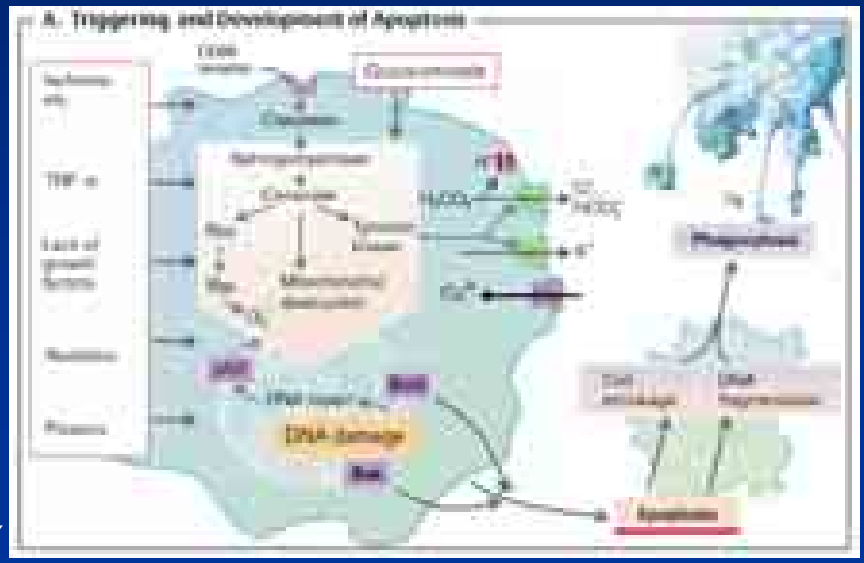
Látkové regulace
Hormonální řízení

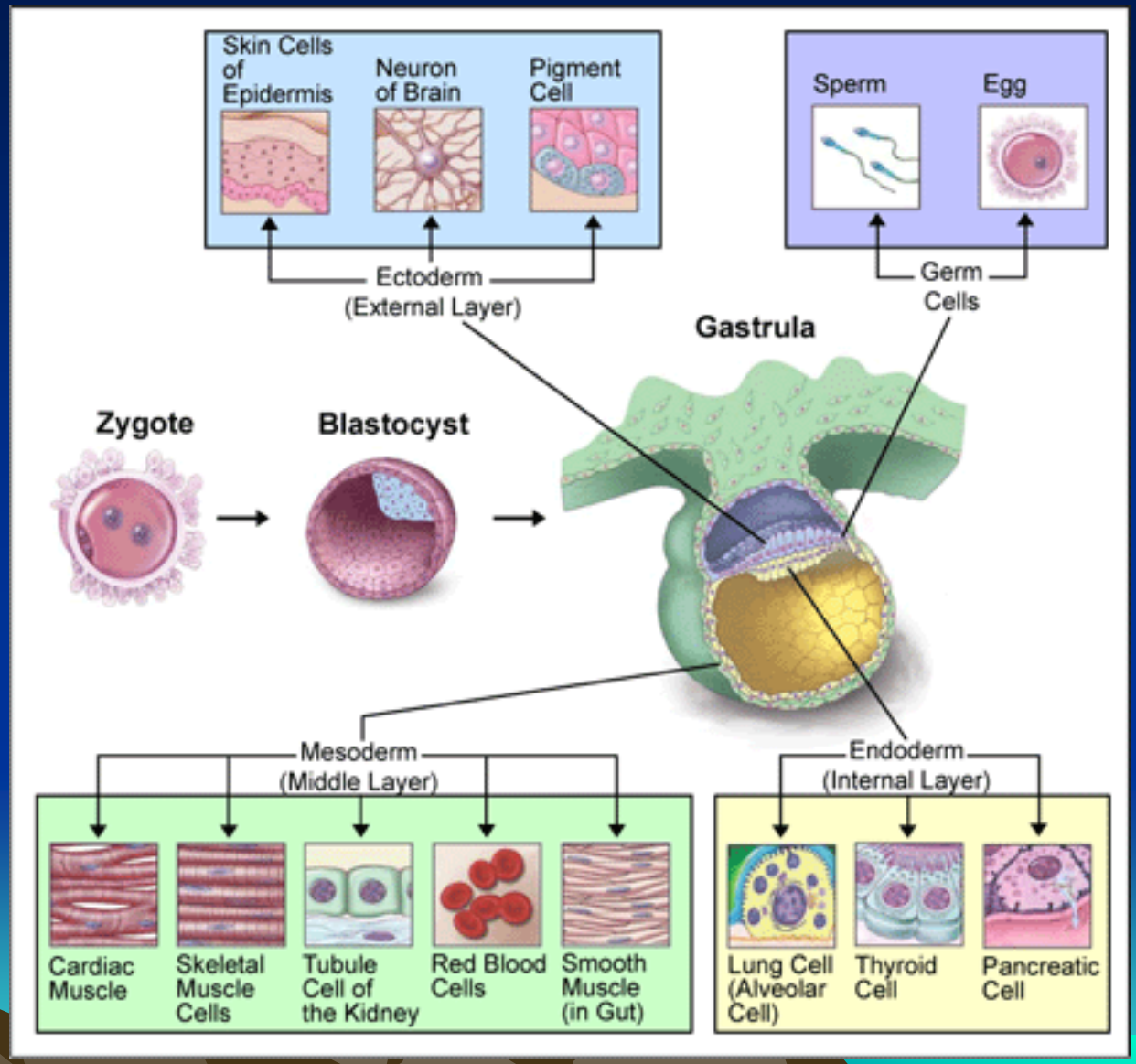
Mezibuněčná komunikace a signálová transdukce



