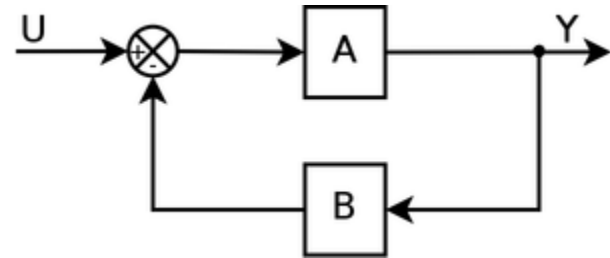
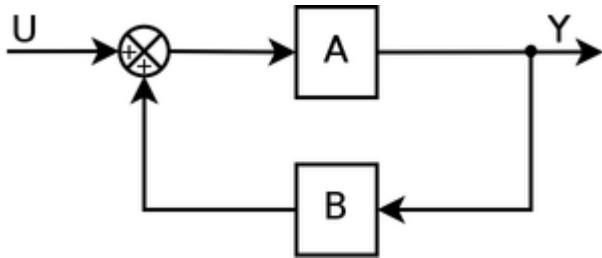
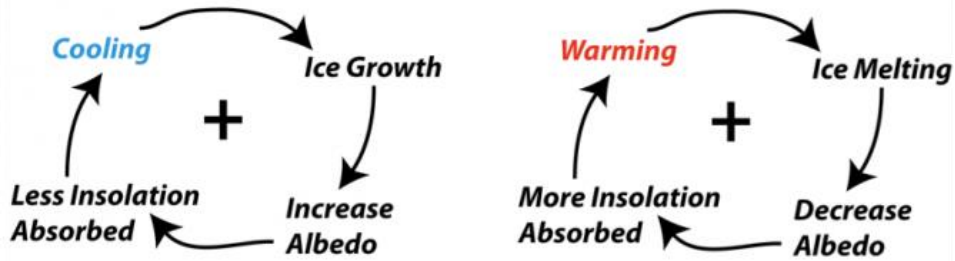


# Endokrinní systém

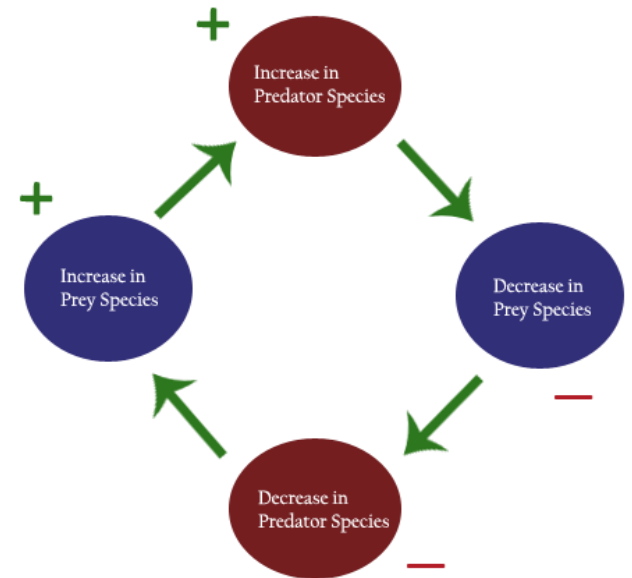
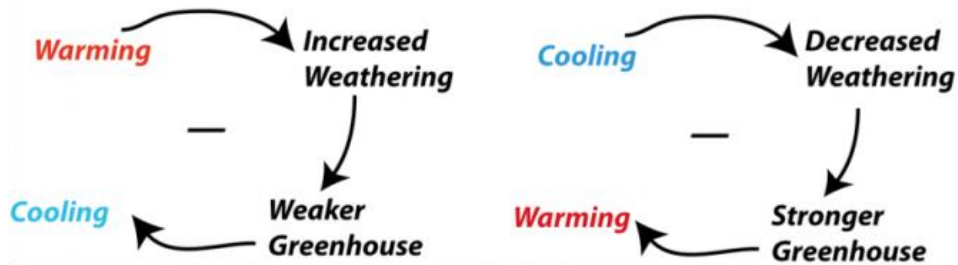
# Pozitivní a negativní zpětná vazba



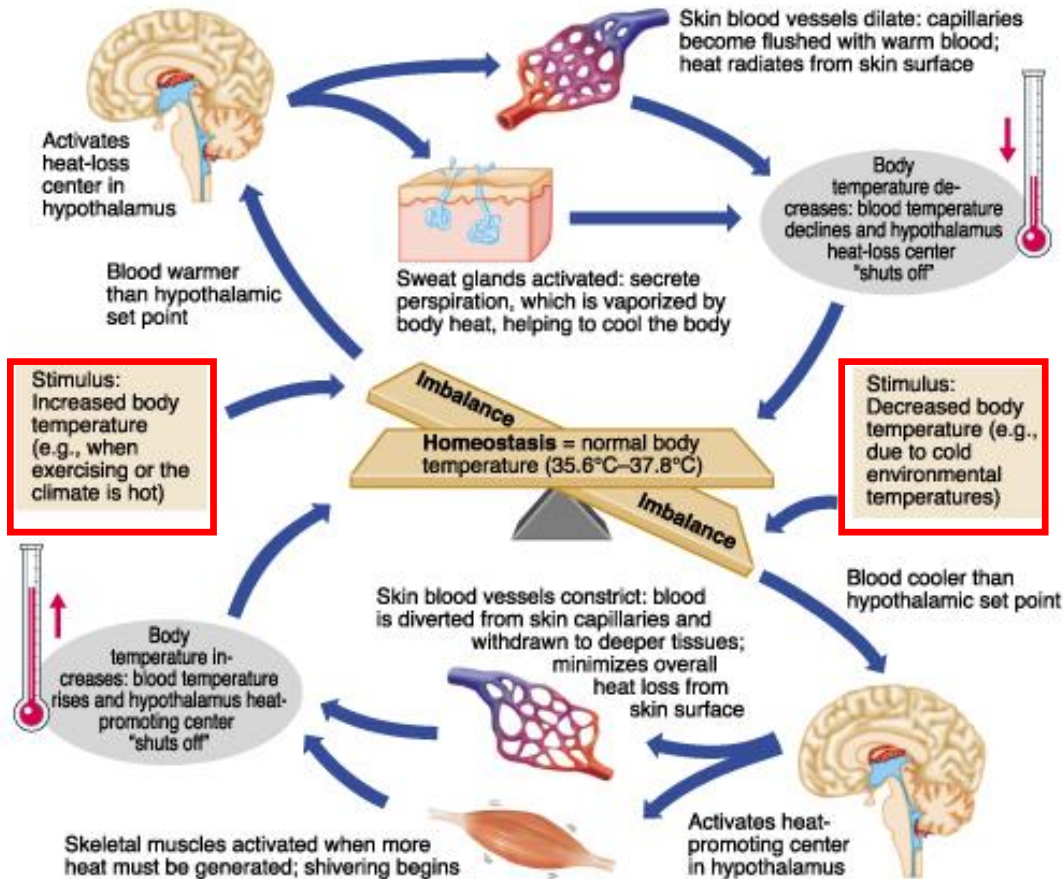
## Positive Feedback Mechanism



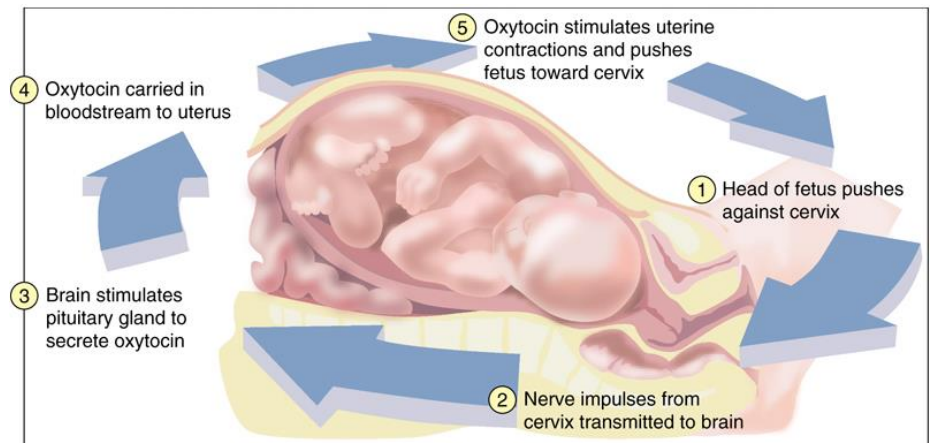
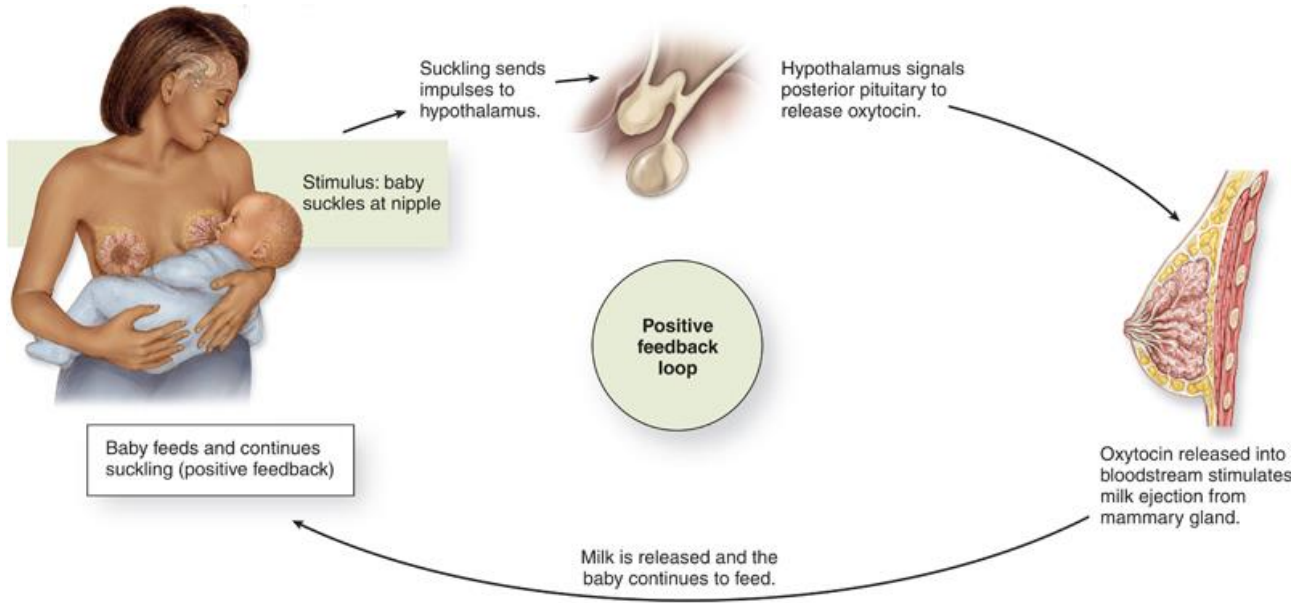
## Negative Feedback Mechanism



