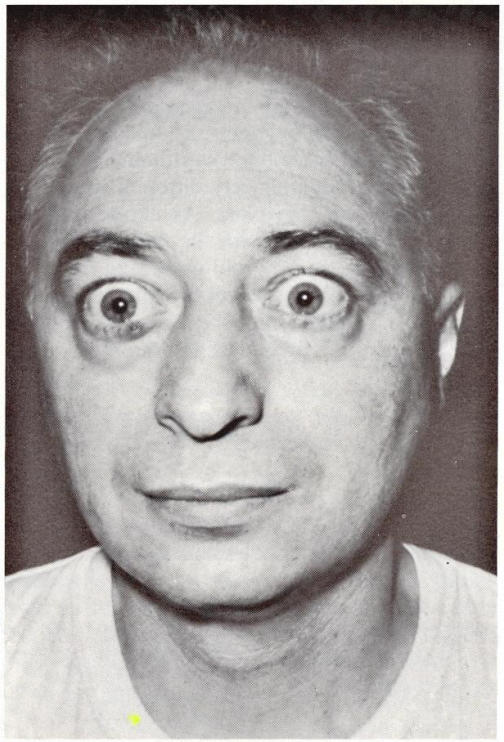


Figure 12.14 The Exophthalmos of Hyperthyroidism. Sometimes hyperthyroidism causes not only an increase in ATP production, nervousness, and body heat, but also protruding eyeballs. (From Lester V. Bergman and Associates.)

FIGURE 23-15 *Exophthalmus*

Hypothyroidism

- ↓ Secretion thyroid hormones
- **Slow metabolism**
- ↓ O_2 use by cells
- Puffiness-skin
- Slow reflexes, speech, thought processes, fatigue
- Slow heart rate
- Treatment: **oral thyroid hormone**

Goiter: enlarged thyroid gland

One cause:

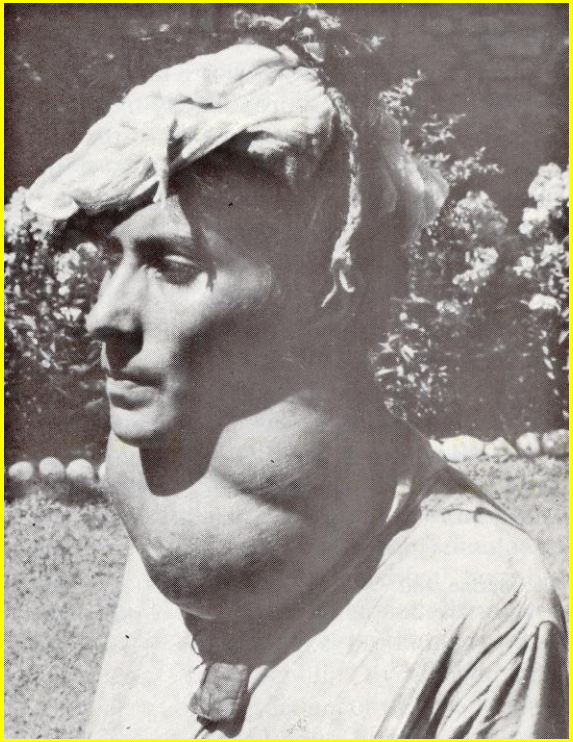
↑ **TSH** causes increased release thyroid hormone

Thyroid gland **hypertrophies** (↑ size)

■ **FIGURE 23-13** *A man with goiter due to excessive TSH stimulation*

Goiter: iodine deficiency

- ↓ **iodine in diet**
- ↑ TSH: stimulates thyroid to grow
- No iodine ✳ thyroid hormone

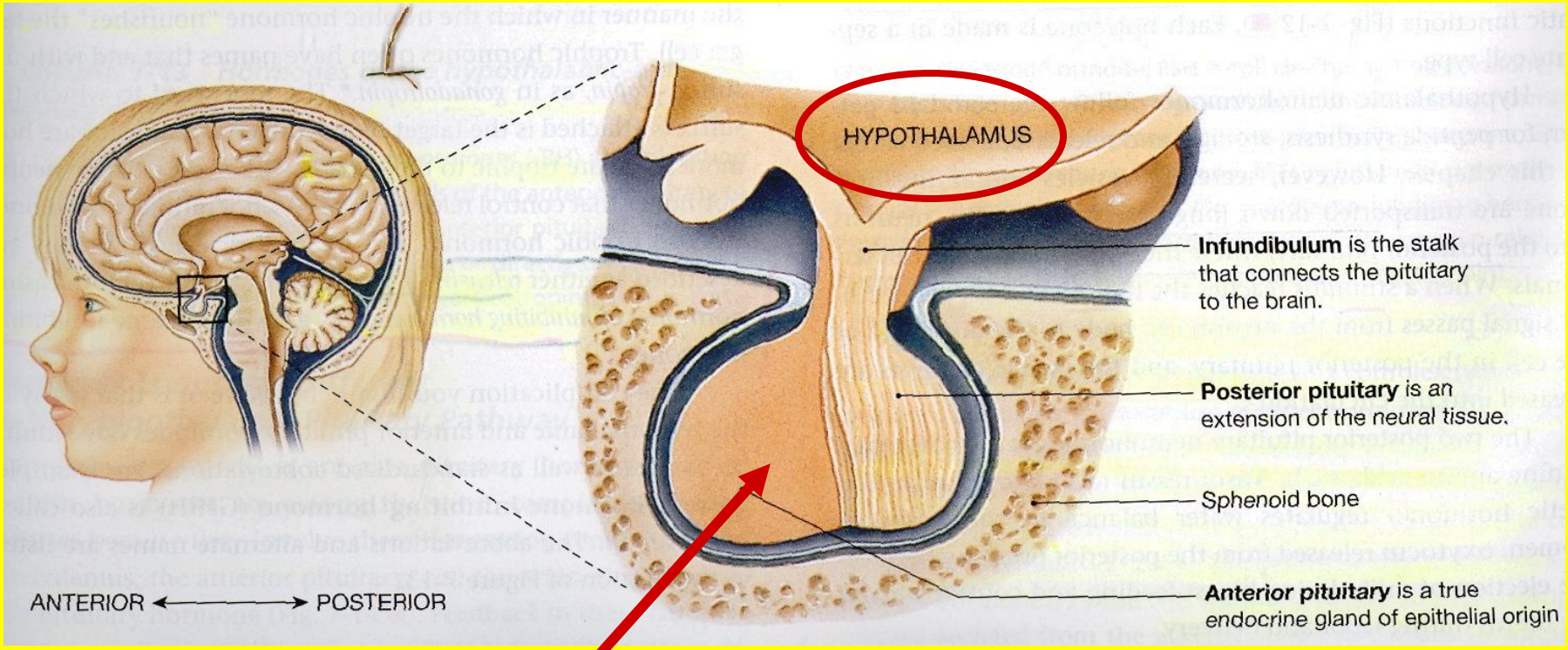


- No feedback shut off TSH
- Treatment: iodine supplement
- **Iodized salt**

#3 Growth hormone: from anterior pituitary: affects **growth & metabolism**

Growth:

1. Bone
2. Soft tissue: organs- heart, lungs, kidneys, intestines, skin, muscles



Anterior pituitary: **growth hormone**

When major **growth** happens

- 1st 2 years of life
- Adolescence: **growth spurt**

  11 years old- girls

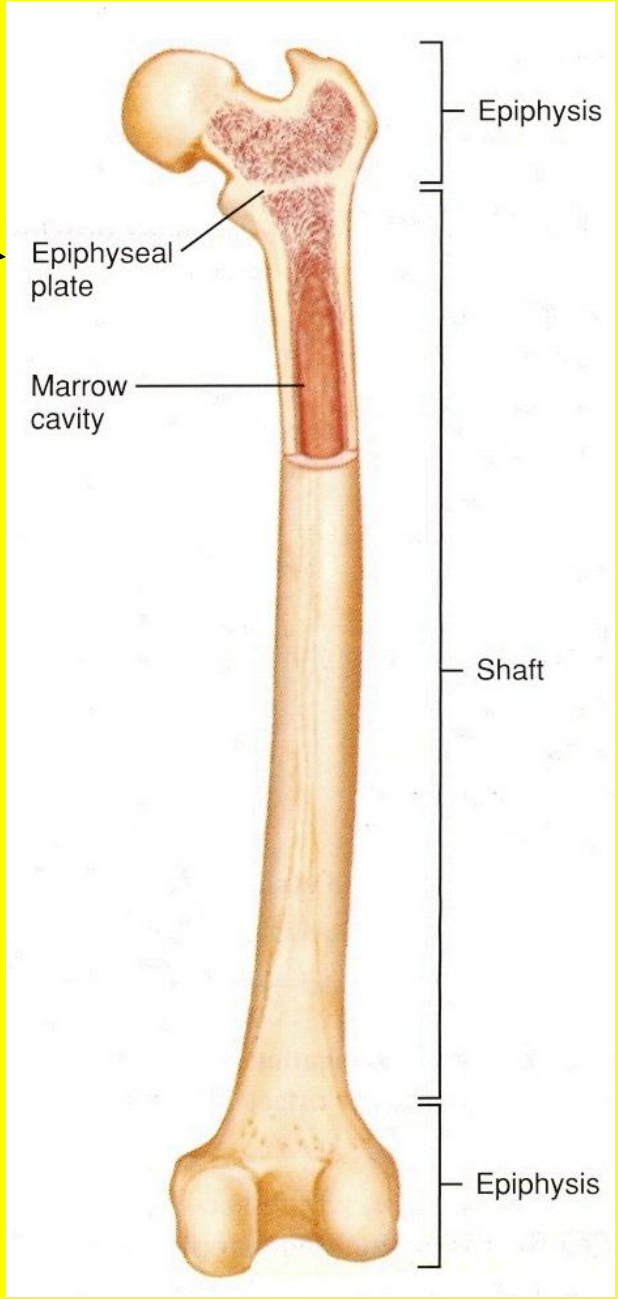
  13 years old- boys

Late teens:

Plate- end of bone

closes

- Can't grow taller
- Bones- only grow **wider** (circumference)



Growth Hormone levels

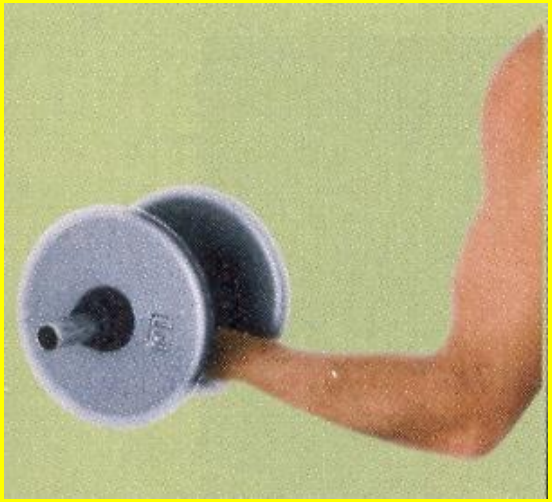
- High secretion in **children**
- Even higher- **teens**
- Maximum at **puberty**: testosterone & estrogen also stimulate growth hormone release
- Adults: lower levels: maintain bone mass/lean (muscle) body mass
- Older adults: still lower: ↓ muscle mass
  ↑ body fat

What **growth hormone** does to make people grow

- Stimulates liver: make glucose
- ↑ Blood glucose & fatty acids (energy for growth)
- ↑ Protein synthesis (muscles, tissues)
- ↑ Cell size (**hypertrophy**)
- ↑ Cell number (**hyperplasia**)

Result:

- **Bones** grow longer
- Increase **lean** Body mass (muscle)
- **Increase size**: heart, lungs, kidneys, intestines



Growth Hormone: Over & Underproduction

Growth Hormone Pathologies

Dwarfism ↓ Growth hormone

secretion or receptor defect

- ↓ growth, ↓ muscle development, ↑ body fat
- Before 1985: treatment- human pituitary extracts: **cadavers**
- 1985: genetically engineered growth hormone: replacement therapy

Gigantism:

Sometimes pituitary tumor in **children**

- ↑Growth hormone
- ↑Growth
- ↑Great height
- Robert Wadlow:

  8’ 11” tall

Figure 11.4 A Giant. When the anterior pituitary produces excessive growth hormone in a child, the child grows rapidly to excessive height. This caused Robert Wadlow, shown here in 1939, to attain a world-record height of 271 cm (8 ft 11 in). (From N. McWhirter, ed., *Guinness Book of World Records,* New York: Sterling Publishing Co., 1982, p. 6. © Sterling Publishing Co., Inc.)

Sun Ming Ming **7’9” 387 pounds**

NBA hopeful from China playing in ABA

Jamie Rose for The New York Times

WORK IN PROGRESS Sun Ming Ming, 23, after a basketball lesson with the former N.B.A. center Gheorghe Muresan in Potomac, Md.