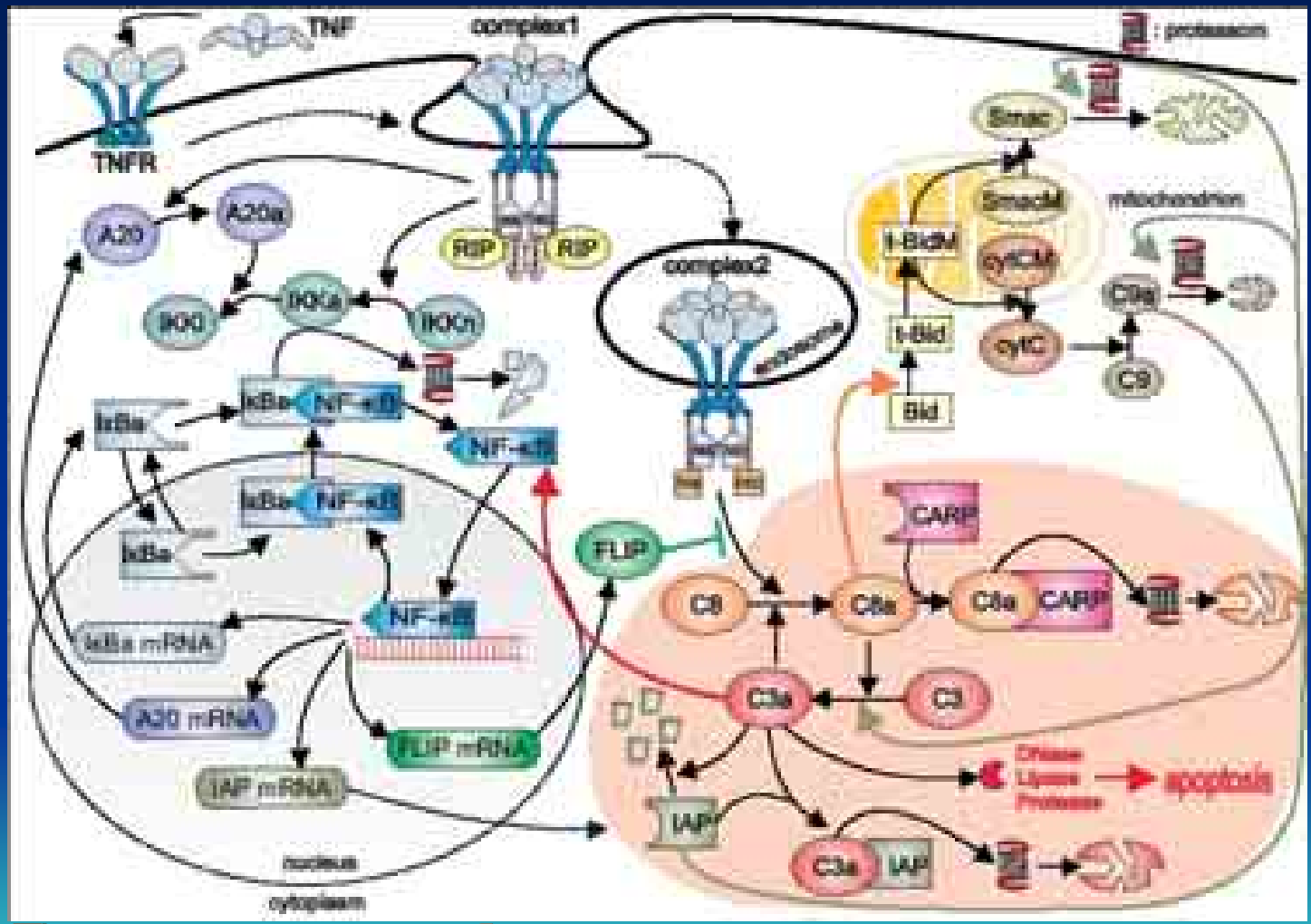
Obecná chemorecepční schopnost buněk
Komunikace ve společenství buněk, rozeznání poškozené nebo cizí buňky
Signály: diferencuj, proliferuj, syntetizuj, zemři…
Porozumění = klíč k podstatě