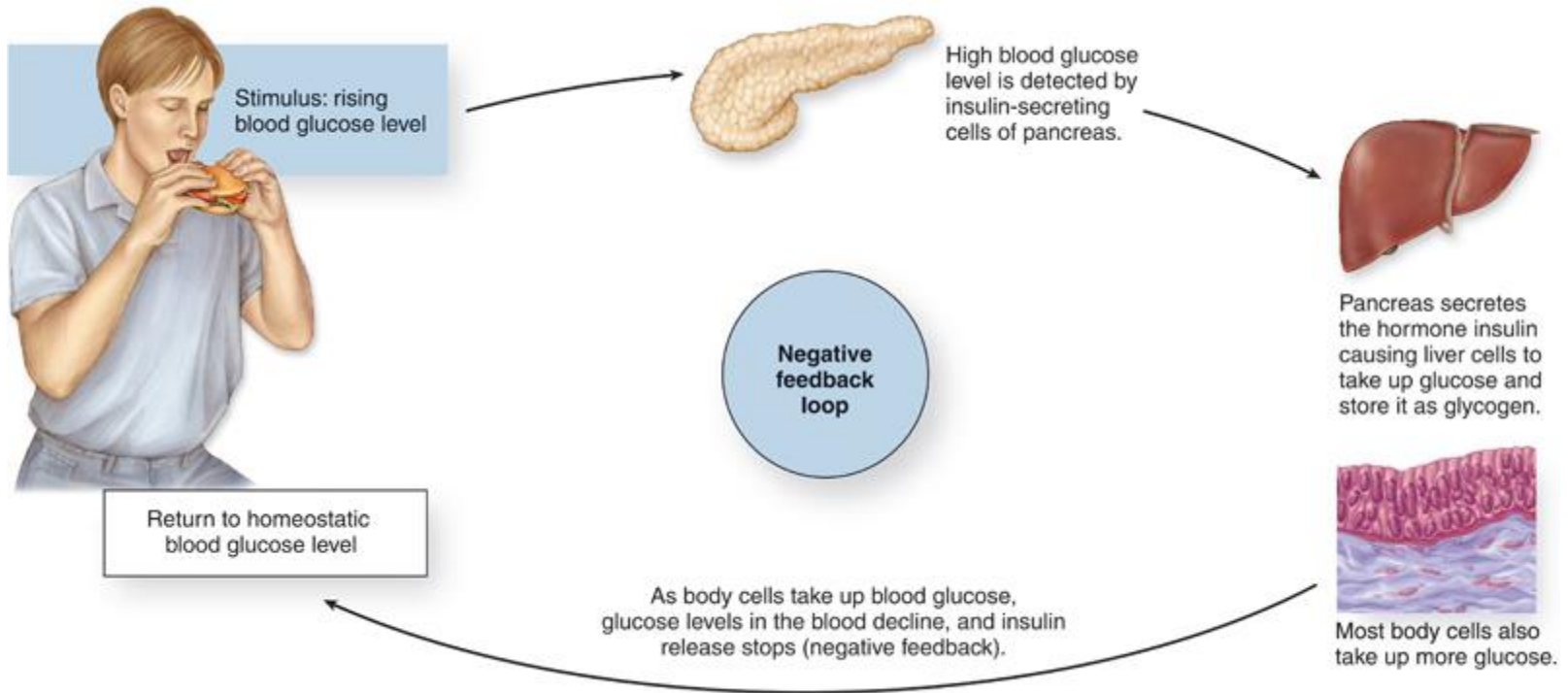
# Termoregulace



# Hormonální regulace



# Hormonální regulace

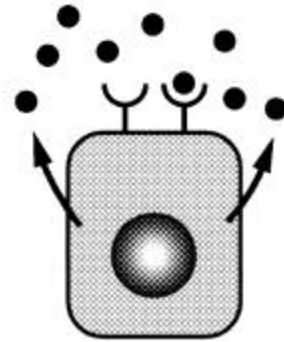




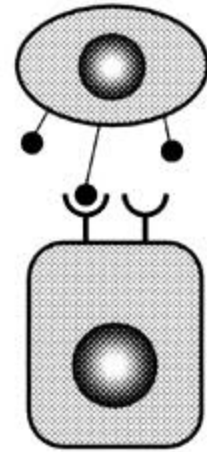
endocrine



paracrine



autocrine



juxtacrine

# Endokrinní systém

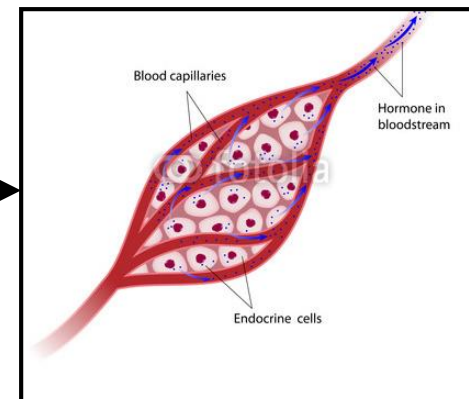
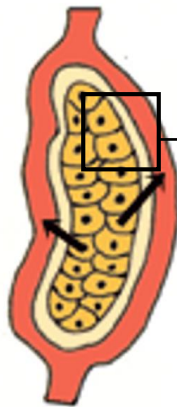
- **Žlázy** (hypofýza, epifýza, štítná žláza, příštítná tělíska, nadledviny)
- **Součást jiných orgánů**  
(pankreas, gonády, ledviny, placenta)
- **Endokrinní buňky** v epitelu, neuroendokrinní buňky, atd.



## Obecná struktura:

- Vazivové pouzdro + septa
- Trámce žláзовého epitelu nebo skupinky žláзовých buněk
- Kapilární síť
  - Fenestrovane kapiláry
  - Sinusoidy

## Exokrinní vs. Endokrinní žláza

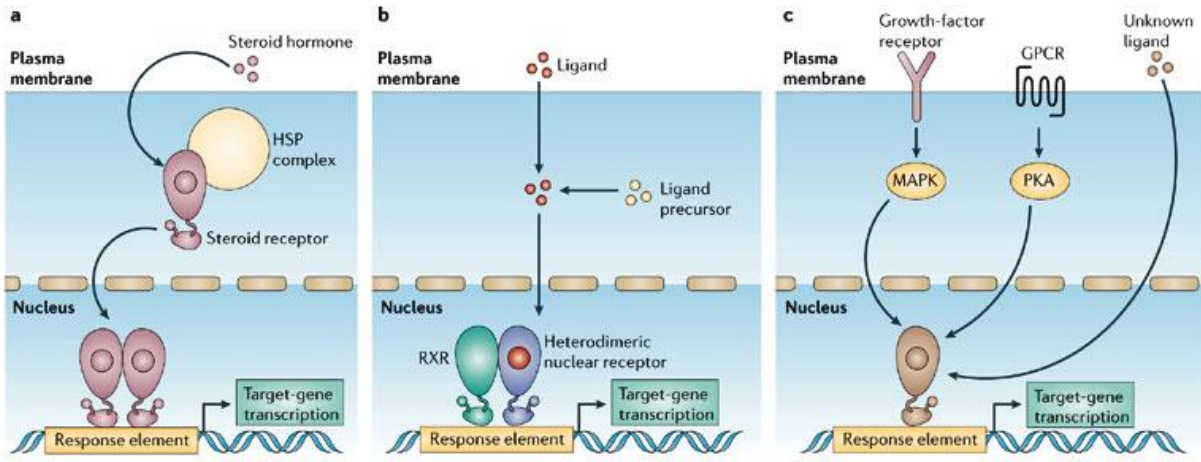
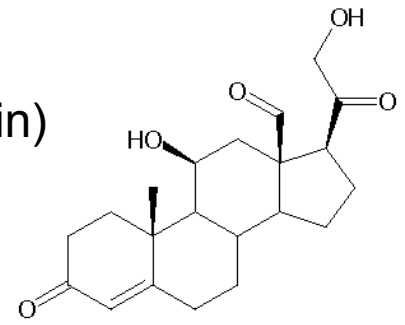


## Charakter sekrece

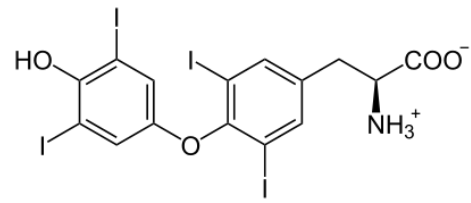
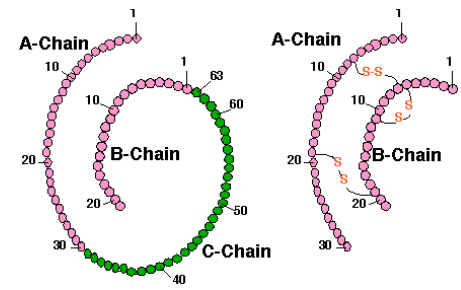
- autokrinní/parakrinní
- neurokrinní
- **endokrinní**

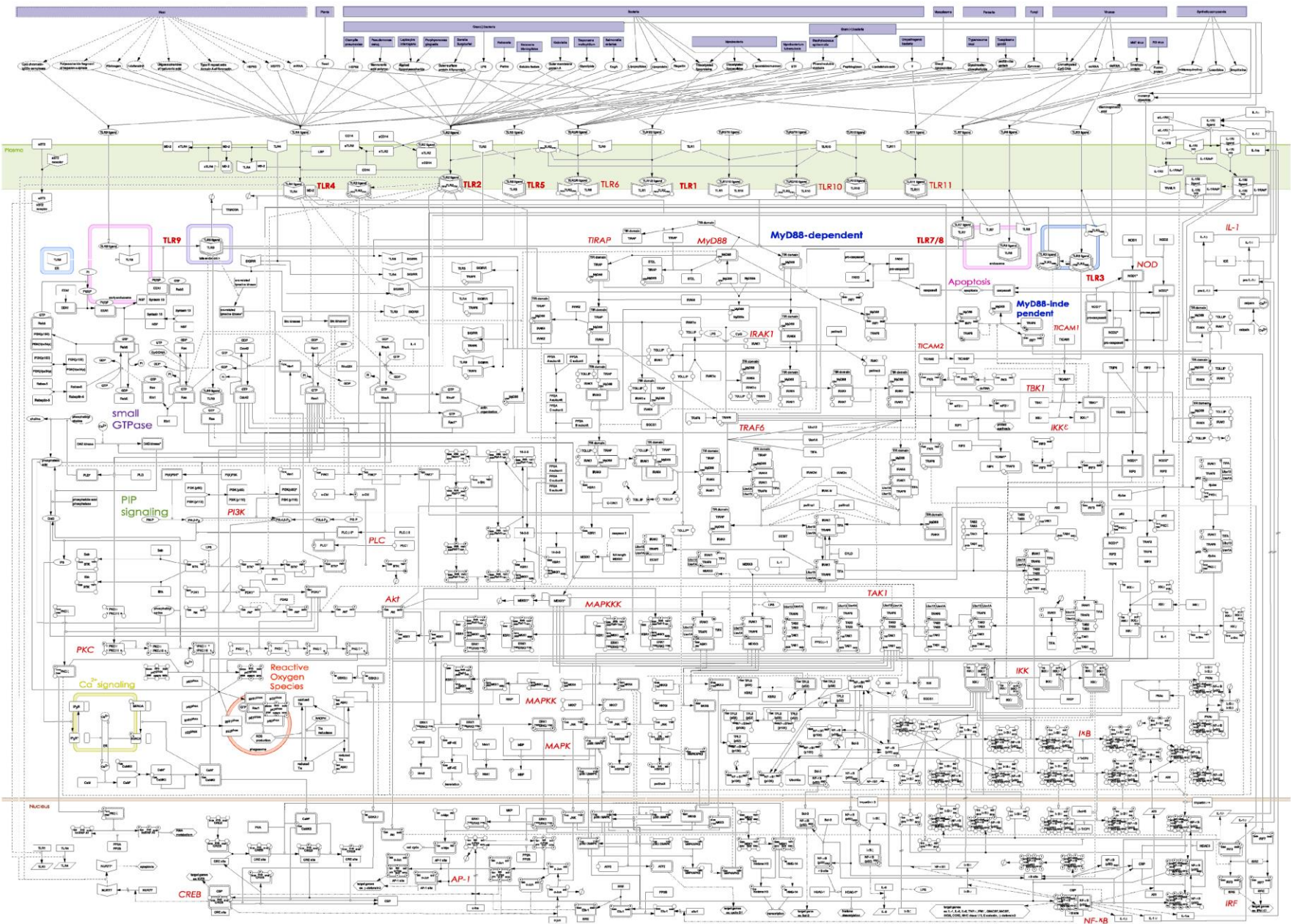
# Hormony:

- **steroidy** – hydrofobní, intracytoplasmatické nebo jaderné receptory (pohlavní hormony, kortikoidy)
- **proteiny a polypeptidy** – hydrofilní, receptory na buněčné membráně (insulin, hormon adenohipofýzy, PTH, ...)
- **aminokyseliny** a jejich deriváty (adrenalin, noradrenalin, thyroxin)



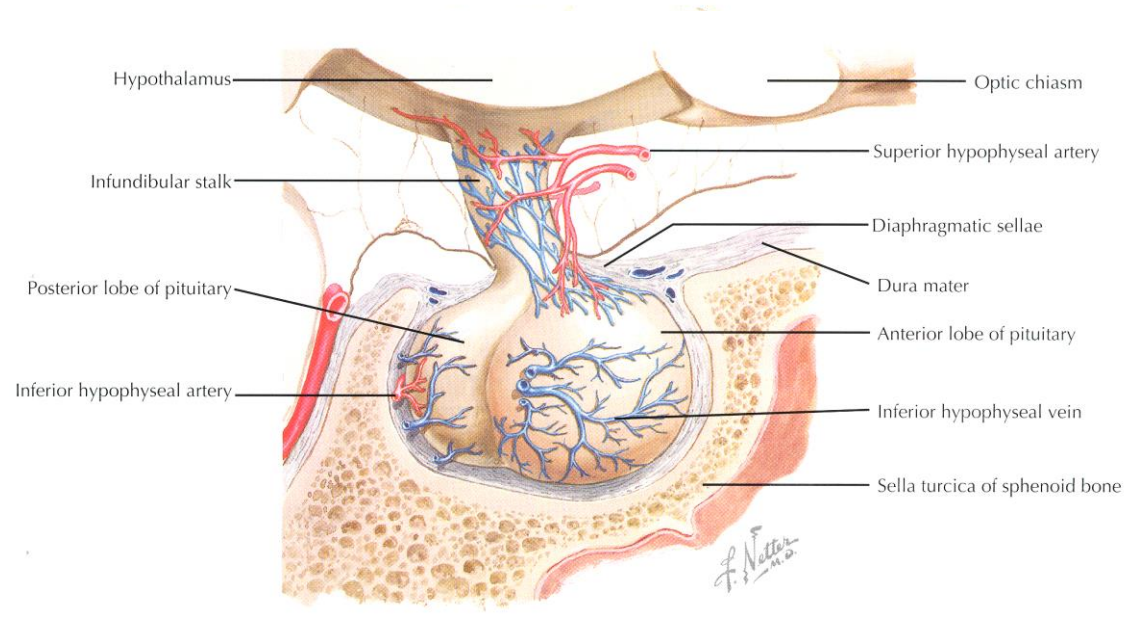
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Nature Reviews | Immunology





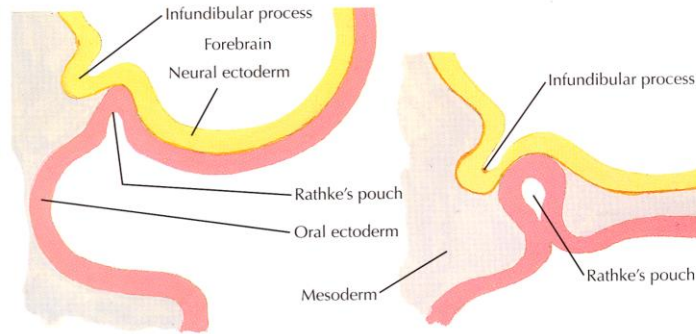
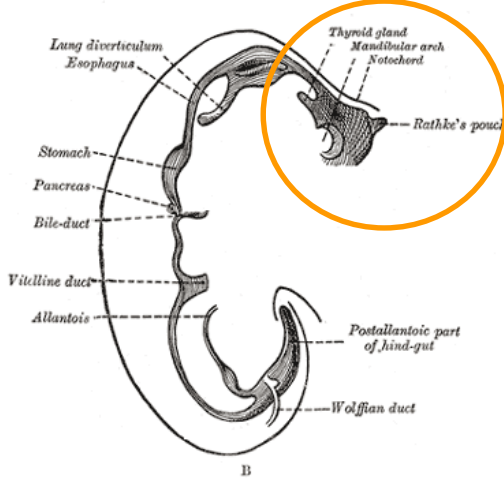
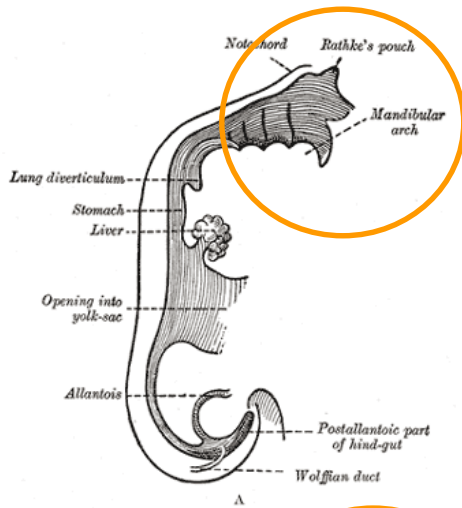
# Hypofýza (gl. pituitaria)