Acromegaly: pituitary tumor **adults**

- ↑ Growth hormone
- ↑ **Size**- forehead, jaw, hands, feet
- ↑ Internal organs
- Problems: hypertension, diabetes, arthritis, enlarged heart, loss vision
- Treatment: surgery or radiation: destroy tumor
- Drugs: ↓ growth hormone production

16

33

52

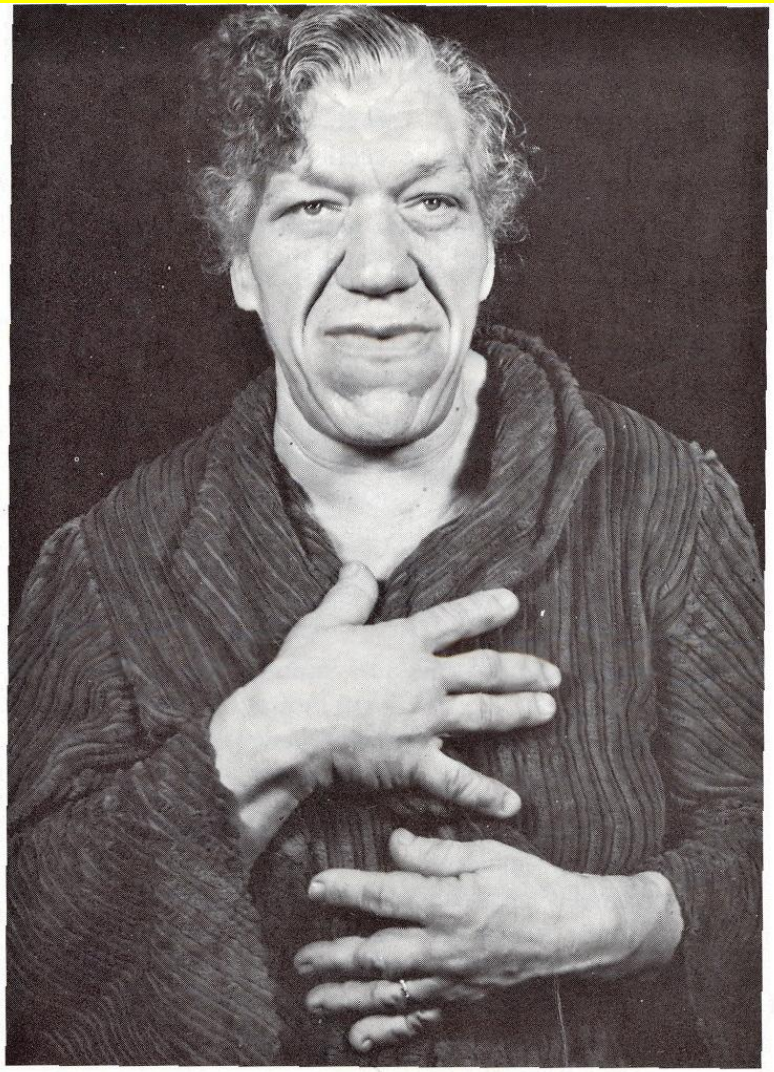


Figure 11.5 Acromegaly. Excessive production of growth hormone in adults causes acromegaly. Bones broaden and other tissues enlarge, causing a progressive disfigurement. The photographs show this progression in one woman, from 16 years of age, when acromegaly had just begun, to age 33 and 52. (From W. H. Daughaday in A. I. Mendeloff and D. E. Smith, eds., *Amer. J. Med.* 20 [1956]:135.)

Growth hormone, anabolic steroids and athletes

Jose Canseco

Mark McGwire

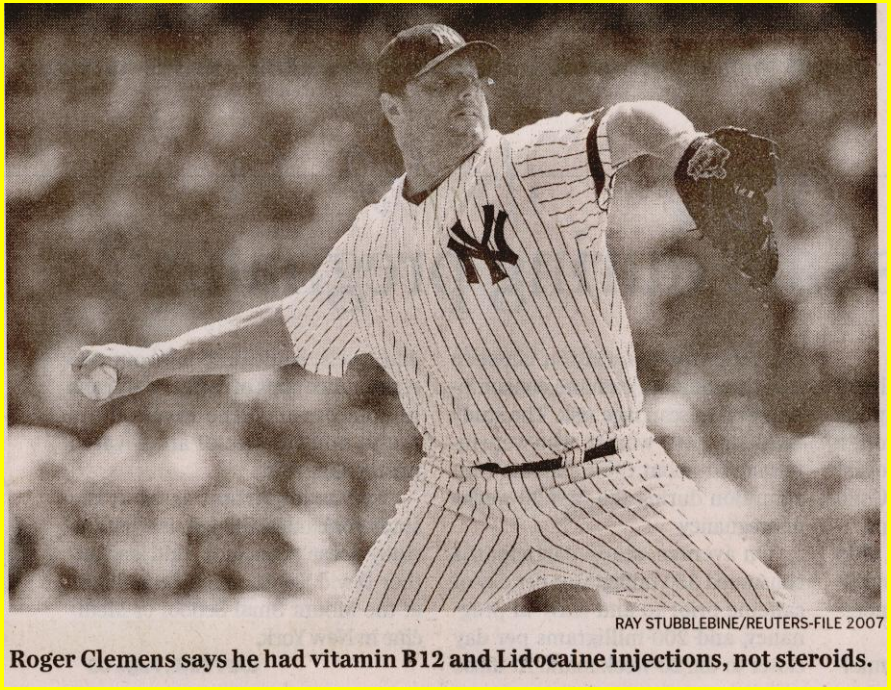
(70 home runs-1998)

Chapter 2 Opener A Brief Guide to Biology, 1/e

Roger Clemens?

Growth hormones

- Improve **muscle mass**



RAY STUBBLEBINE/REUTERS-FILE 2007

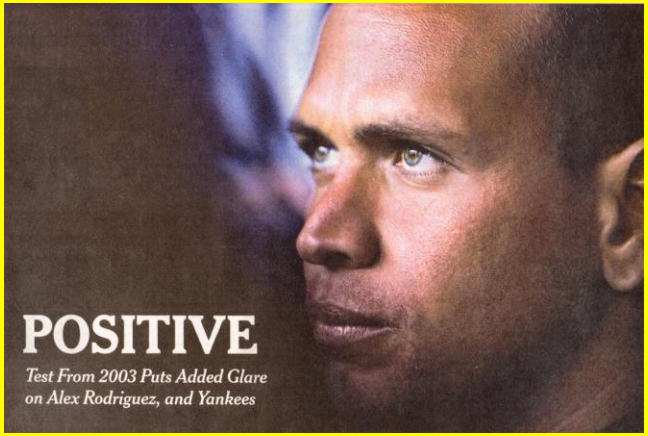
Roger Clemens says he had vitamin B12 and Lidocaine injections, not steroids.