Chemotaxe

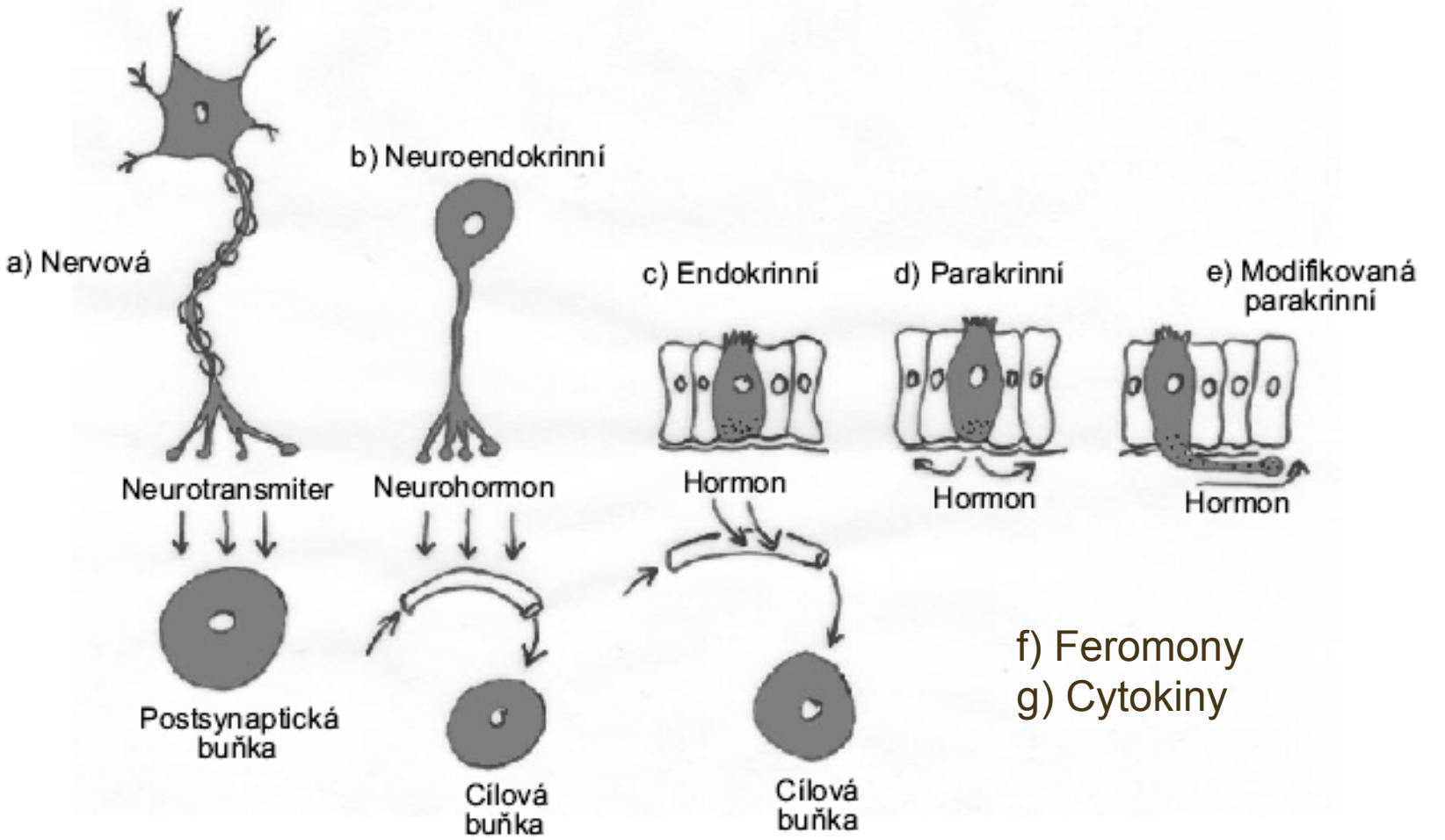
Embryonální diferenciace



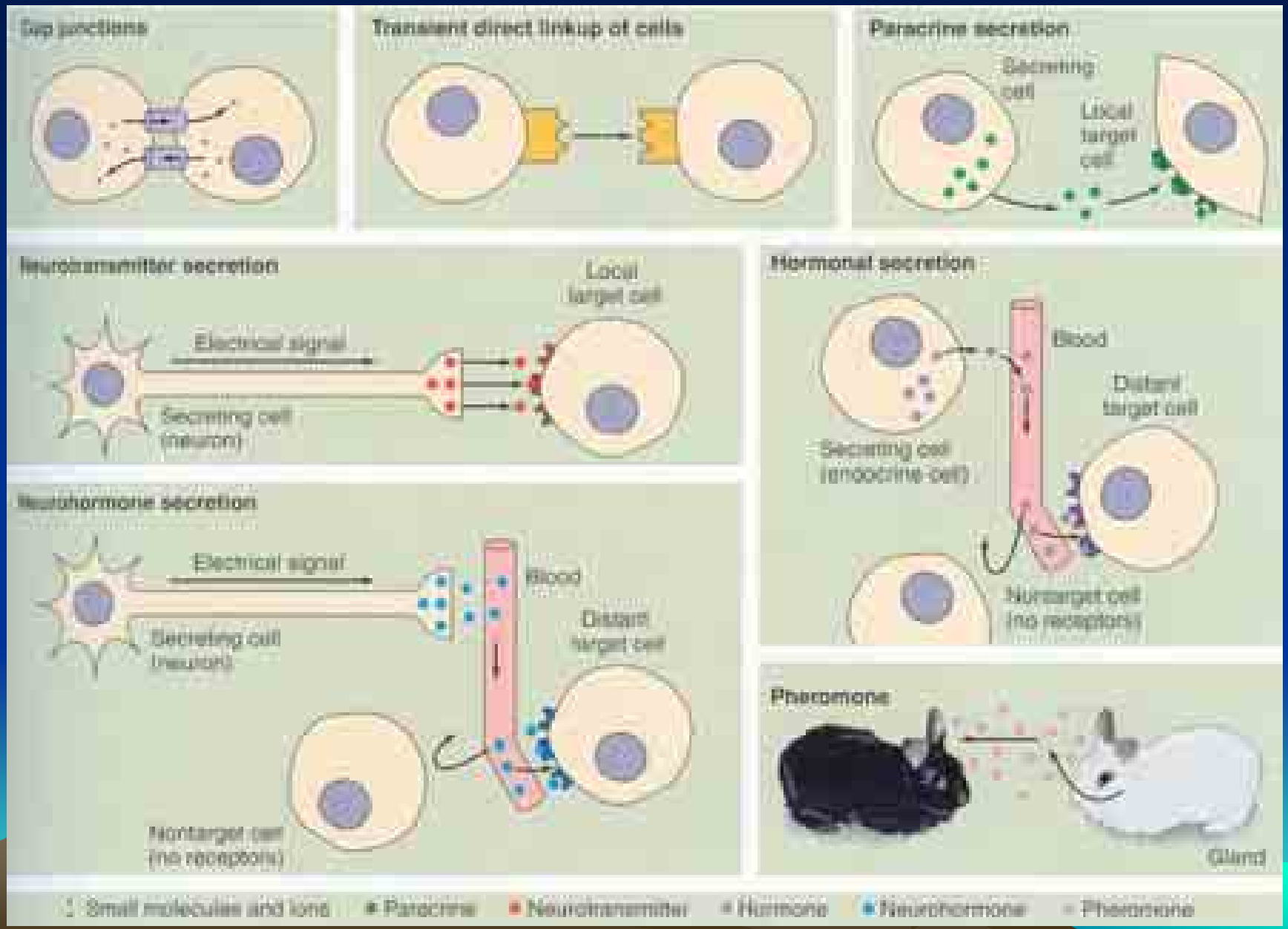
Signály: difernecuj!, zemři!, proliferuj!