Centrální postavení v lidském endokrinním systému

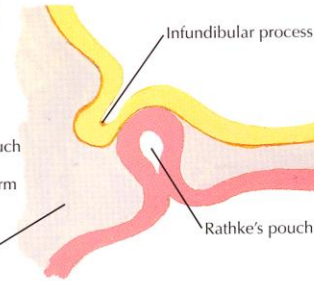


# Dvojí embryonální základ hypofýzy

- Ektoderm (Rathkeho výchlípek)
- Neuroektoderm ventrální stěny diencefalonu



1. Beginning formation of Rathke's pouch and infundibular process



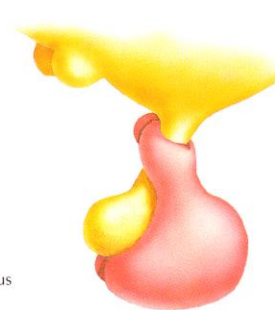
2. Neck of Rathke's pouch constricted by growth of mesoderm



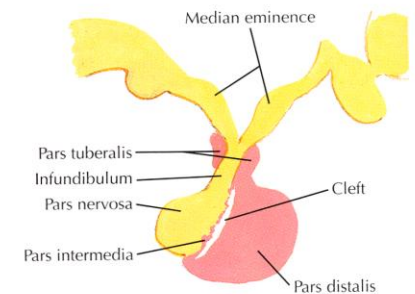
3. Rathke's pouch "pinched off"



4. "Pinched off" segment conforms to neural process, forming pars distalis, pars intermedia and pars tuberalis



5. Pars tuberalis encircles infundibular stalk (lateral surface view)

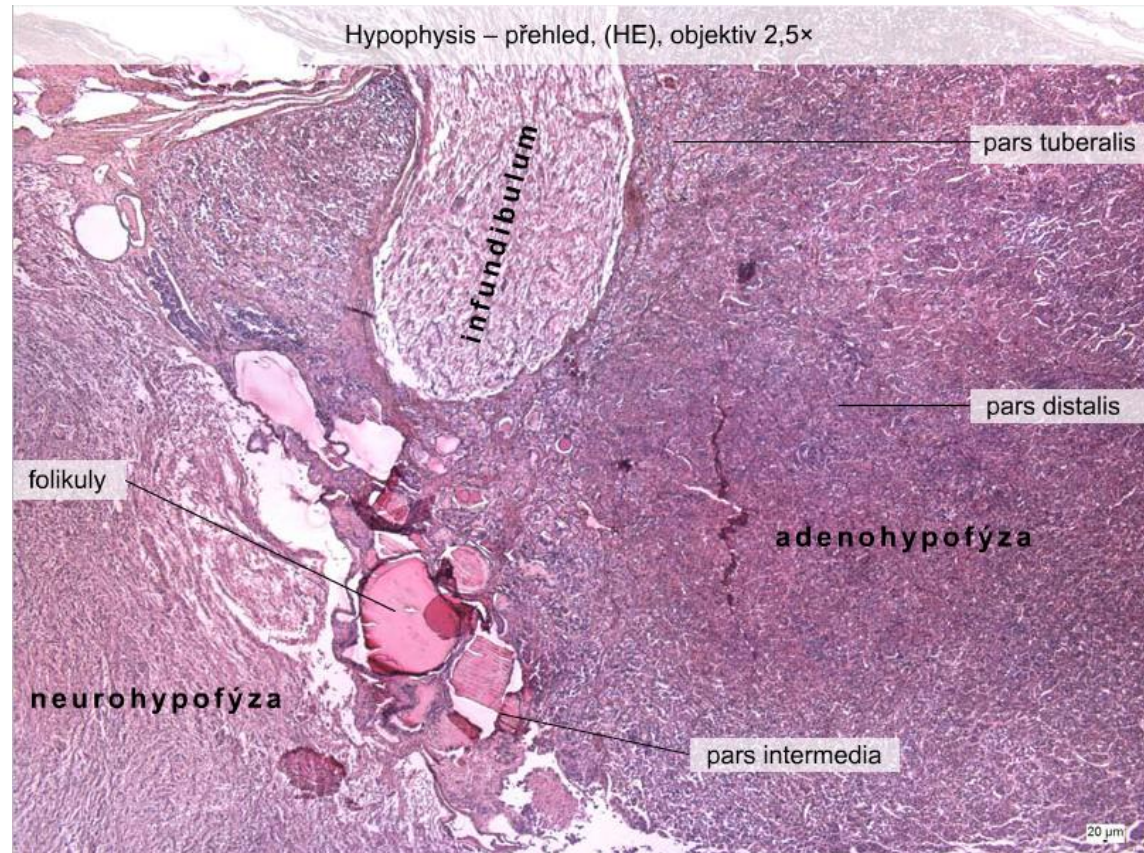


6. Mature form

F. Netter M.D.

## Struktura:

- adenohypofýza (pars distalis, pars tuberalis, pars intermedia)
- neurohypofýza (pars nervosa)
- infundibulum



# Adenohypofýza

## Chromofilní buňky

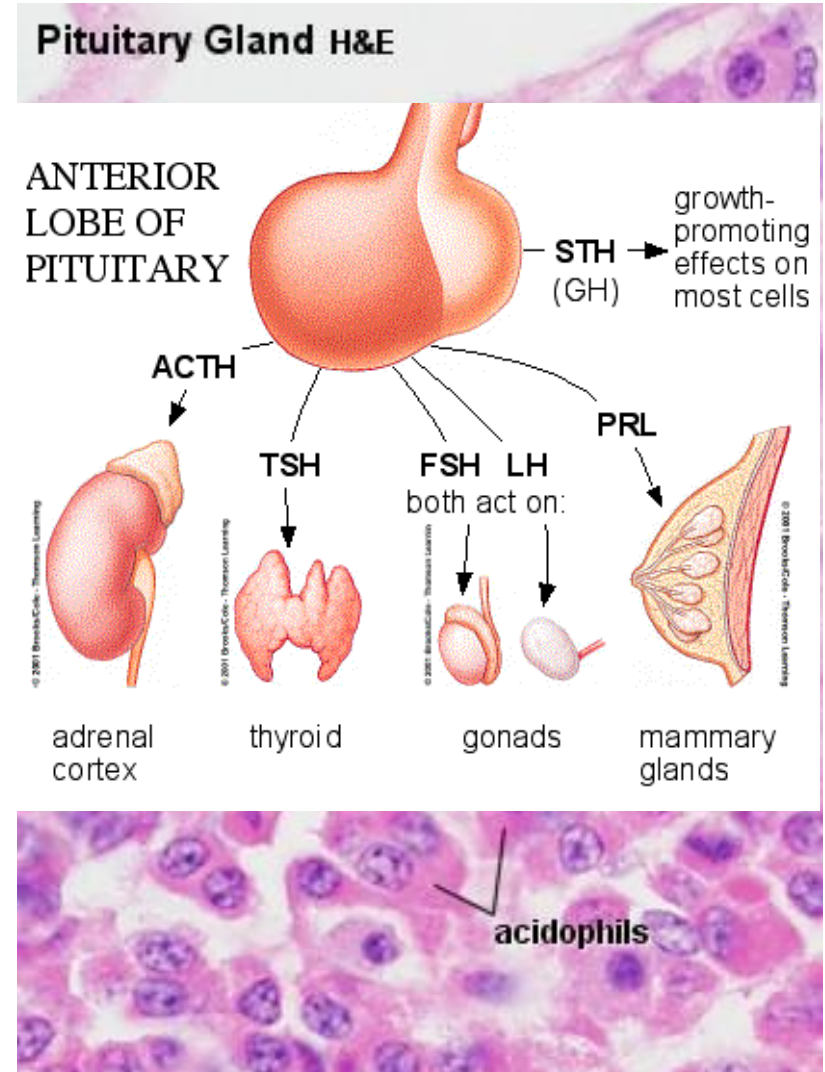
### Acidofilní

- *Somatotropní* (STH, somatotropní)
- *Mammotropní* (LTH, prolaktin)

### Basofilní

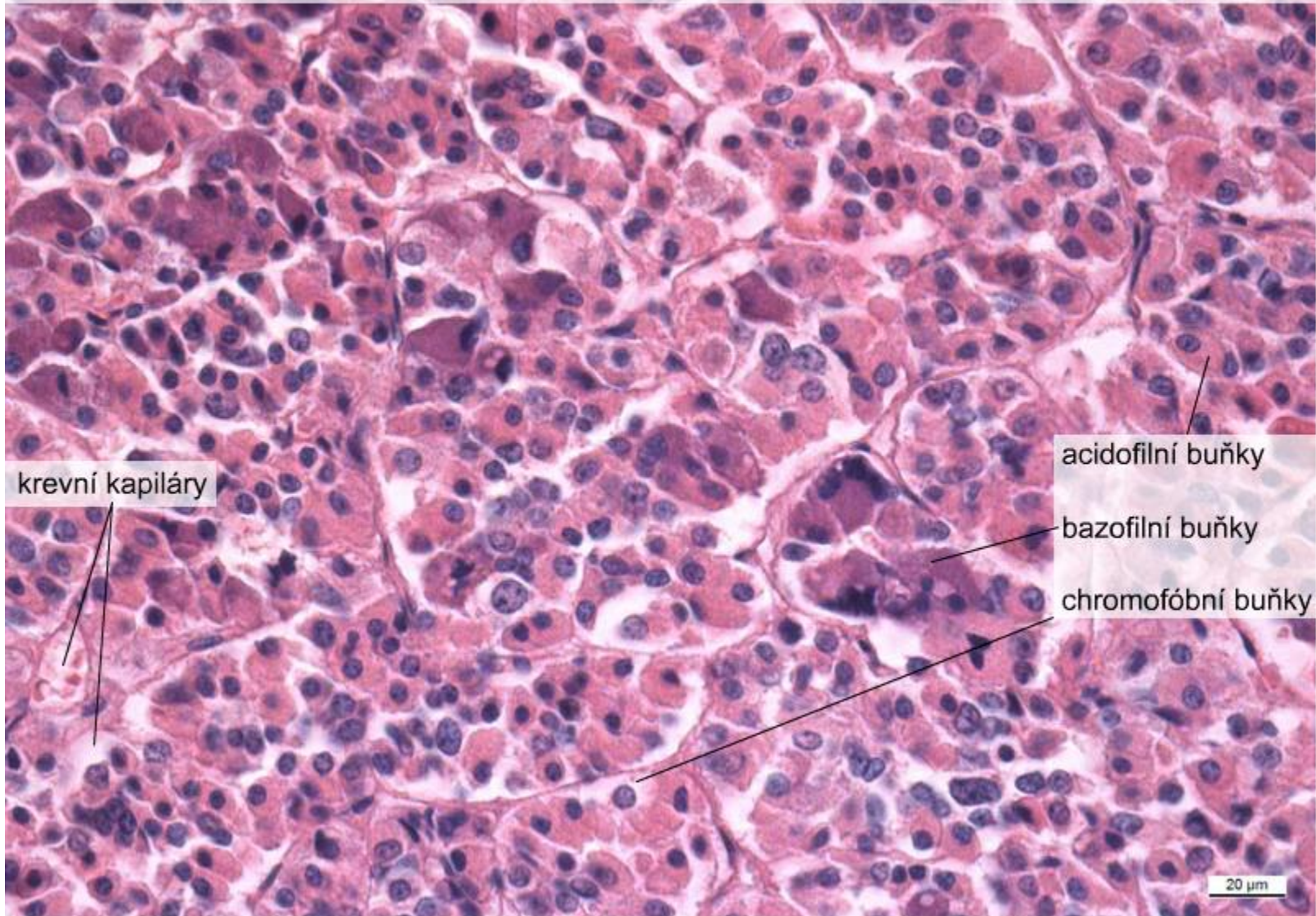
- *Thyreotropní* (TSH, tyreotropní)
- *Gonadotropní* (FSH, LH)
- *Kortikotropní* (ACTH, adrenokortikotropní)