Side effects

- Insulin resistance
- Inflammation pancreas

Anabolic Steroids- performance enhancing drugs

- Banned- International Olympic Committee
- Mimic- male sex hormones **(androgens)**
- ↑ Protein synthesis
- ↑ Muscle development



Anabolic steroids: side effects

- Jaundice, liver failure
- Liver tumors
- Hypertension
- ↓ HDL (good cholesterol)
- Heart damage
- ↓ **Sperm production**, ↓ **size testes**
- ↓ **Testosterone**
- ↓ **Sex drive**
- **Acne**

Anabolic Steroids: women athletes

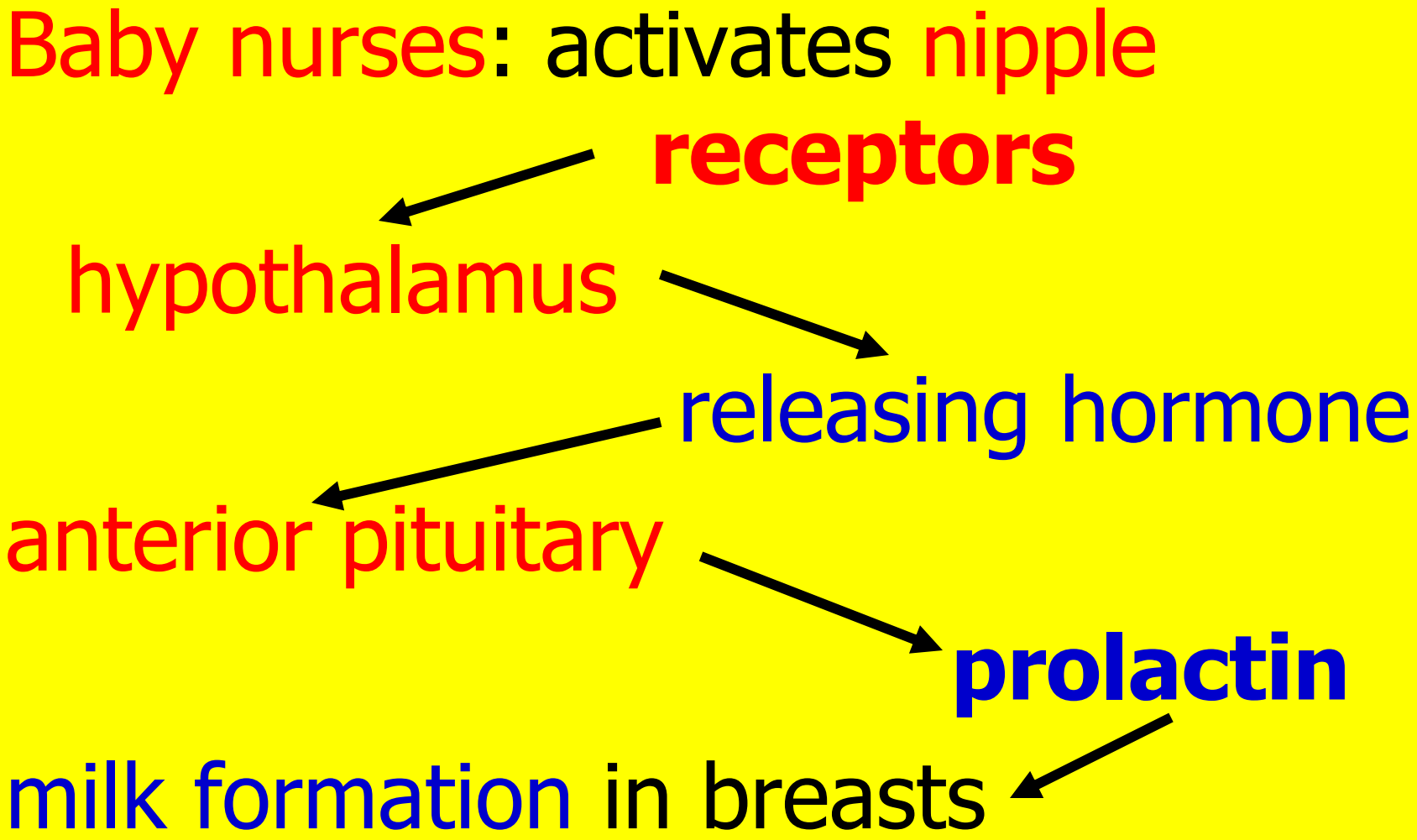
- ↓ Egg development & ovulation
- ↓ Breast size
- Disrupts menstrual cycle
- Deep voice
- **Facial Hair**

Anterior Pituitary Hormones

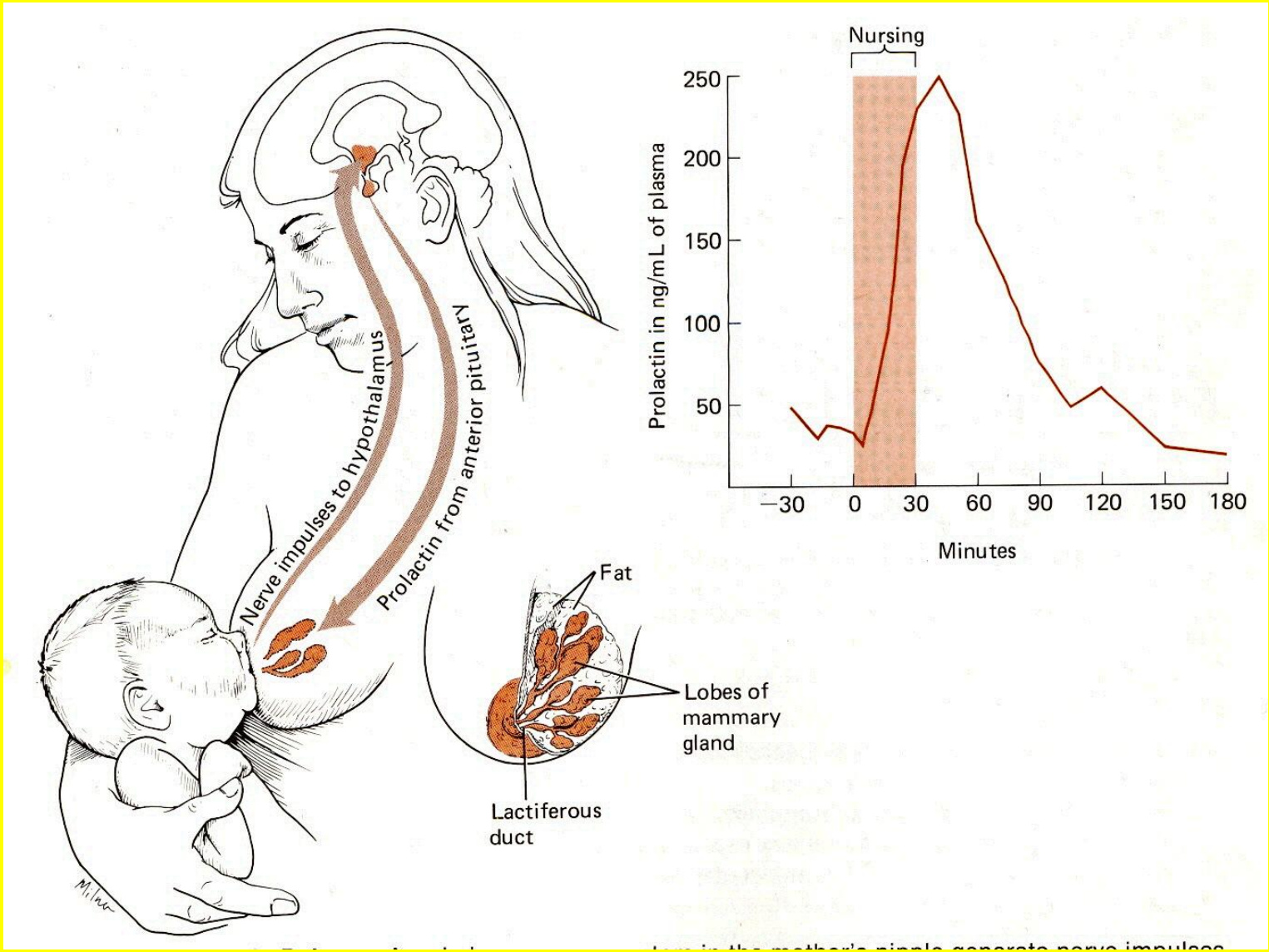
1. ACTH
2. Thyroid Stimulating Hormone
3. Growth Hormone
4. Prolactin *
5. Follicle Stimulating * Hormone
6. Luteinizng Hormone *