Způsob předání signálu – mezi buňkami



Způsob předání signálu – mezi buňkami

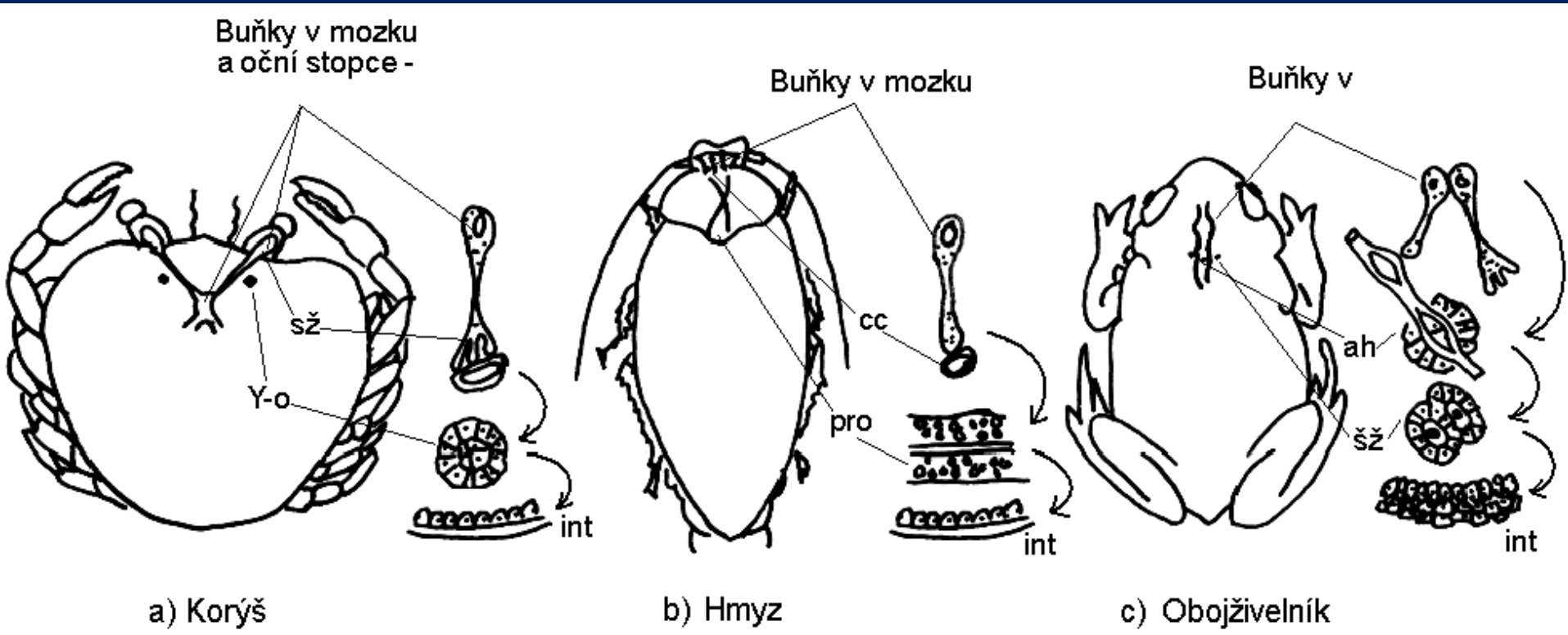


Chemická struktura

- Eikosanoidy – (prostaglandiny)
- Plyny – (NO, CO)
- Puriny – ATP, cAMP
- Aminy – od tyrozinu (adrenalin, par. histamin)
- Peptidy a proteiny – mnoho hormonů neurohormonů
- Steroidy – hormony a feromony
- Retinoidy – od vit A

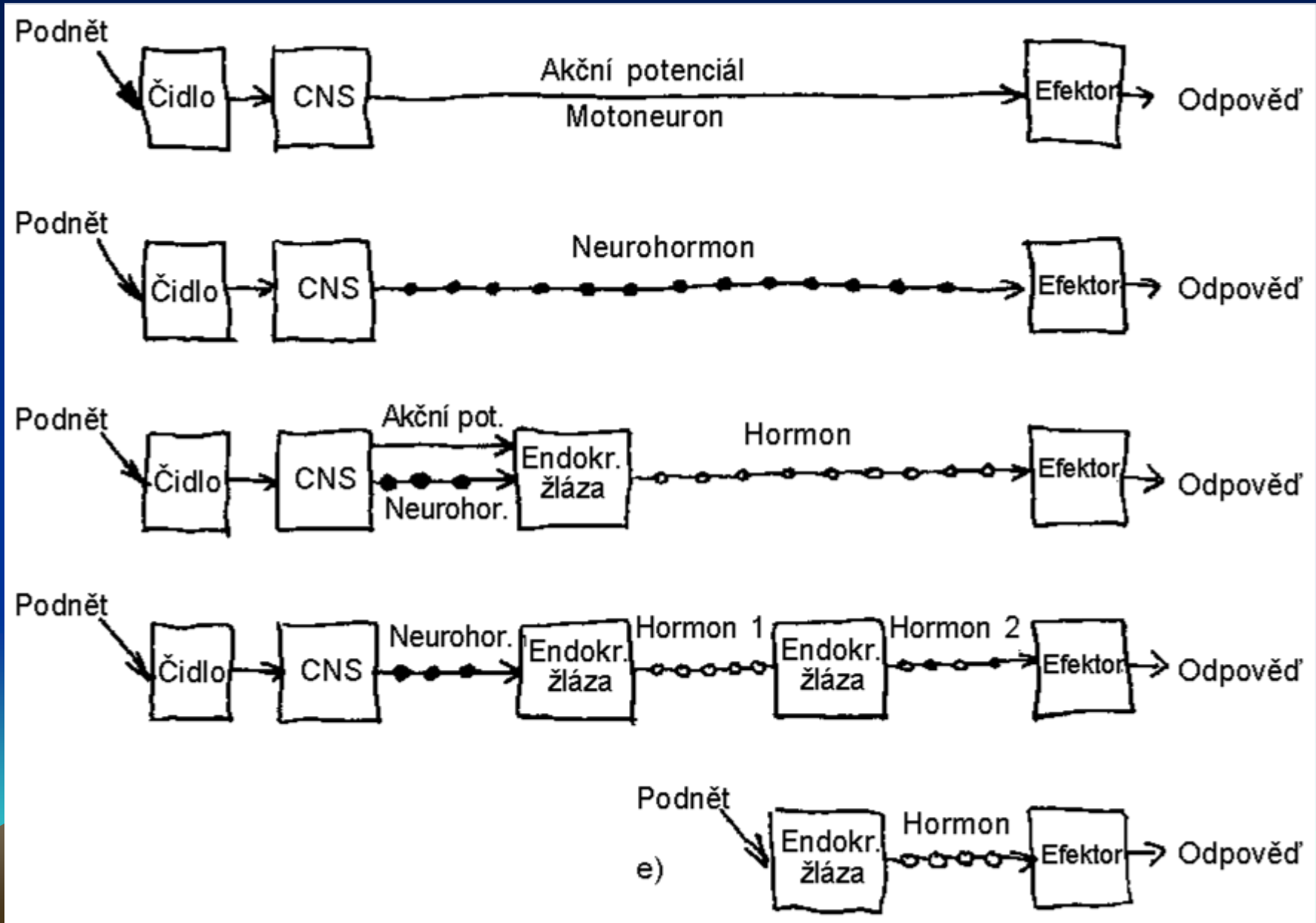
Způsob předání signálu – jeden klíč a různé dveře