## Chromofobní buňky



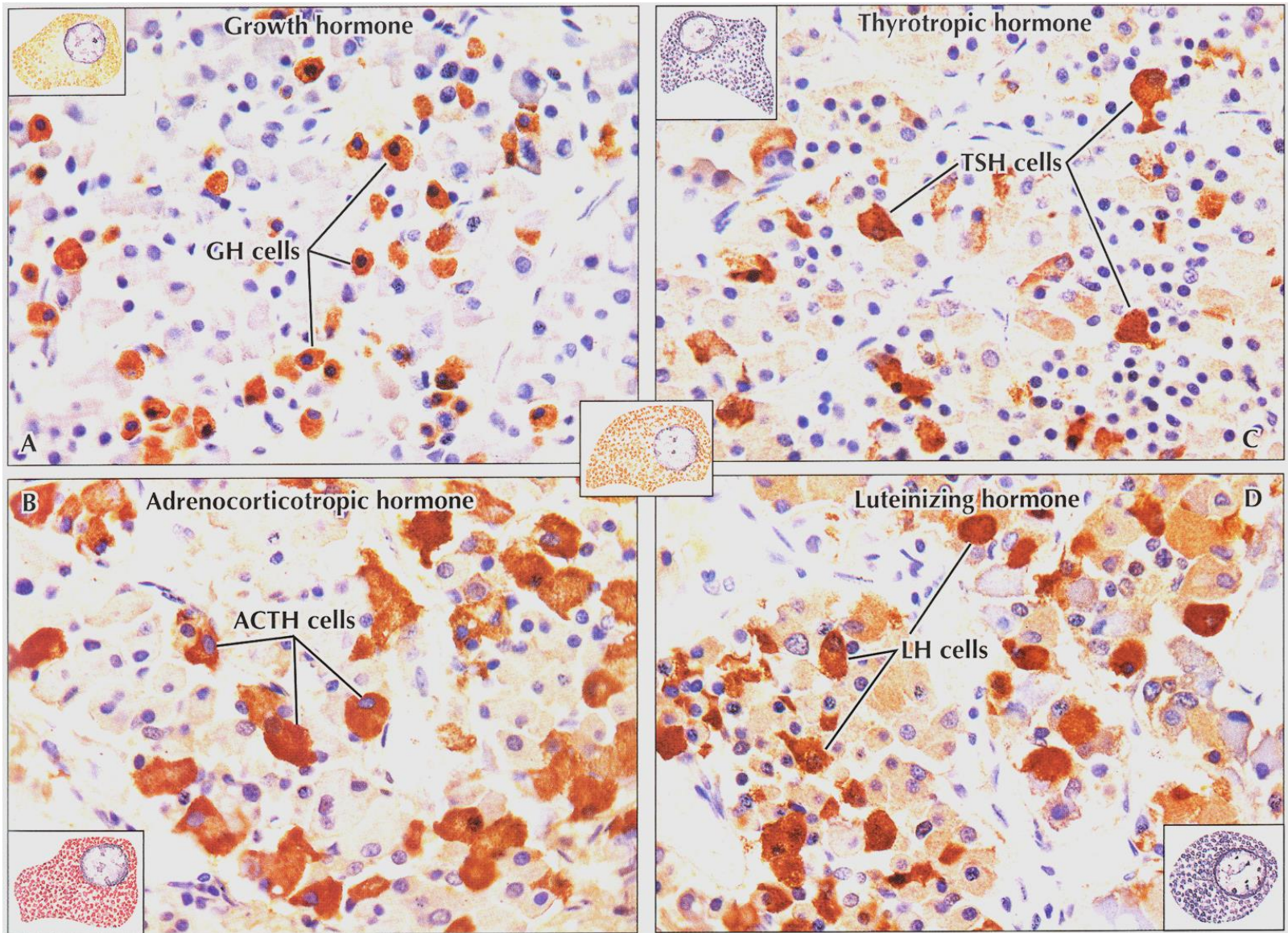
# Adenohypophysis

Hypophysis – přední lalok, (HE), objektiv 20×





# Adenohypofýza



# Neurohypofýza

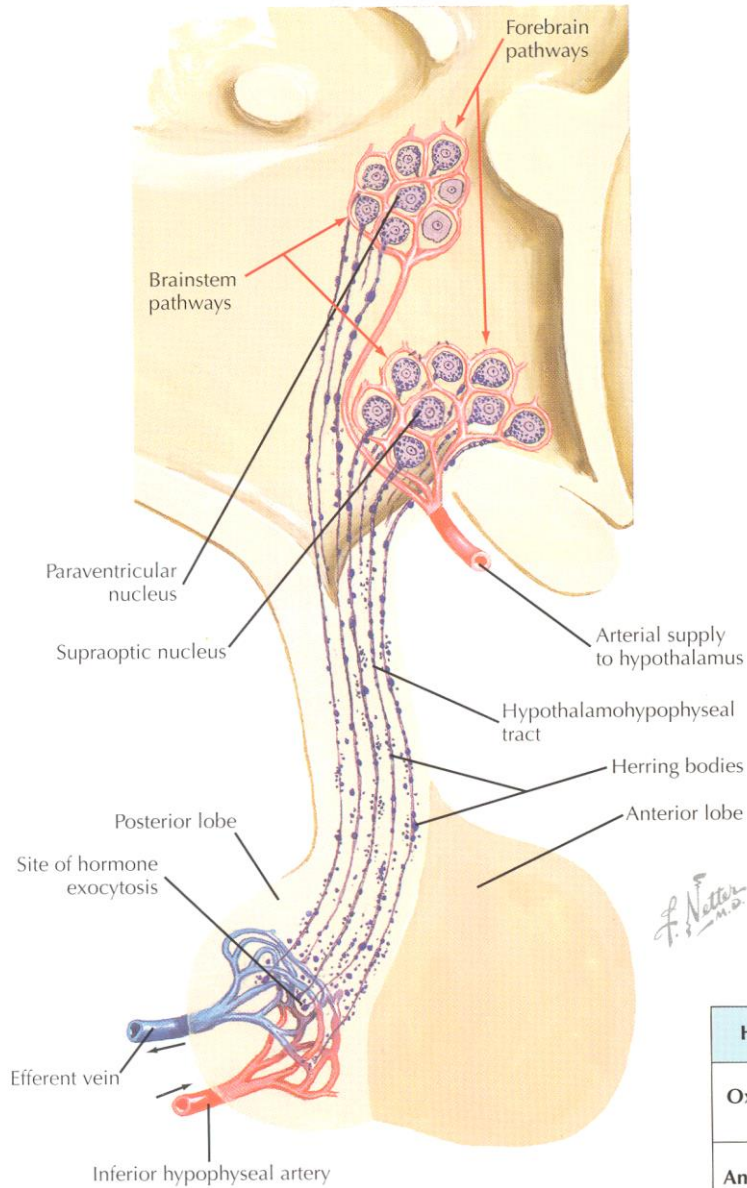
## Struktura

- **Nemyelinizovaná nervová vlákna** – axony neurosekrečních buněk hypotalamických jader (n. supraopticus a paraventricularis)
- **pituicyty** (neuroglie)

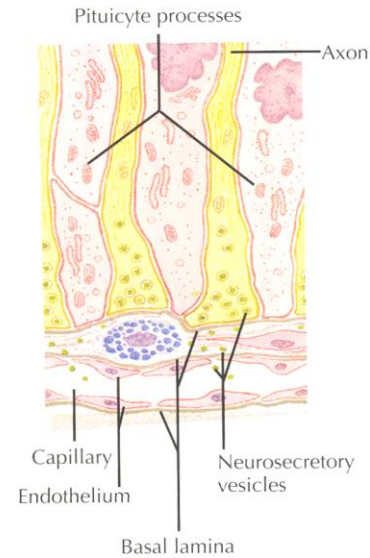
## Hormony

- *oxytocin* (OT)
- *antidiuretický hormon* (ADH, vasopressin)

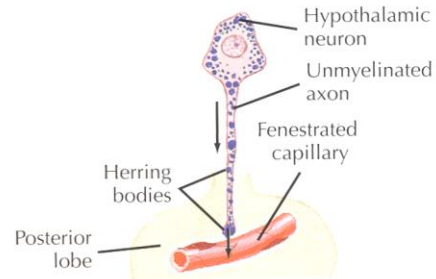
Herringova tělíška – neurosekreční zakončení – dilatace poblíž kapilár



▼ Neurosecretory Ending (posterior pituitary).

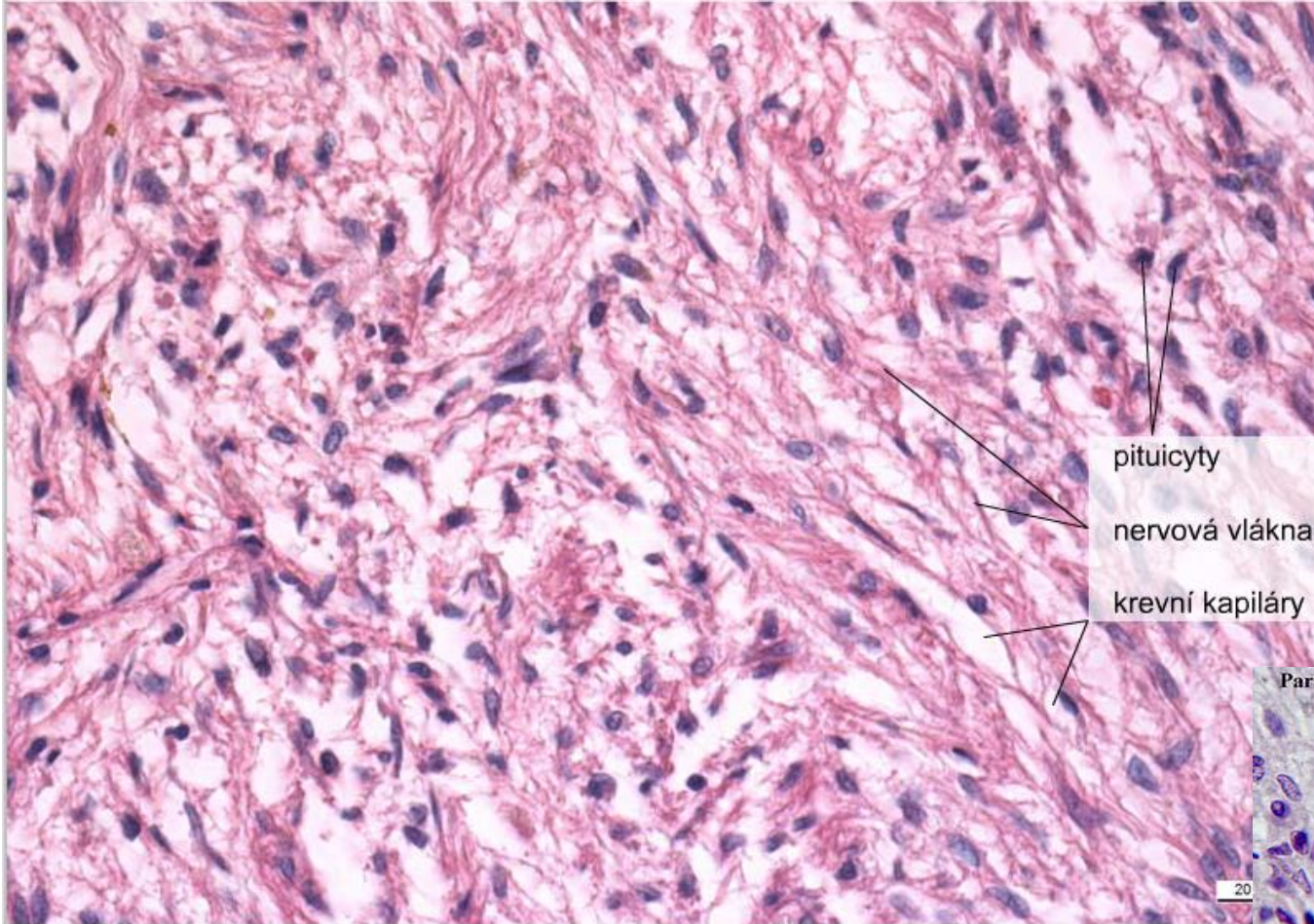


▼ Origin of ADH.



| Hormone                     | Principal Action                                   | Principal Nucleus of Origin |
|-----------------------------|--|-----------------------------|
| Oxytocin (OXY)              | Uterine contraction, milk ejection                 | Paraventricular             |
| Anti-diuretic hormone (ADH) | Water excretion in kidney, arteriolar constriction | Supraoptic                  |