#4 Prolactin

- ↑ Mammary gland **development**
- Estrogen/progesterone also increase mammary development- pregnancy
- ↑ **Production of milk**
- Prepares breasts for **lactation**: **secretion of milk**


Baby nurses: activates nipple
receptors
hypothalamus
releasing hormone
anterior pituitary
prolactin
milk formation in breasts

Positive feedback

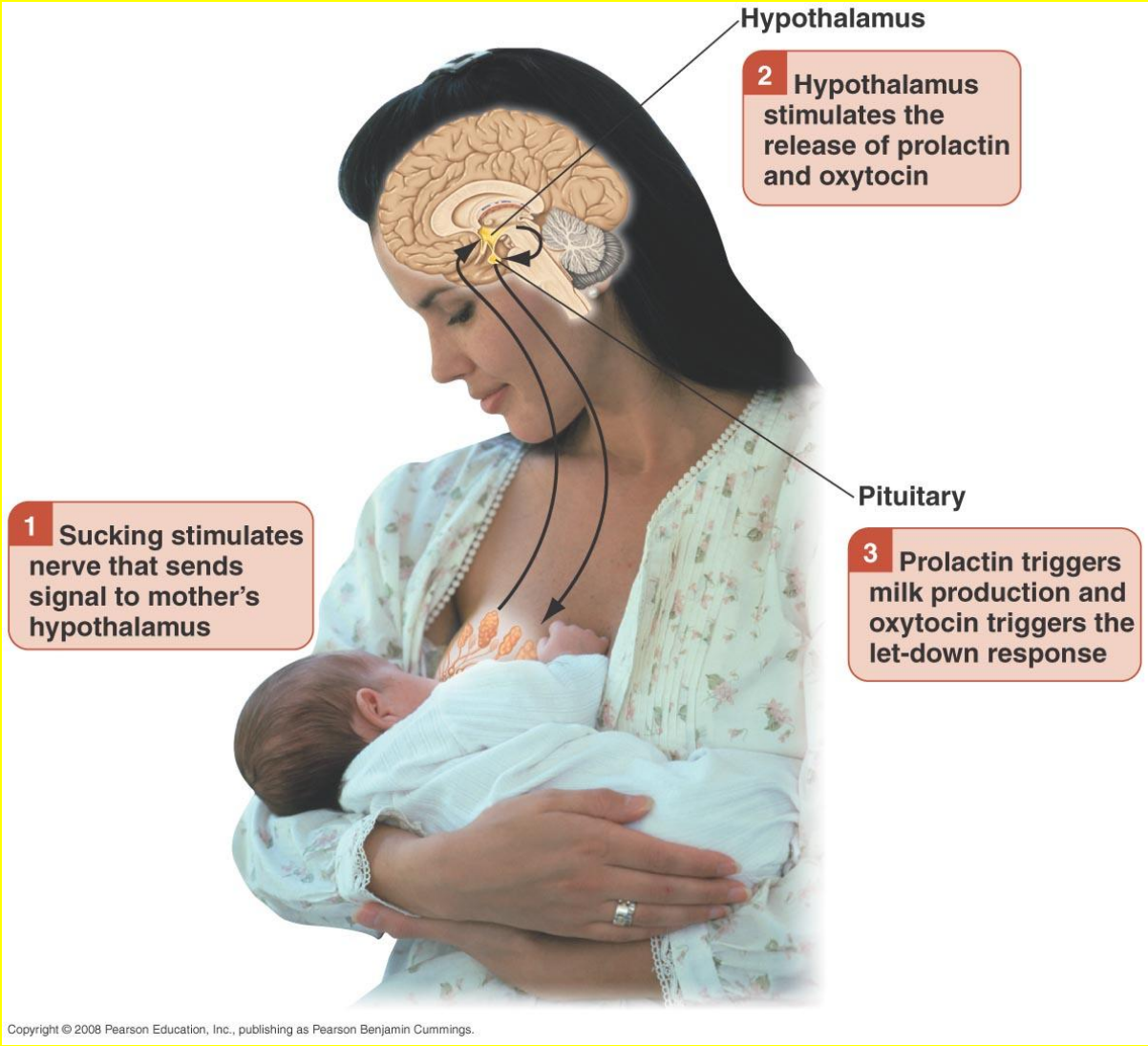


Prolactin:

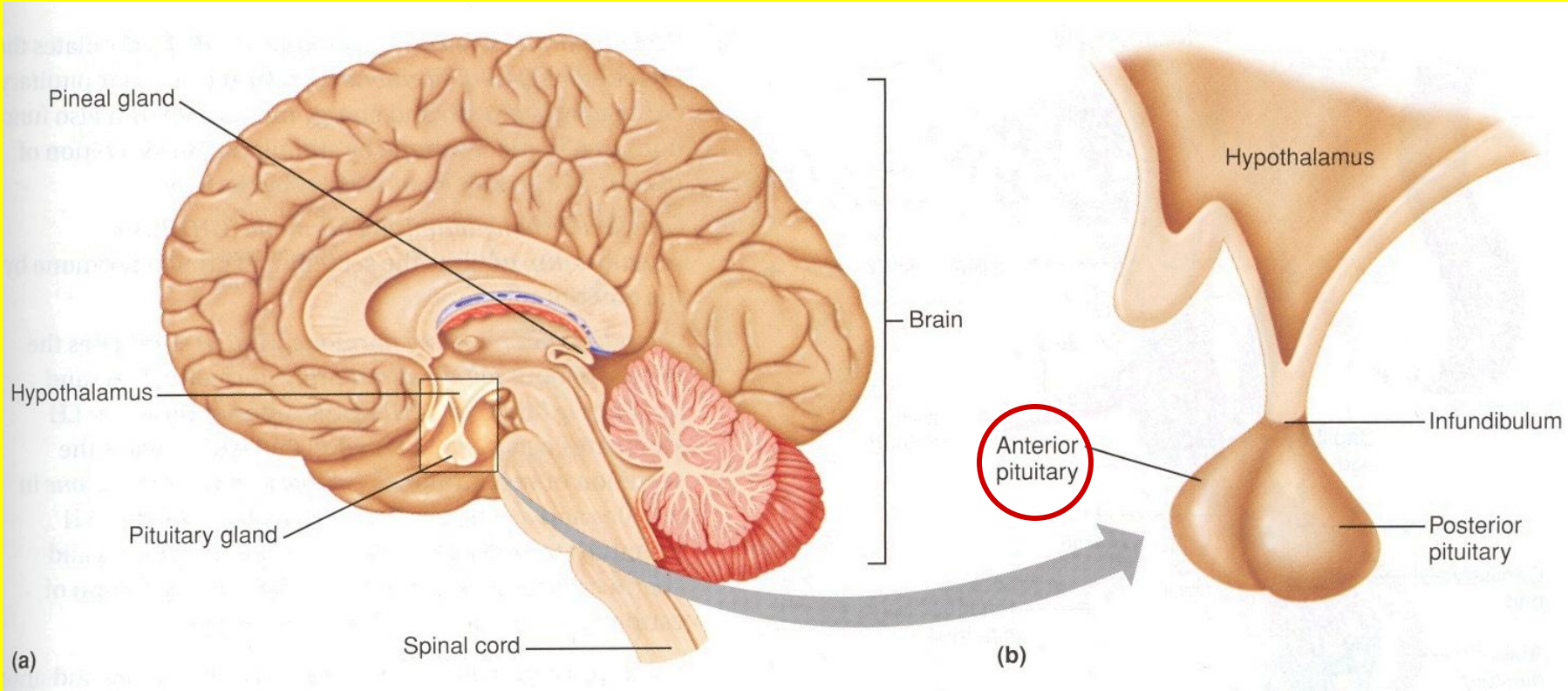
Milk Production

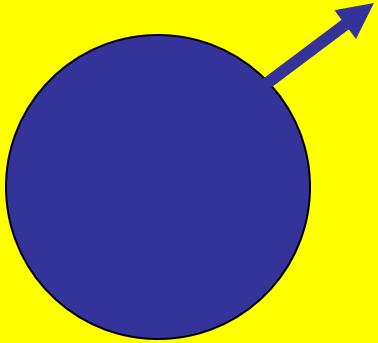
Oxytocin:

Milk release

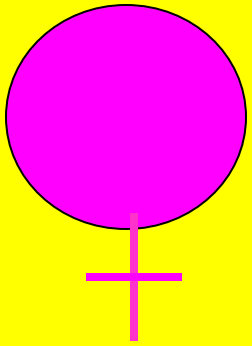


#5 Follicle Stimulating Hormone (FSH)





FSH



Promotes

Sperm

Production

(spermatogenesis)

Egg development

ovaries: **estrogen**

Reproductive

Tract

Female

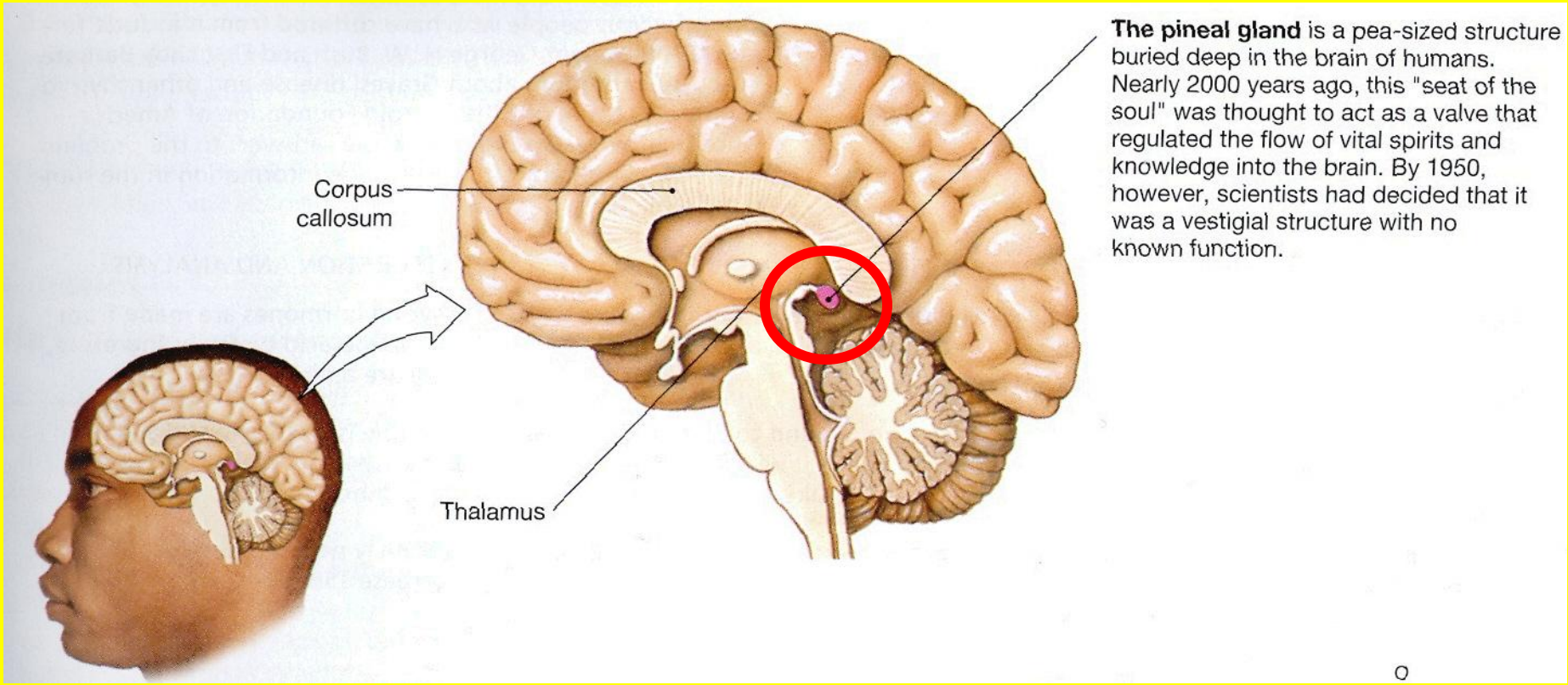
Body

Characteristics

#6 Luteinizing Hormone

Males	Females
Testes	**Ovaries**
↓	↓
Androgens (testosterone) Sex organs & Male sex Characteristics	Release egg **(ovulation)** Production estrogen & progesterone