Kaskáda od neurosekrece po cílový orgán
Extracelulární kaskáda

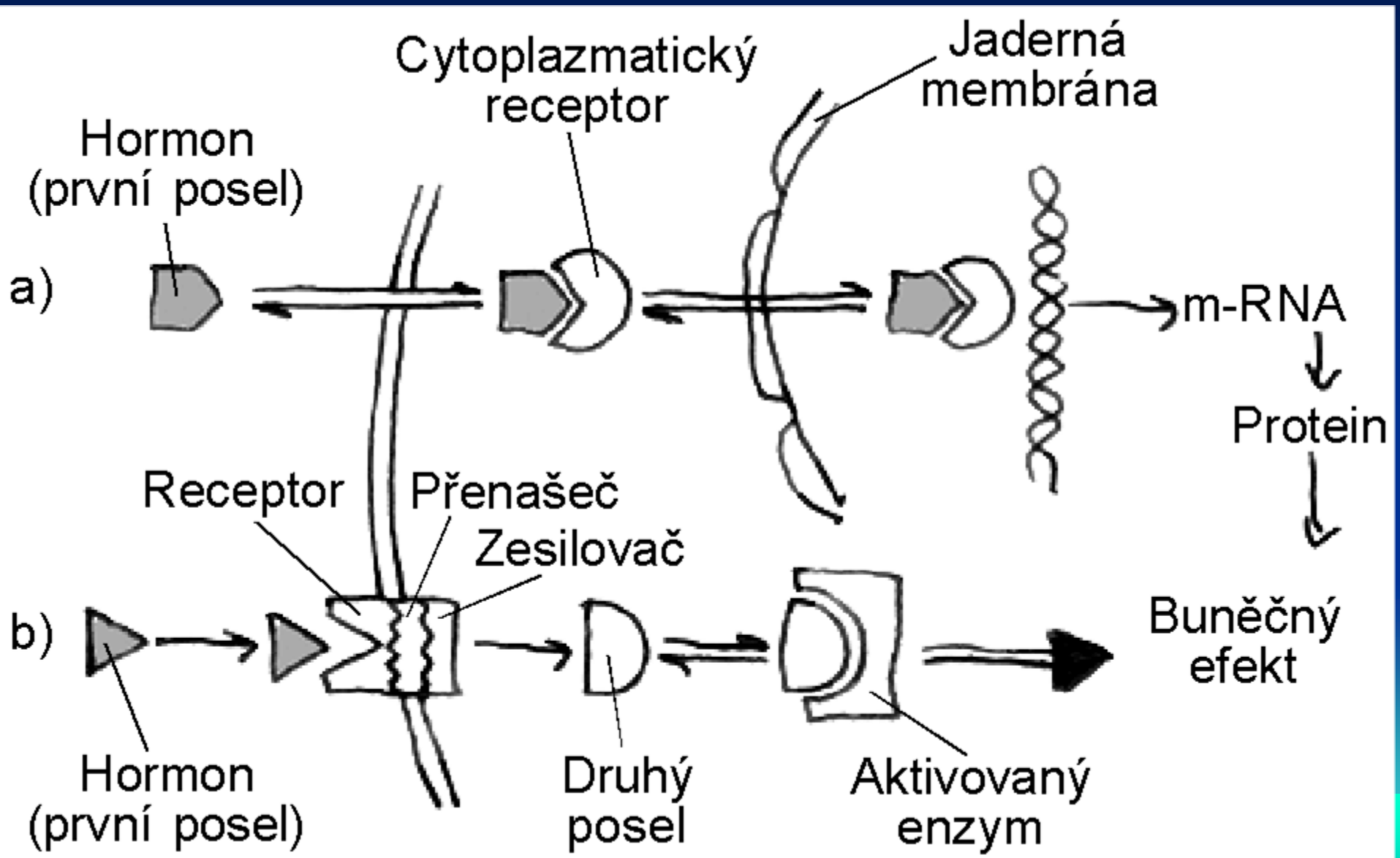