Hypophysis – zadní lalok, (HE), objektiv 40×

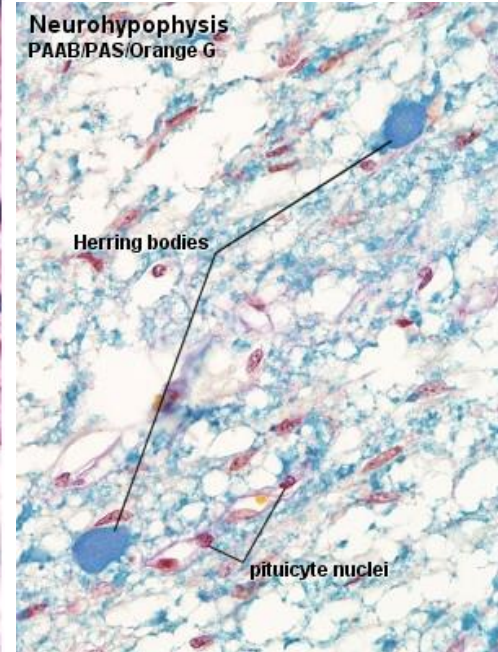


pituicyty

nervová vlákna

krevní kapiláry

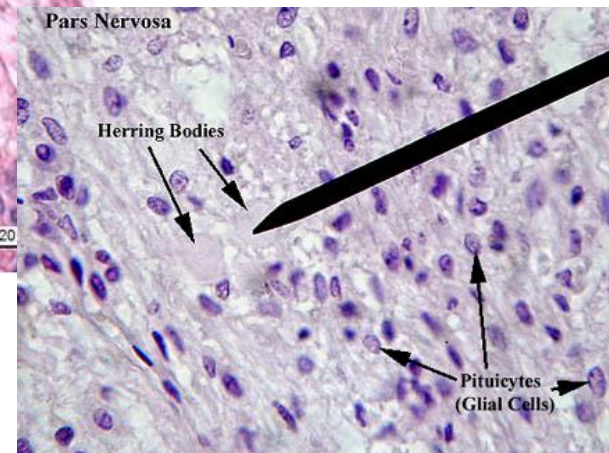
Neurohypophysis  
PAAB/PAS/Orange G



Herring bodies

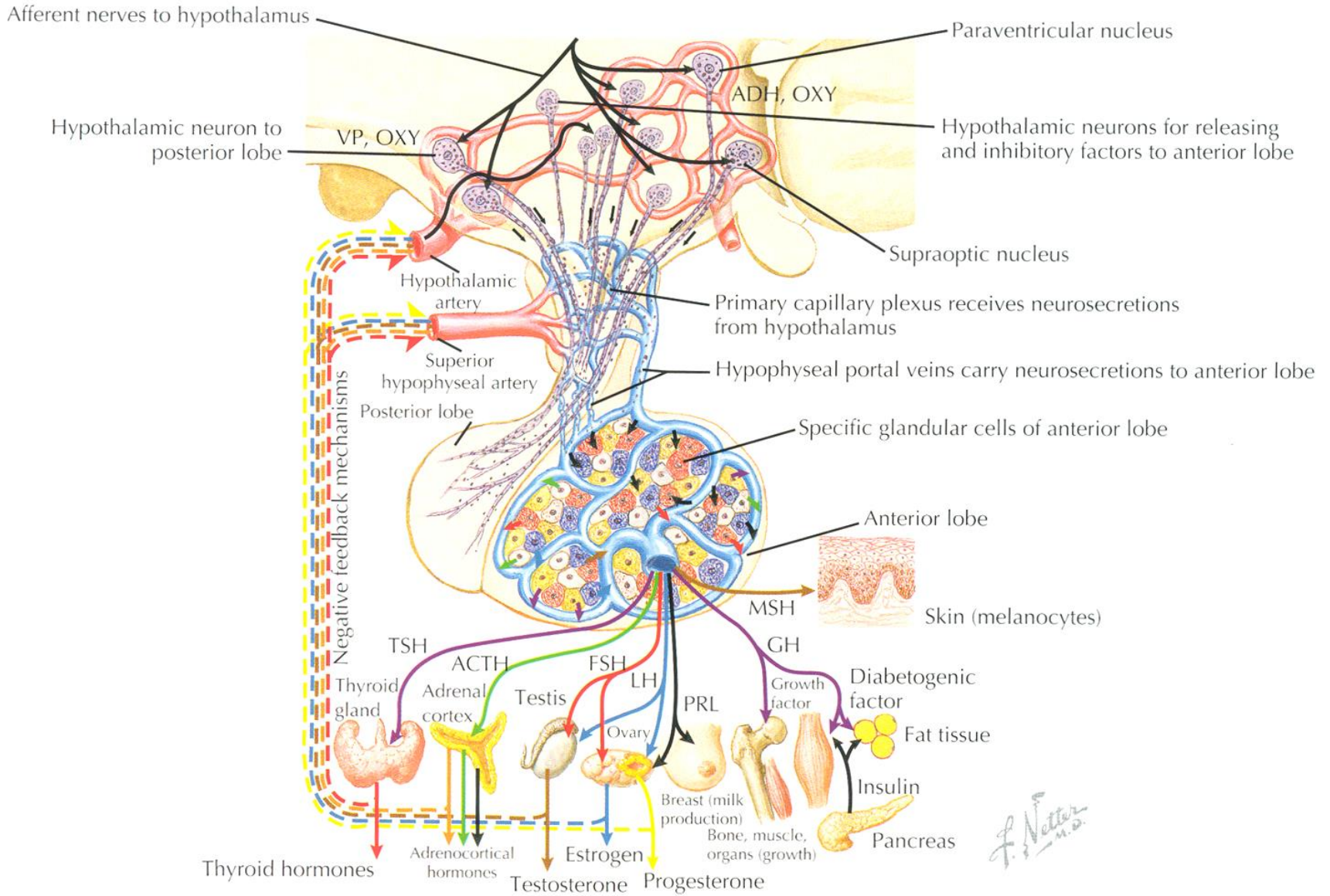
pituicyte nuclei

Pars Nervosa

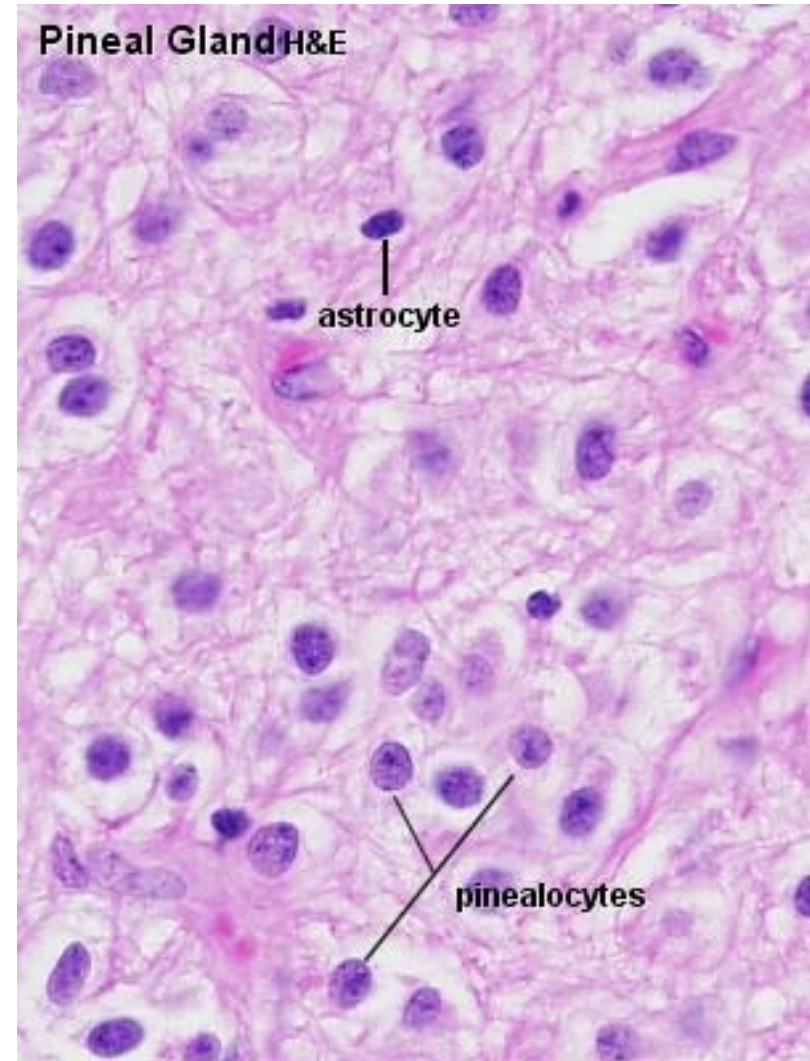
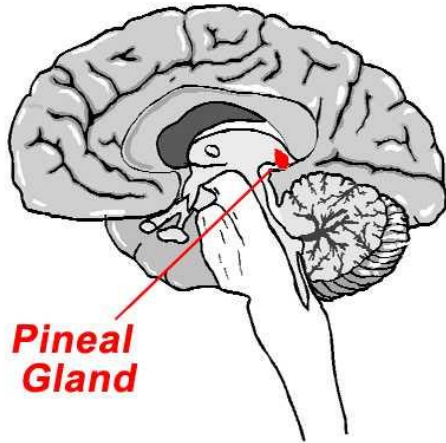


Herring Bodies

Pituicytes  
(Glial Cells)

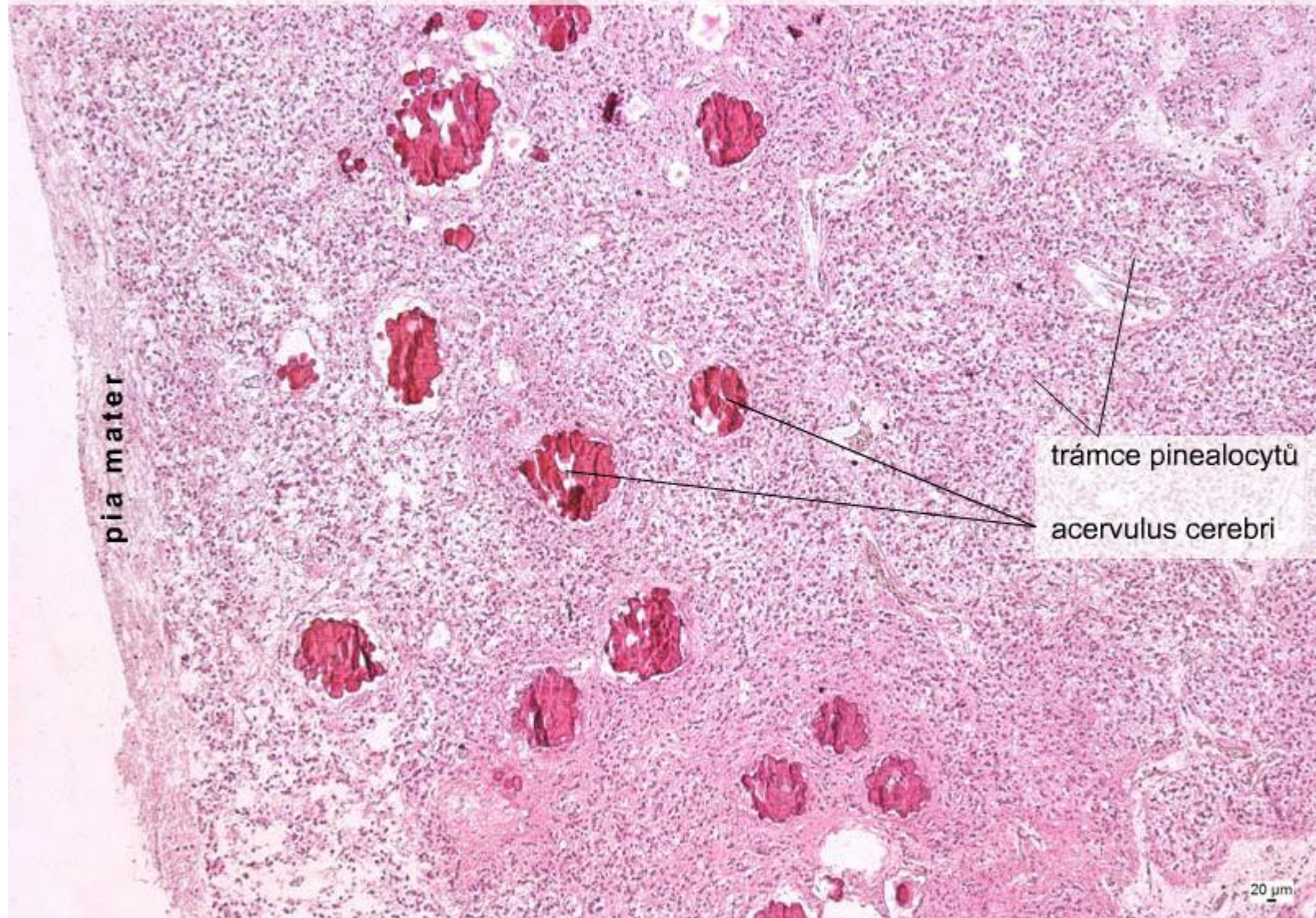


# Epifýza (c. pineale)



- Vazivové pouzdro + septa
- Nemyelinizovaná nervová vlákna
  - *pinealocyty* (95%, velké, světlé, kulatá jádra)
  - *astrocyty* (glie; tmavém podlouhlá jádra)
- melatonin

Epiphysis, (HE), objektiv 5×



pia mater

trámce pinealocytů

acervulus cerebri

20 μm

# Štítná žláza (gl. thyroidea)

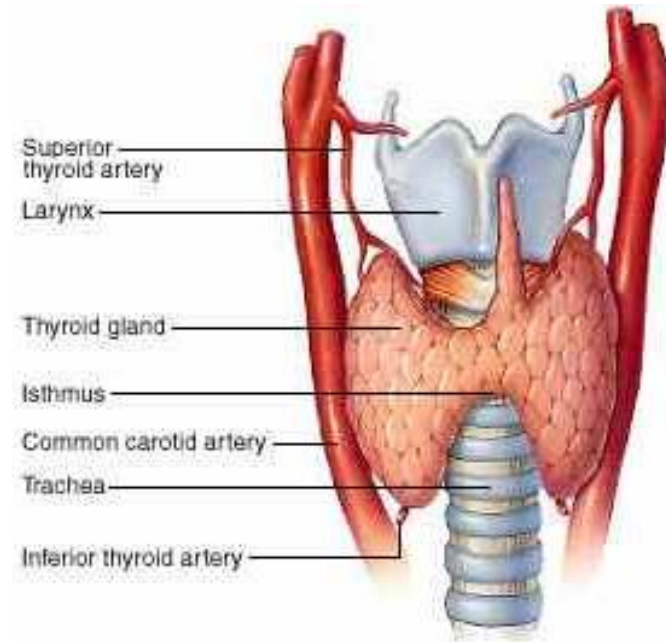
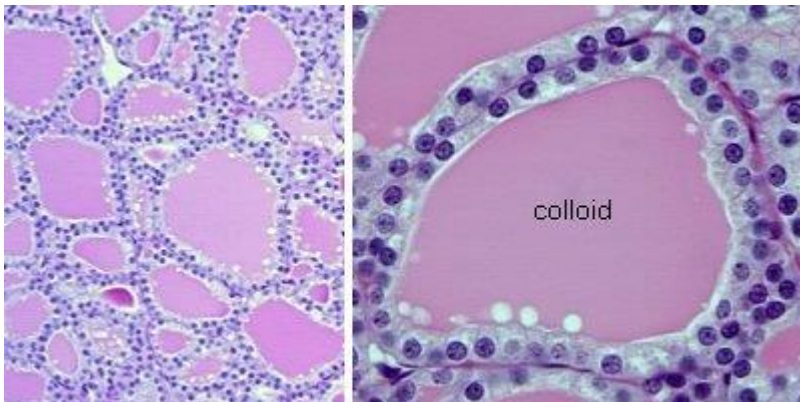
- Thyroidní hormony (**T3, T4**)
- **C buňky** *calcitonin*,