Pineal Gland: pea size in brain

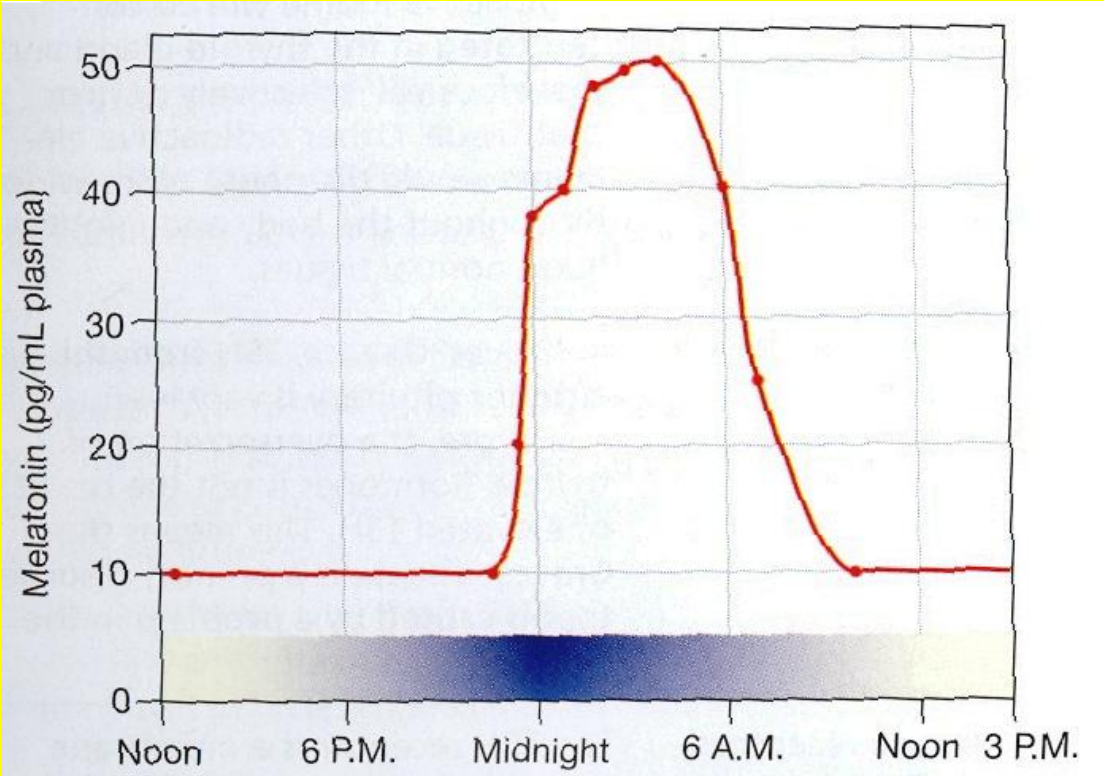


Releases: **Melatonin "Darkness Hormone"**

- Establishes **24** hour day/night cycle (internal biological clock)
- **Circadian rhythm**: daily rhythm coordinates body activities

Melatonin ↑ night ↓ day

- Potent sleep inducing agent



Melatonin is the "darkness hormone," secreted at night as we sleep. It is the chemical messenger that transmits information about light-dark cycles to the brain center that governs the body's biological clock.