Kaskáda od neurosekrece po cílový orgán

Extracelulární kaskáda



Intracelulární kaskáda



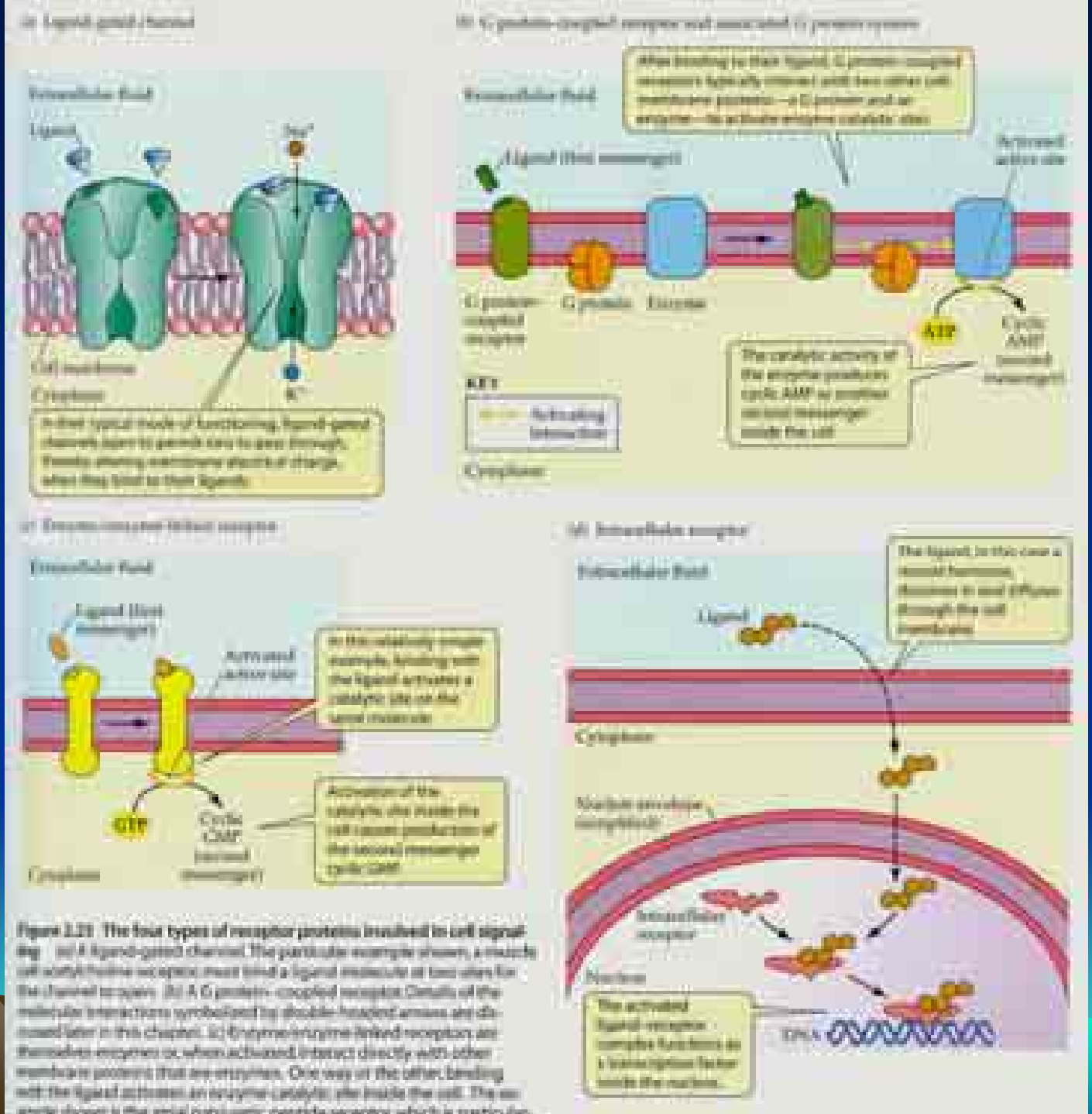