**Vazivový obal + septa**

**Laloky** → lalůčky - **folikuly**

**Folikuly** (50  $\mu\text{m}$  - 1 mm)

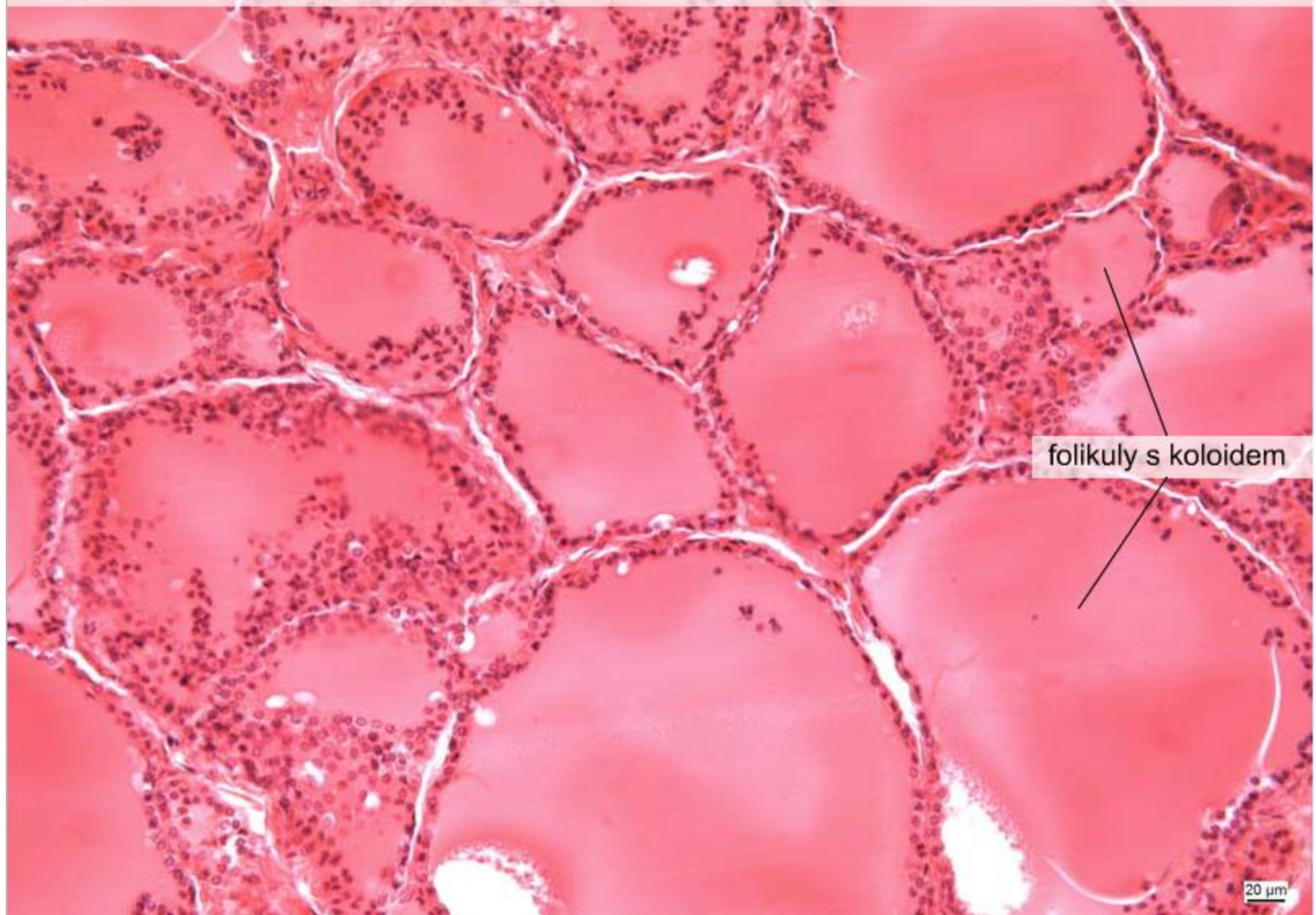
- Odděleny řídkým vazivem
- Jednoduchý kubický epitel
- Koloid



20 g



Glandula thyroidea, (HE), objektiv 20×



# Thyroid gland - follicles

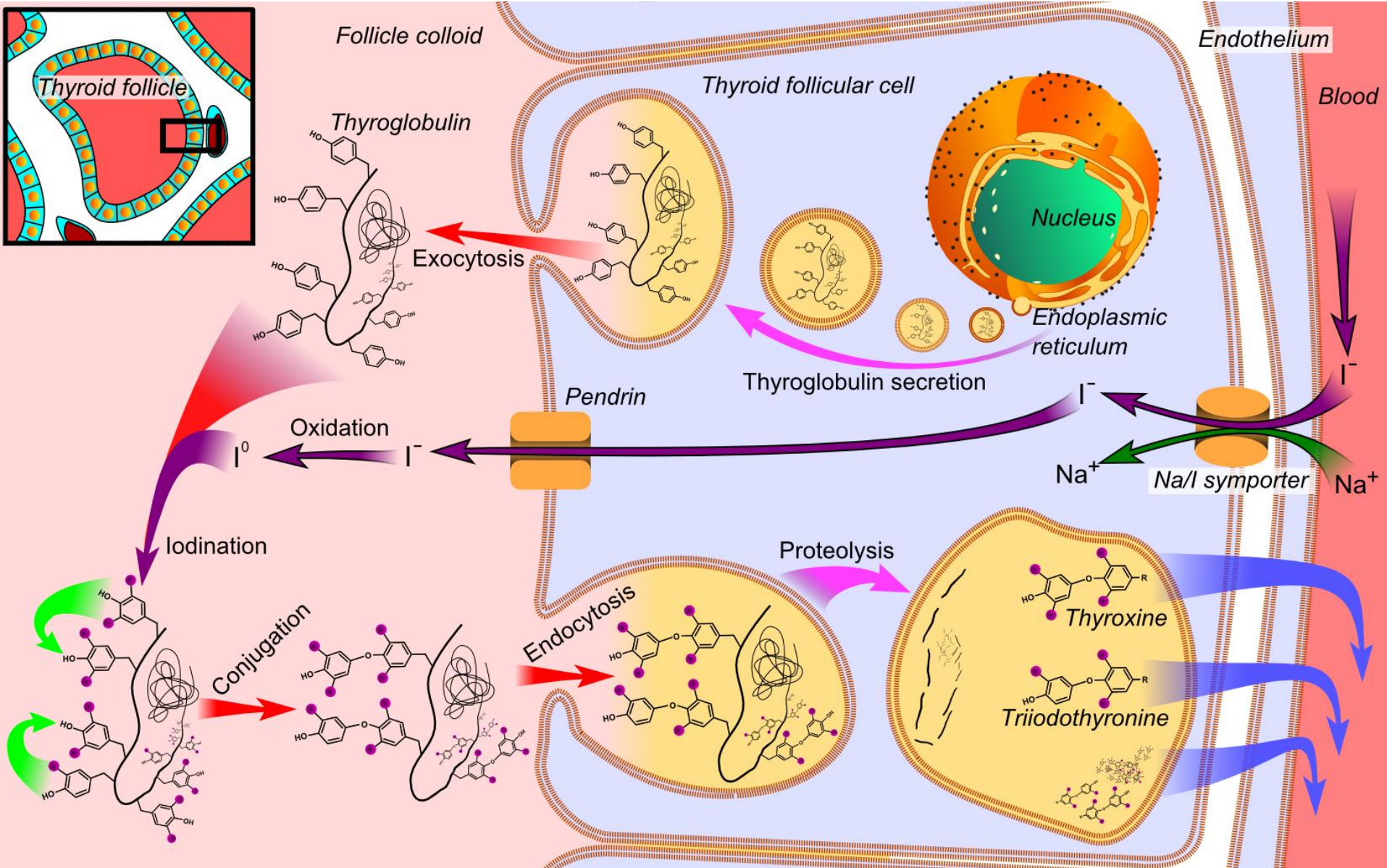


**C buňky (parafolikulární)** - báze epitelu, bez kontaktu s koloidem

thyreoglobulin

trijodothyronin  $T_3$

tetraiodothyronin (thyroxin)  $T_4$



# Přistitná žláza (gl. parathyreoidea)

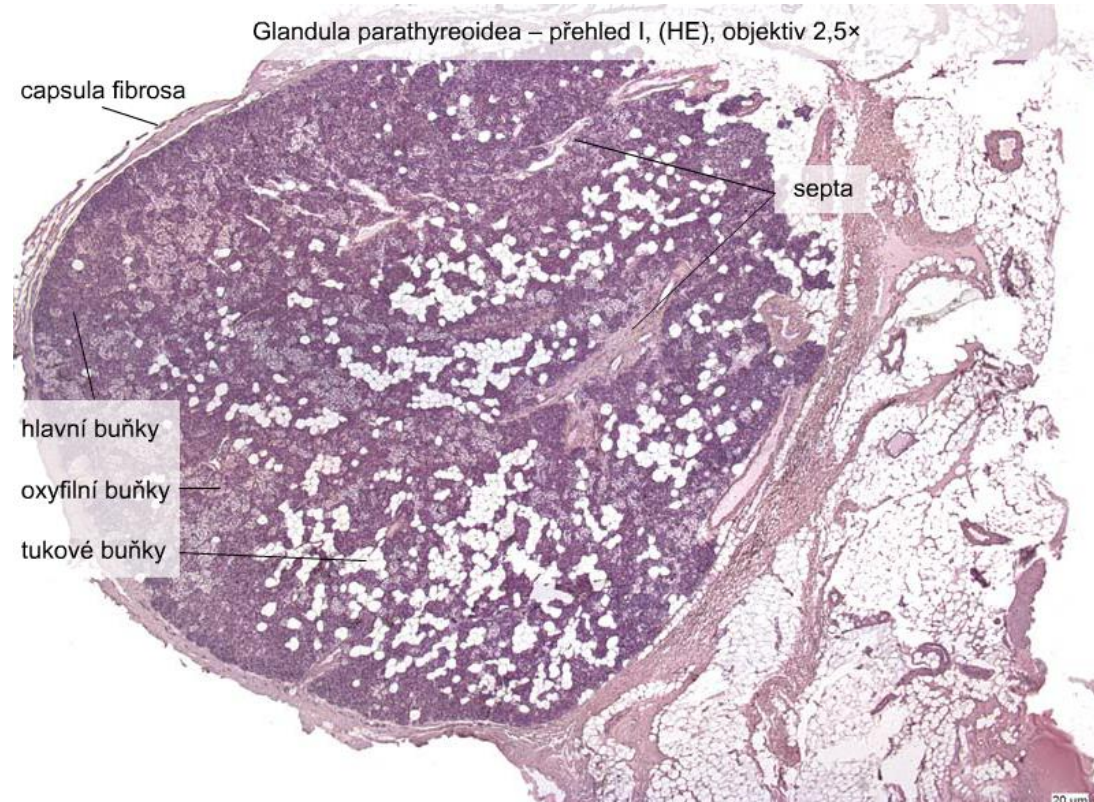
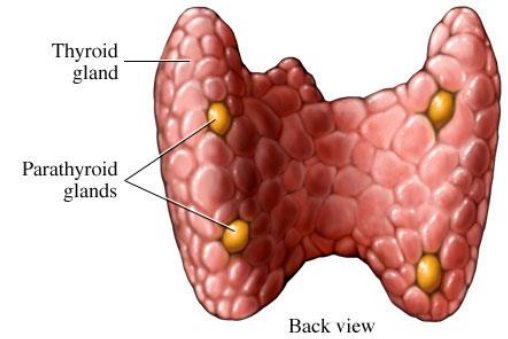
6 mm, 130 mg