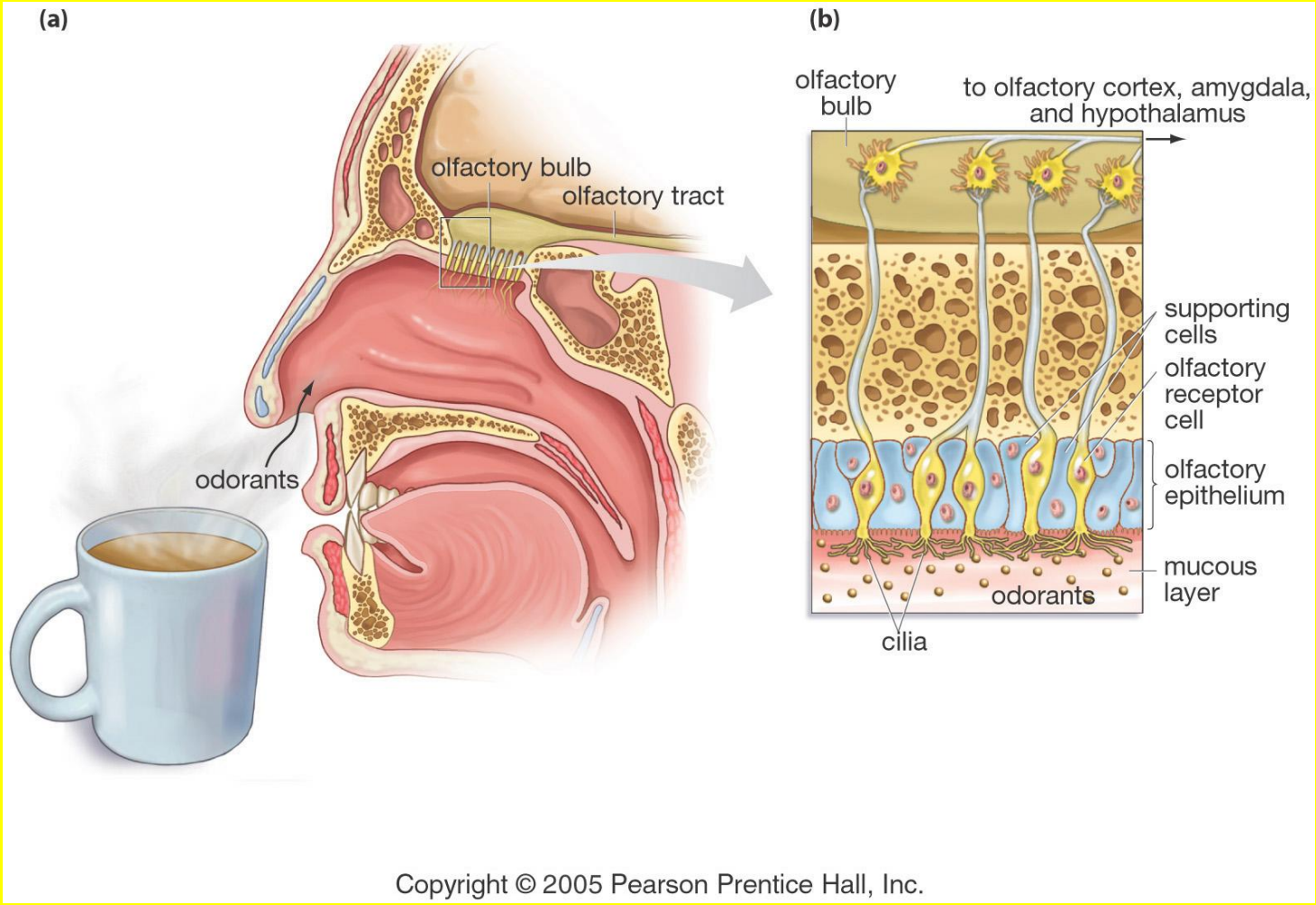
Jet lag: day sleepy, decreased energy

- Lasts few days after flying across many **time zones**
- Changes in circadian rhythm
- Melatonin/light exposure may help

Pheromones: "communicative odors"

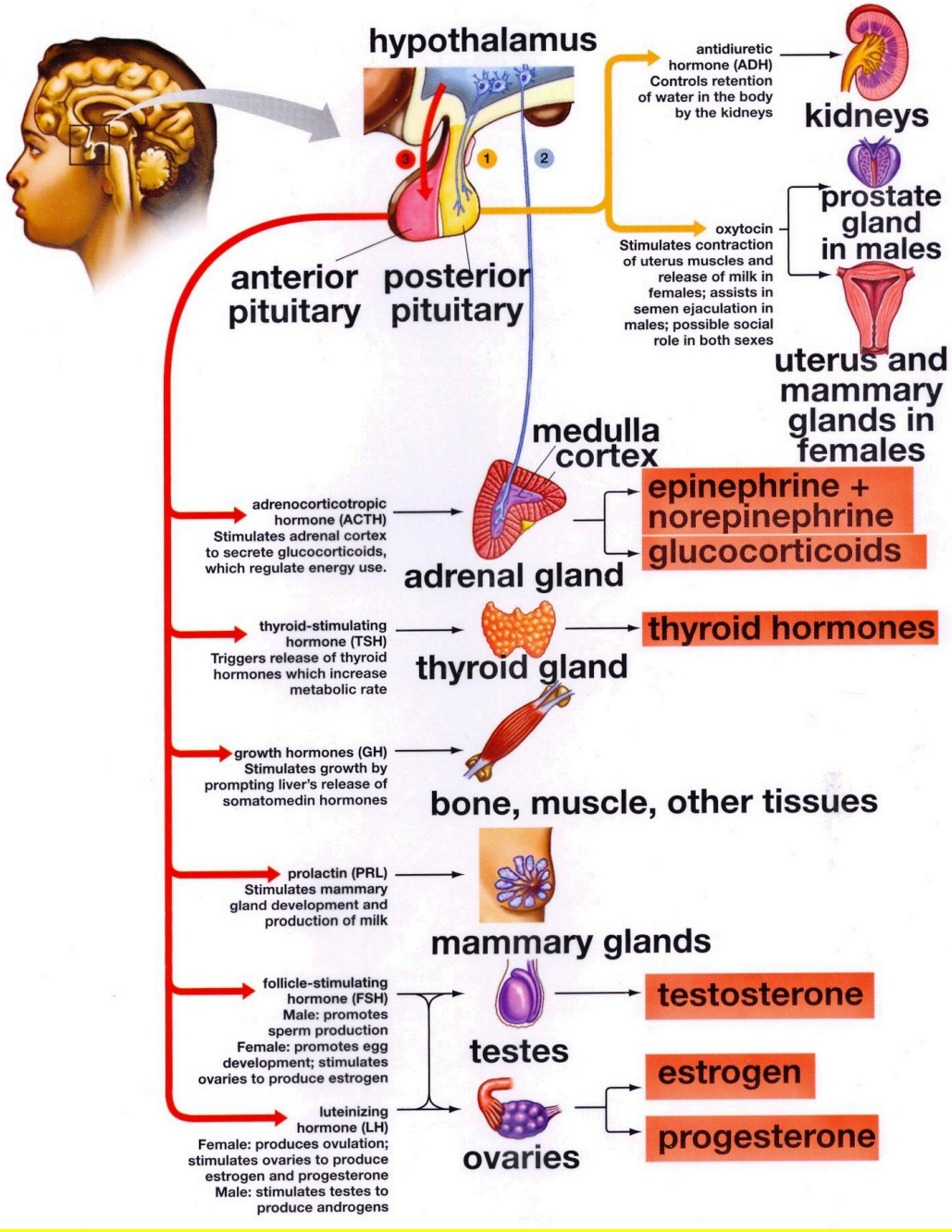
- **External hormones** found in many animals: cause physiological response in same species
- Cause changes behavior: **ants** tell other **ants** about food source
- **Sexual attractants-** monkeys
- Female monkeys ⟶ volatile acids from vagina during **ovulation**

Do humans have pheromones?



Human Pheromones?

- Arm pit secretions: volatile steroids related to sex hormones
- Women: ↑ vaginal acids during ovulation
- **Synchronization**- menstrual cycles: women living together
- Musklike odors: perfumes/after shaves
- Difference humans vs. other animals
- Humans: ↓ **sense of smell**


hypothalamus
antidiuretic hormone (ADH) Controls retention of water in the body by the kidneys
kidneys
oxytocin Stimulates contraction of uterus muscles and release of milk in females; assists in semen ejaculation in males; possible social role in both sexes
prostate gland in males
uterus and mammary glands in females
anterior pituitary
posterior pituitary
1
2
3
medulla
cortex
adrenocorticotropic hormone (ACTH) Stimulates adrenal cortex to secrete glucocorticoids, which regulate energy use.
epinephrine + norepinephrine
glucocorticoids
adrenal gland
thyroid-stimulating hormone (TSH) Triggers release of thyroid hormones which increase metabolic rate
thyroid hormones
thyroid gland
growth hormones (GH) Stimulates growth by prompting liver's release of somatomedin hormones
bone, muscle, other tissues
prolactin (PRL) Stimulates mammary gland development and production of milk
mammary glands
follicle-stimulating hormone (FSH) Male: promotes sperm production Female: promotes egg development; stimulates ovaries to produce estrogen
testosterone
testes
luteinizing hormone (LH) Female: produces ovulation; stimulates ovaries to produce estrogen and progesterone Male: stimulates testes to produce androgens
estrogen
progesterone
ovaries