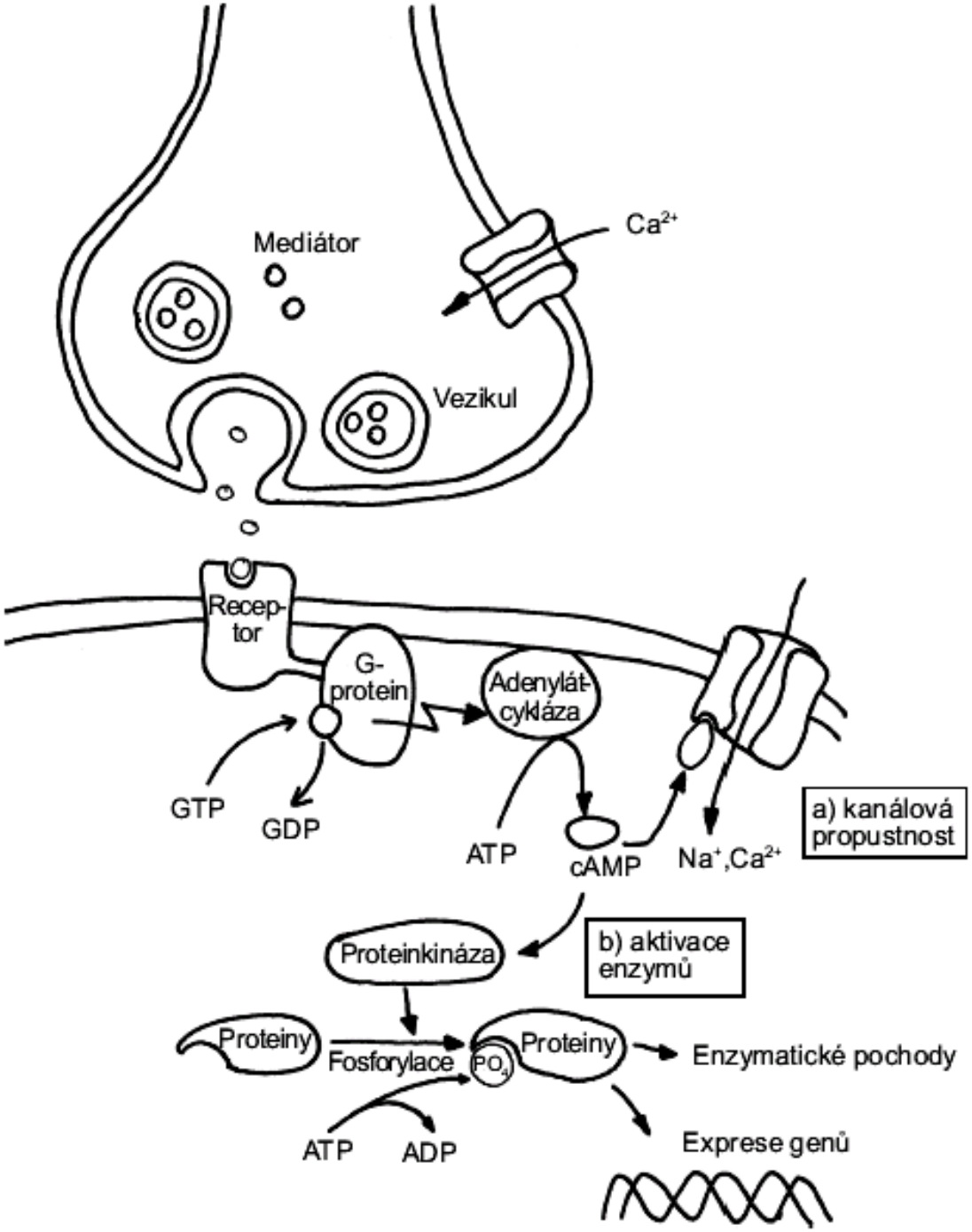
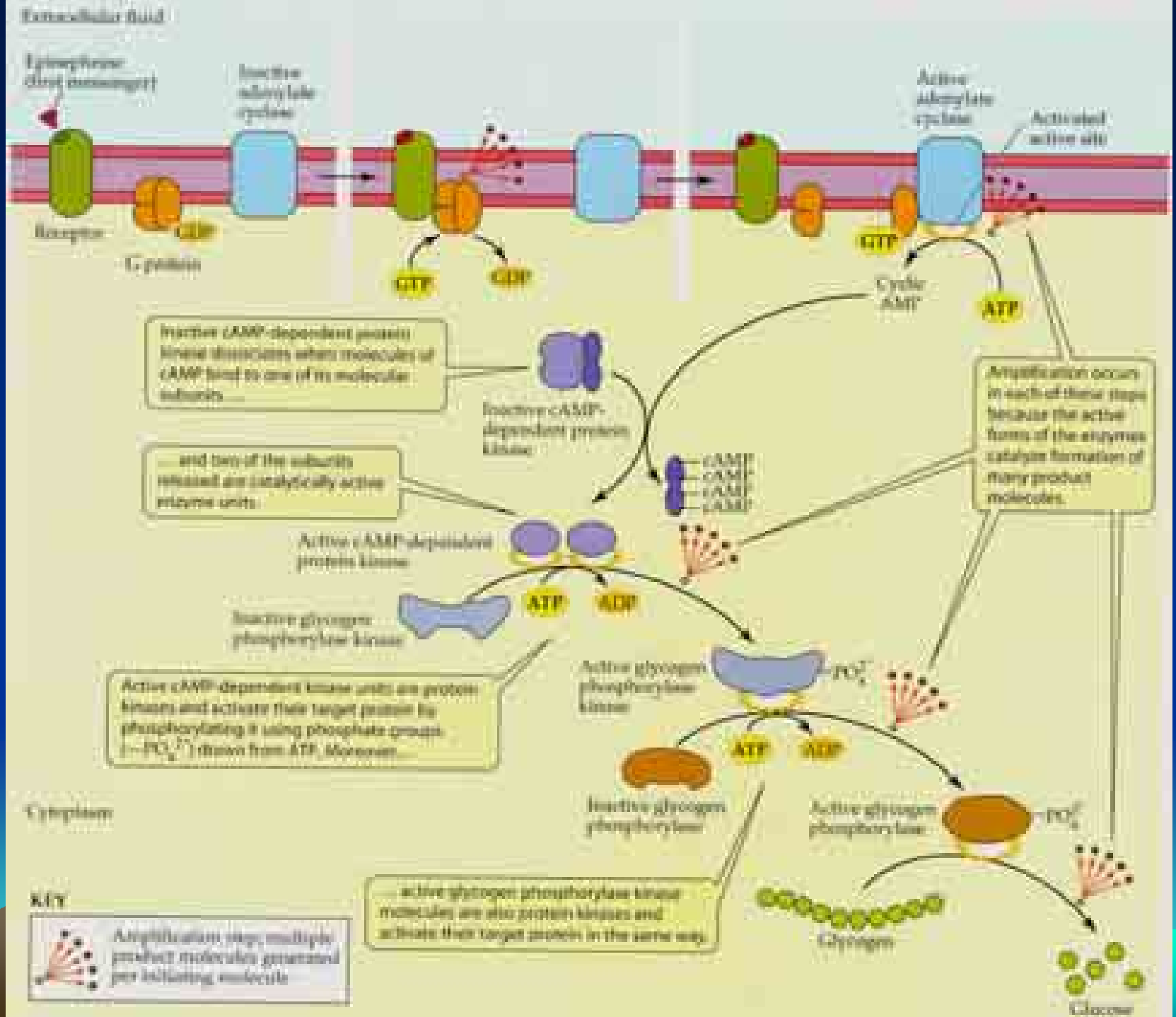
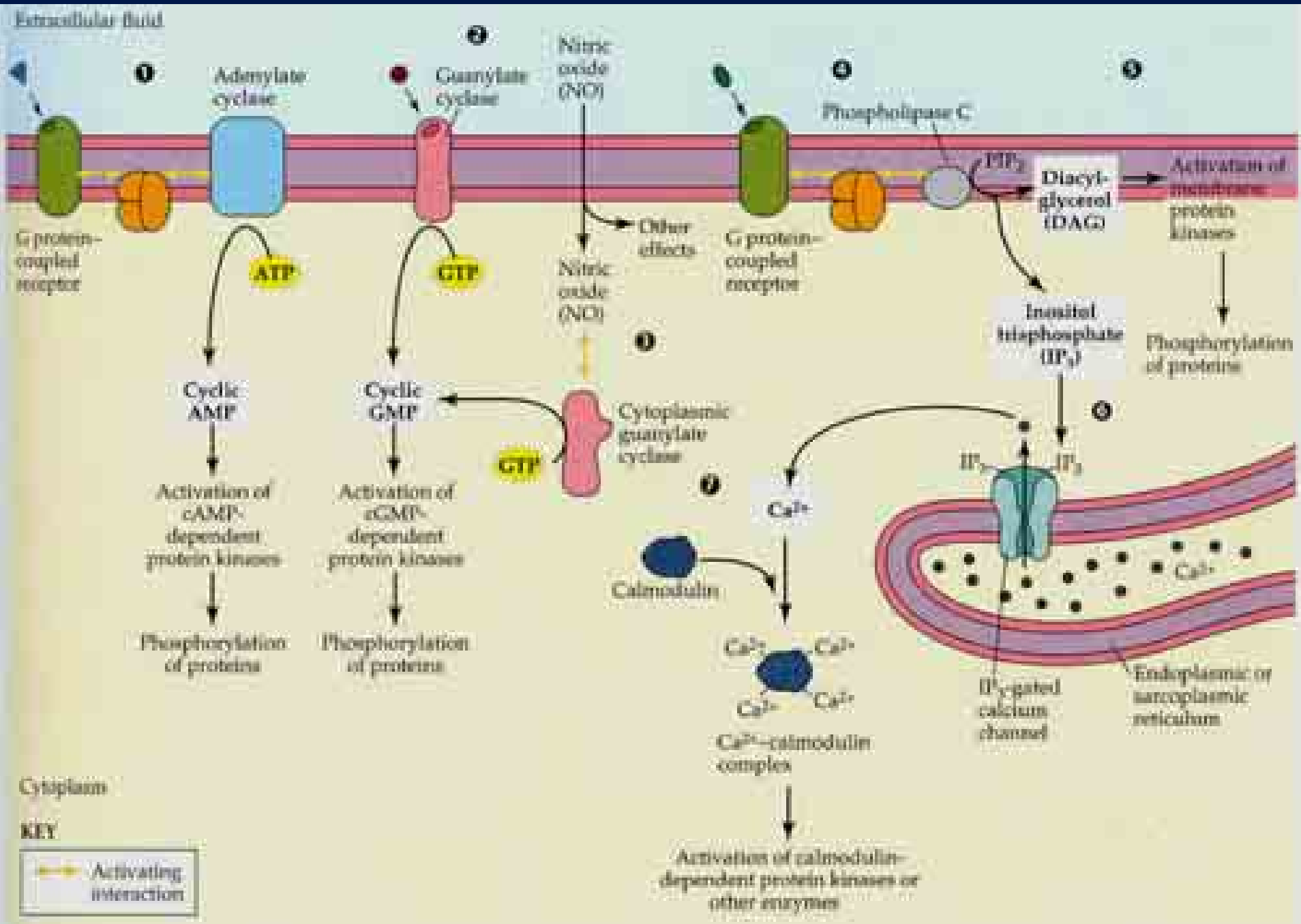