Vazivové pouzdro + septa

Kapilární síť

**Trámce nebo skupiny žlázových buněk**

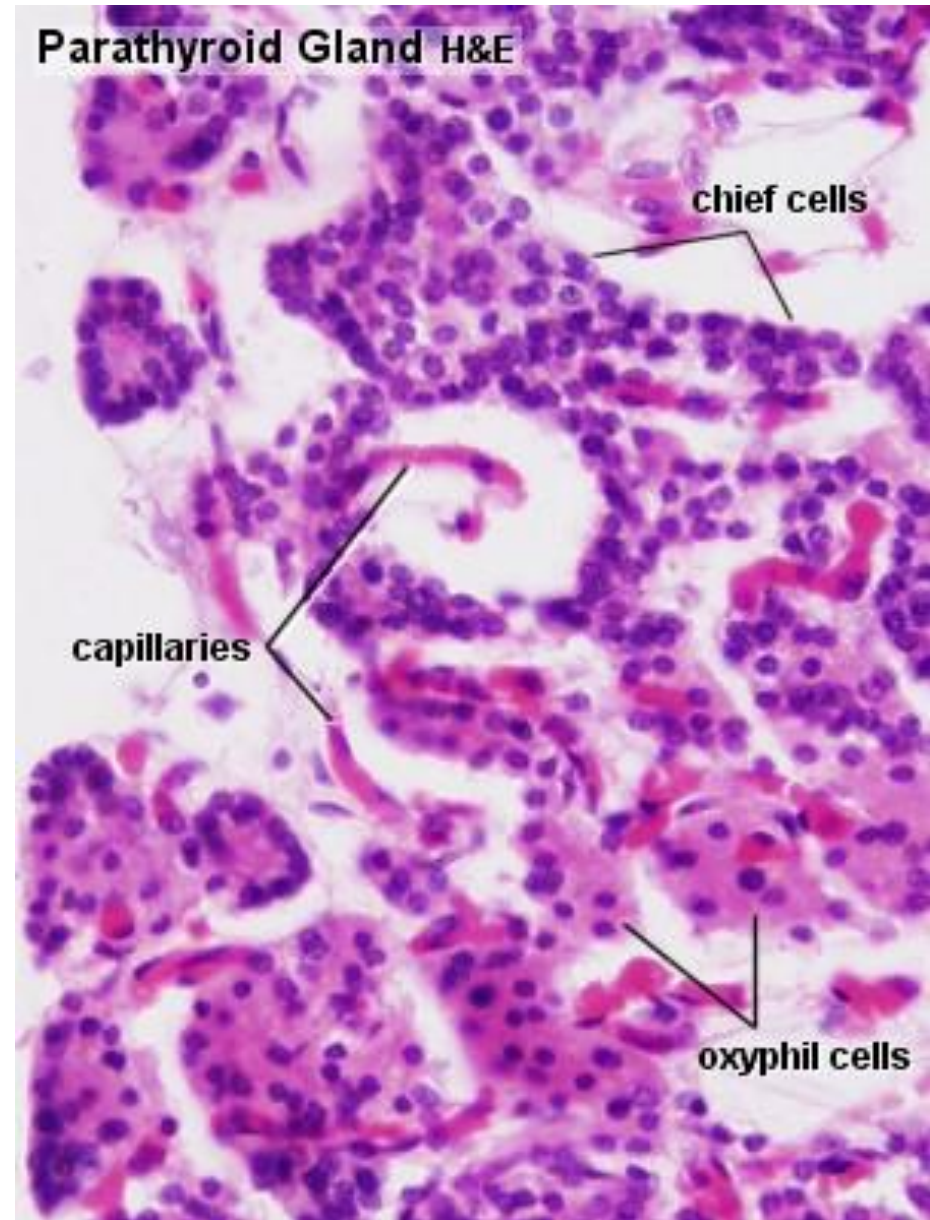
- Hlavní
- Oxyfilní
- Tukové



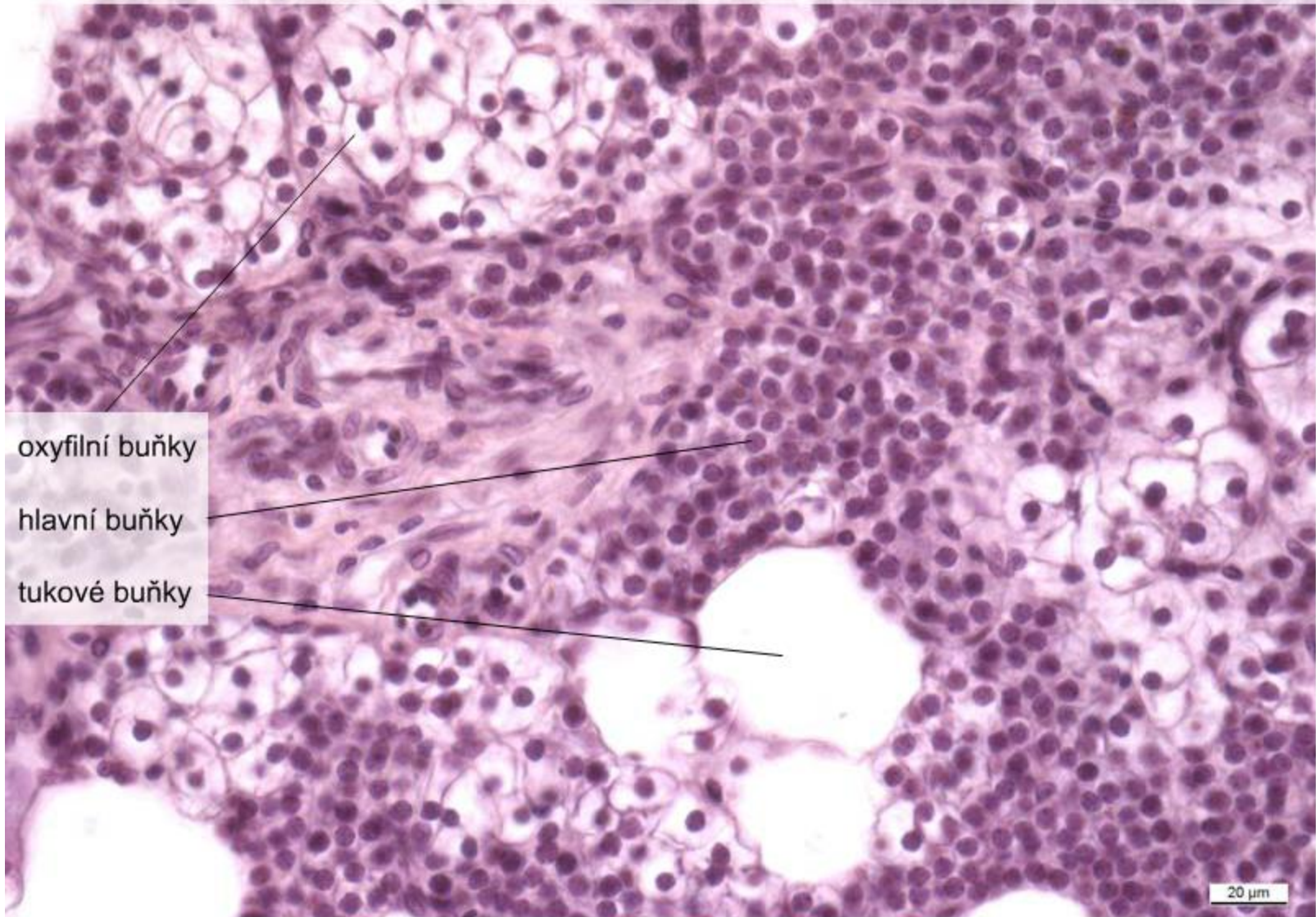
## *Hlavní buňky*

- nejpočetnější
- malé buňky (7-10 $\mu$ m) s velkým jádrem
- mírně acidofilní
- PTH – vápníkový metabolismus

- *Oxyfilní*
  - větší, polyedrické,
  - silně acidofilní/eozinofilní
  - kulaté jádro
  - glykogen

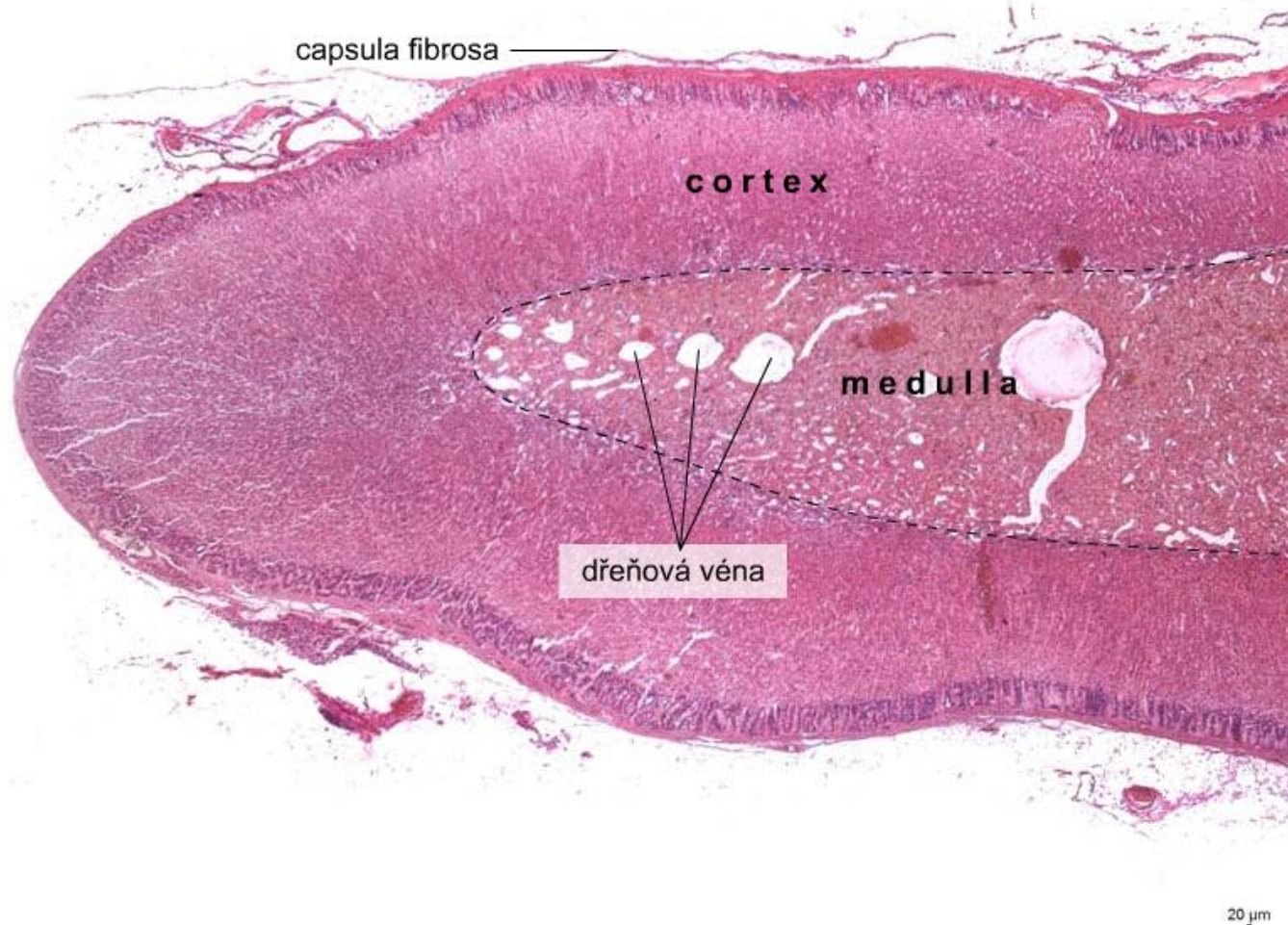


Glandula parathyreoidea – přehled II, (HE), objektiv 40×



# Nadledviny

Corpus suprarenale – přehled, (HE), objektiv 2,5x



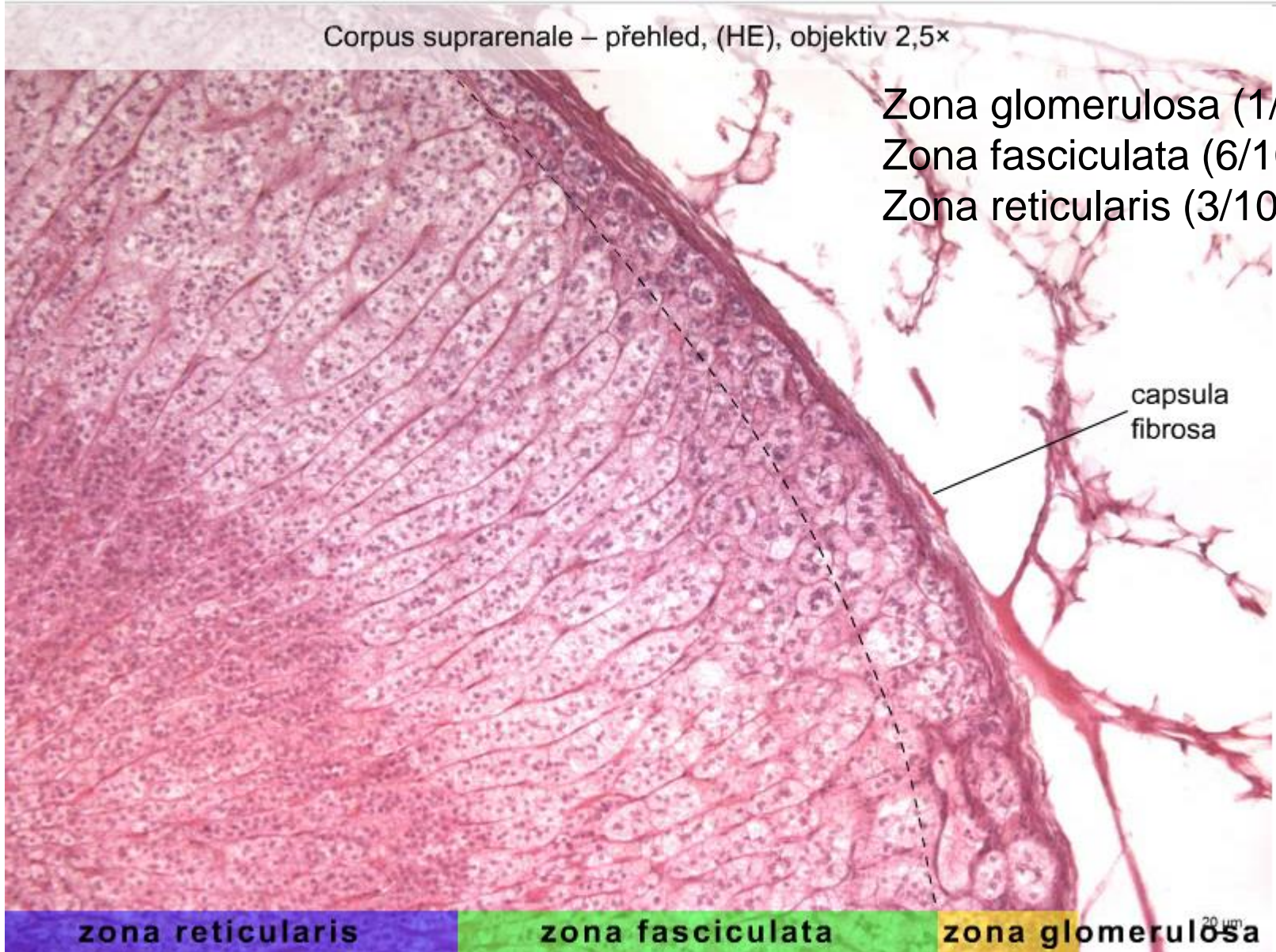
Vazivový obal + septa

Kapilární síť

Různý embryonální původ kůry (coelomový epitel) a dřeně (neuronální lišta - neuroektoderm)

# Kůra (Cortex)

Corpus suprenale – přehled, (HE), objektiv 2,5×



Zona glomerulosa (1/10)

Zona fasciculata (6/10)

Zona reticularis (3/10)

capsula  
fibrosa

zona reticularis

zona fasciculata

zona glomerulosa

20 μm



# Hormony kůry nadledviny

- Steroidy produkované v kortexu = KORTIKOSTEROIDY
- Steroidogenní buňky
  - SER, lipidové kapénky, mitochondrie
  - *mineralokortikoidy*
  - *glukokortikoidy*

Aldosteron – zona glomerulosa

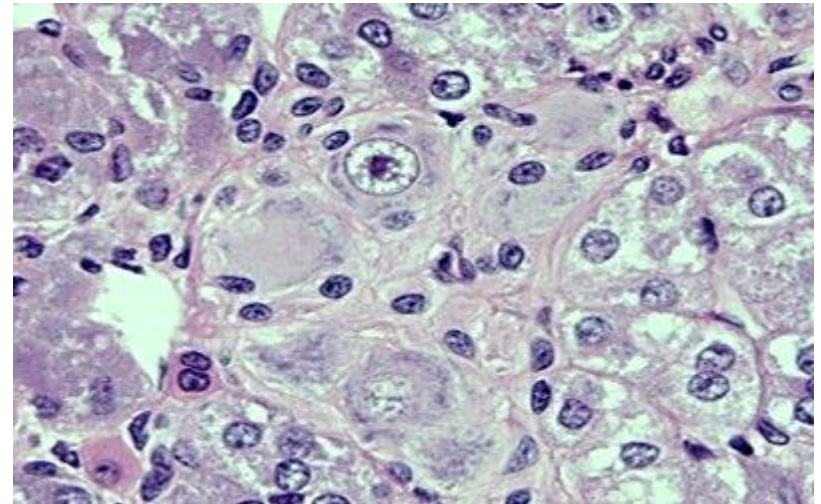
Kortisol – zona fasciculata

Androgeny, estrogeny, progesteron – zona reticularis

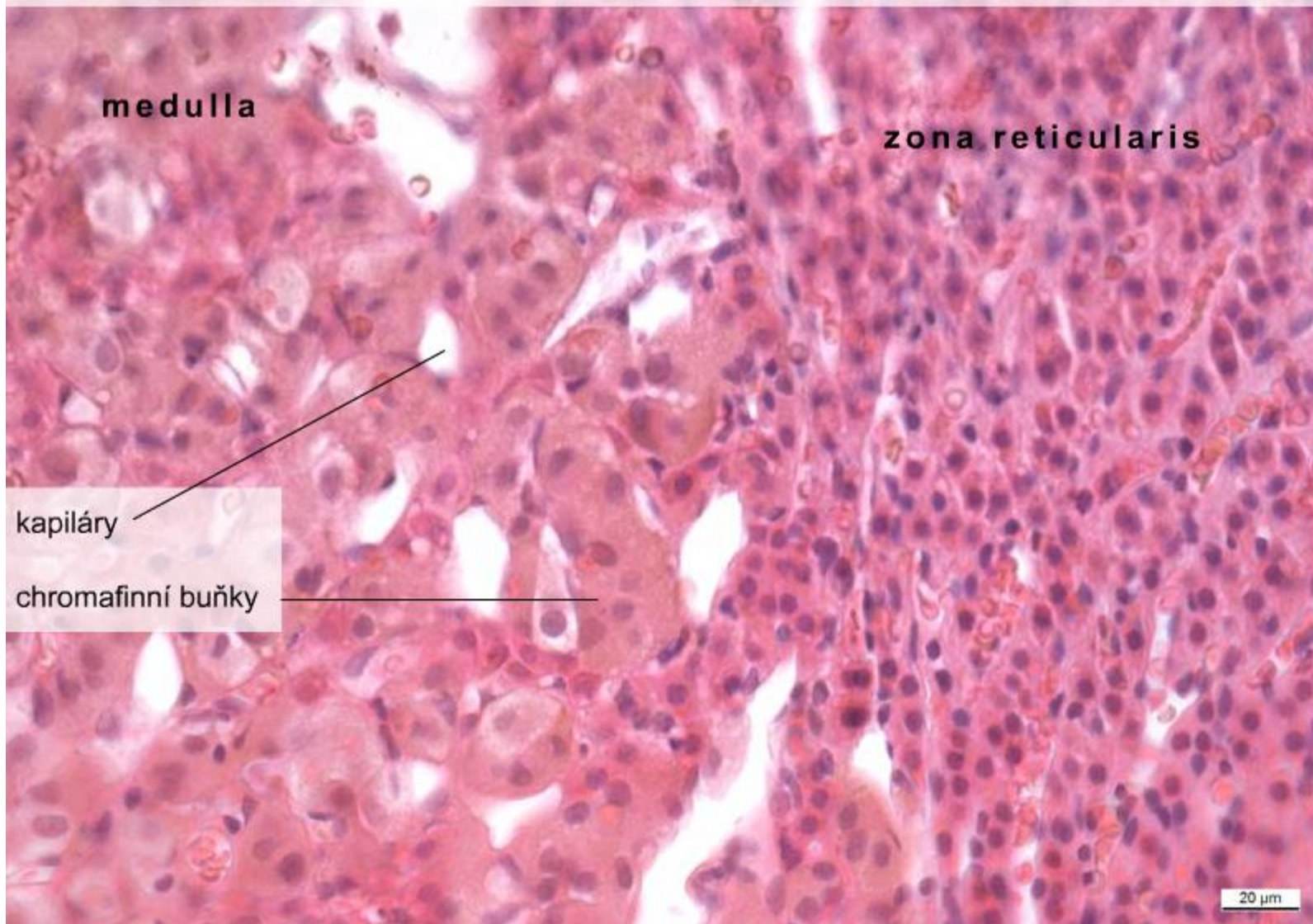
# Dřeň nadledviny

Shluky žlázových buněk v retikulárním vazivu

- chromafinní buňky – modifikované postgangliové neurony
  - gangliové buňky
  - kapiláry, venuly, nervová vlákna
- 
- adrenalin a noradrenalin



Corpus suprarenale – medulla, (HE), objektiv 40×



medulla

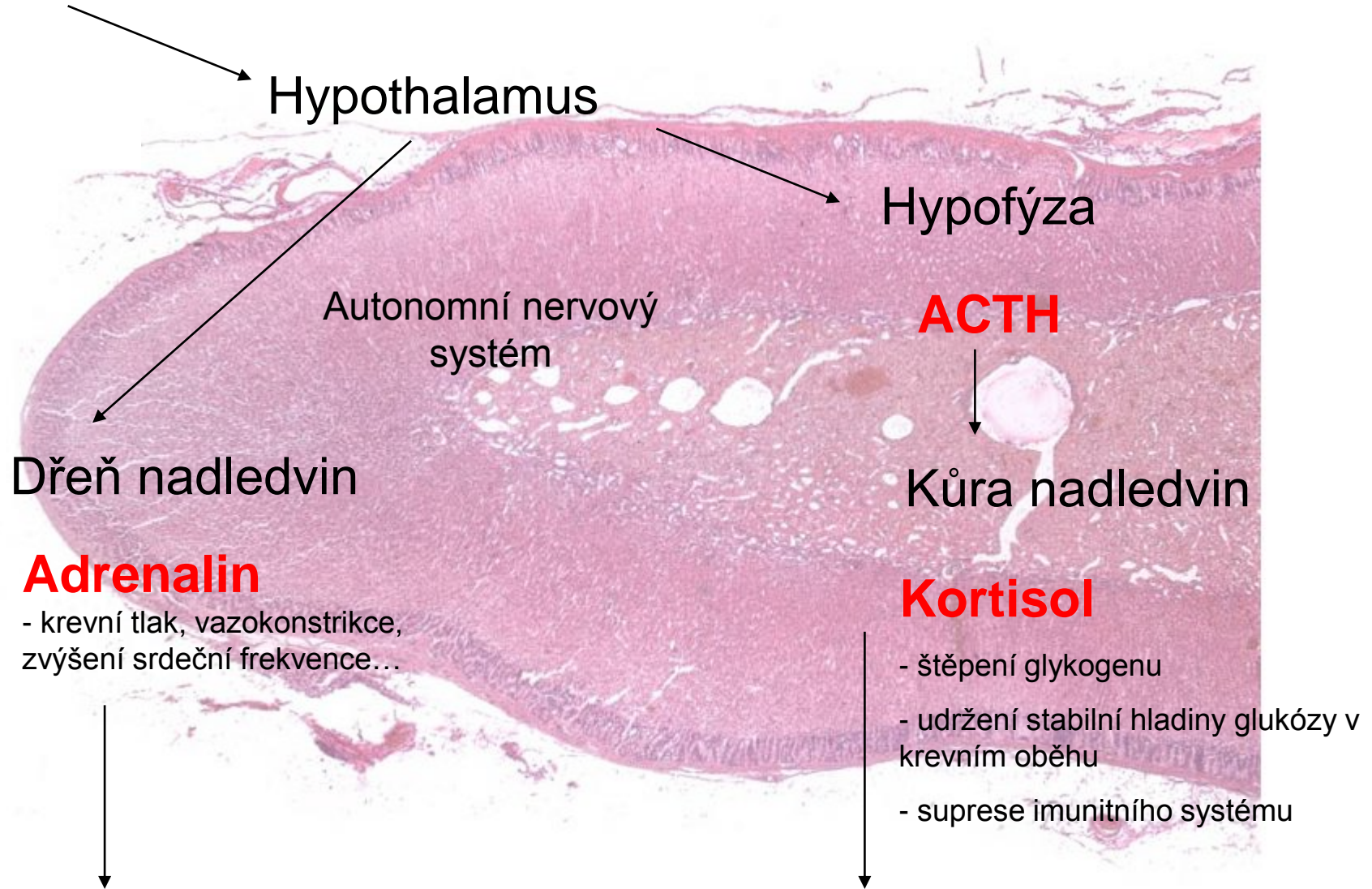
zona reticularis

kapiláry

chromafinní buňky

20 μm

**Stres**

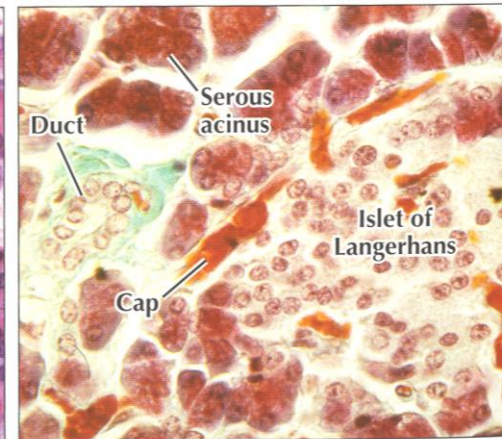
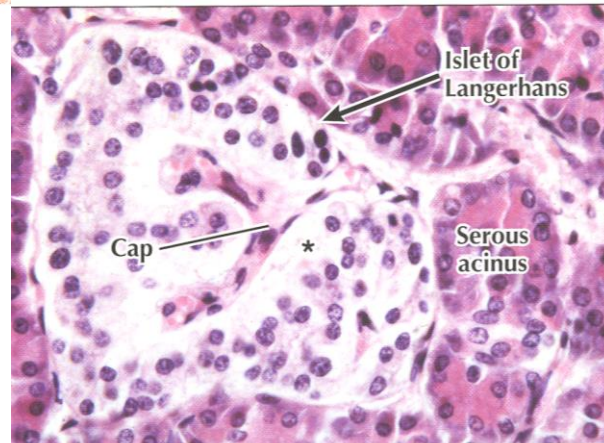
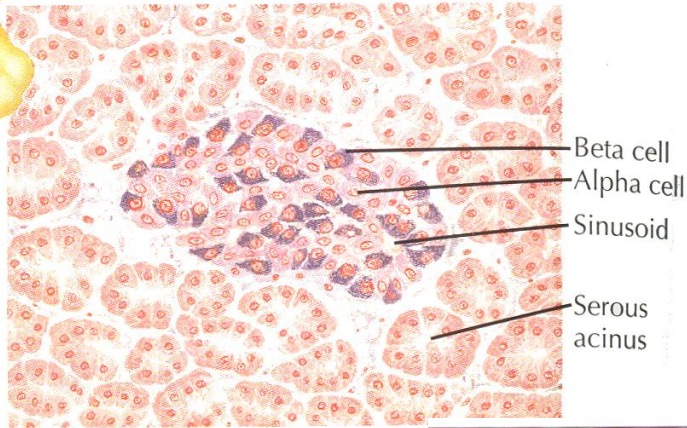
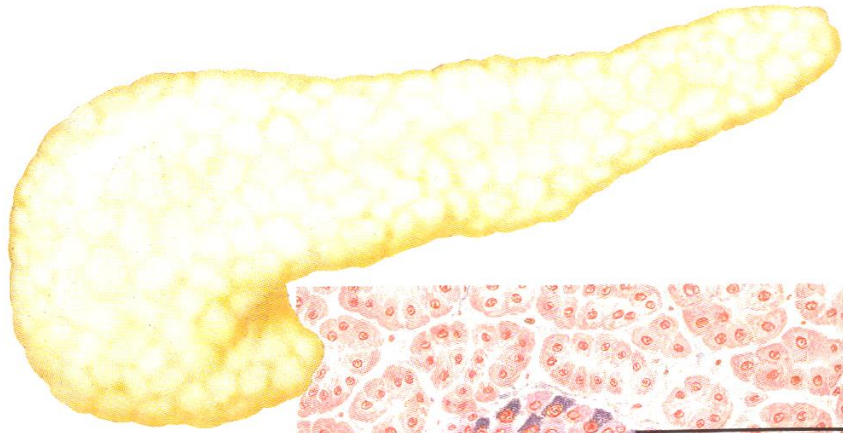


**Fight or Flight**

**Adaptace, regenerace**

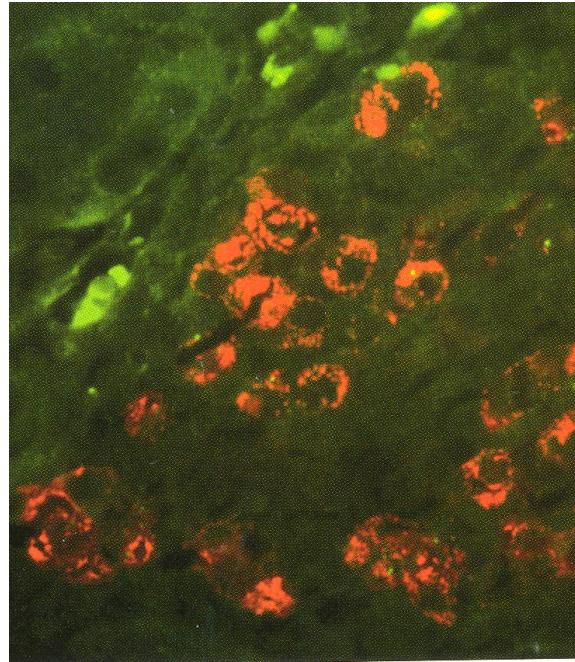
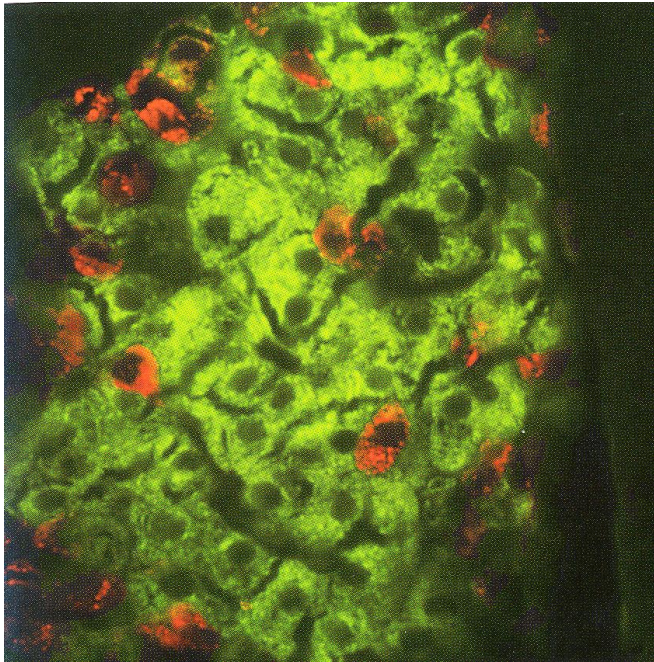
20  $\mu$ m

# Langerhansovy ostrůvky pankreatu



# Langerhansovy ostrůvky pankreatu

## A diabetes typu I



B-buňky produkující inzulin



Ab-anti insulin –Alexa Fluor

A-buňky produkující glukagon



Ab-anti glukagon –Texas Red

# Preparáty

- 52. Hypophysis cerebri
- 53. Epiphysis
- 54. Glandula thyreoidea
- 55. Glandula parathyroidea
- 56. Corpus suprarenale
- 23. Pankreas – Langerhansovy ostrůvky