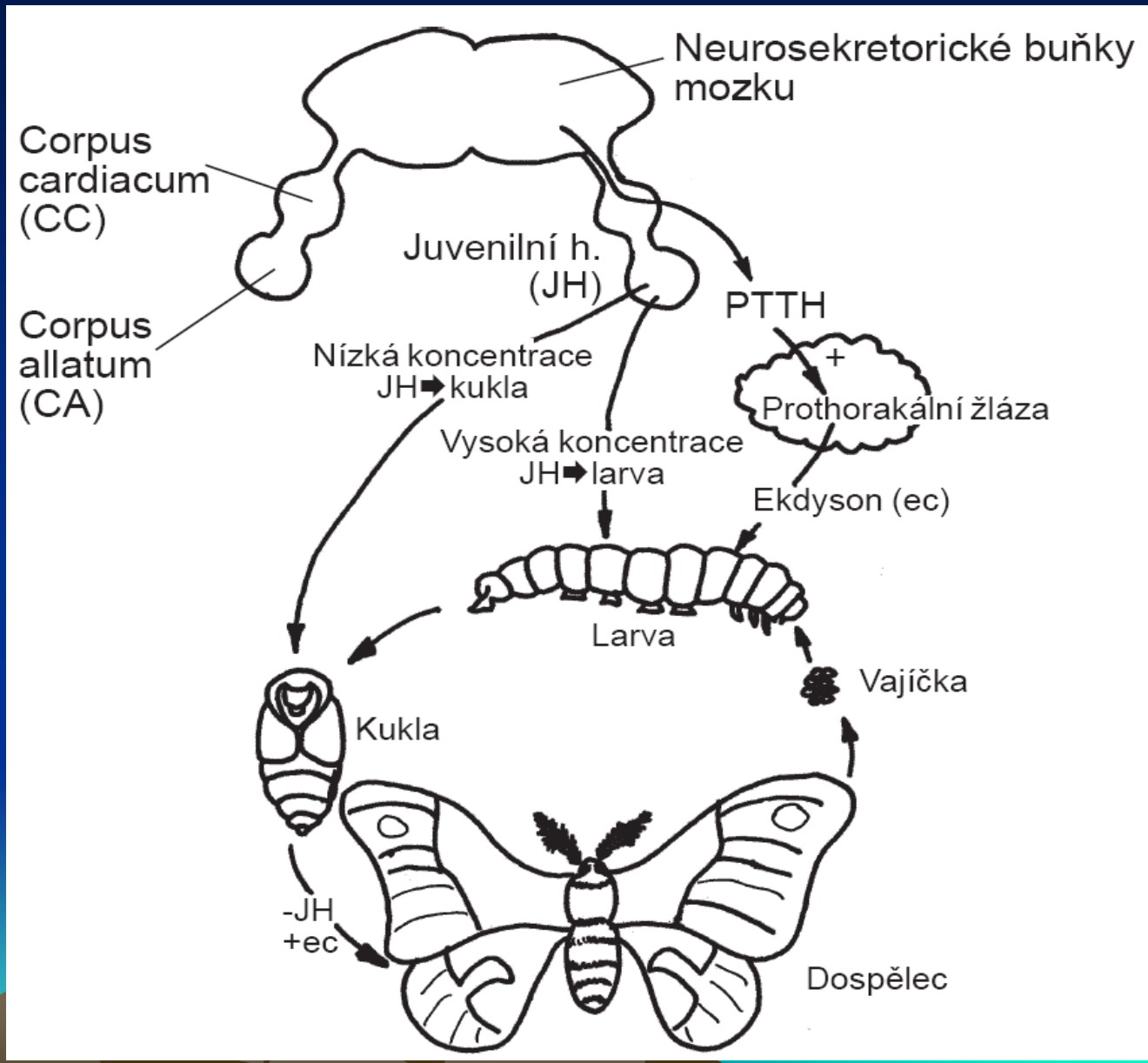
Figure 3.23 The four types of receptor proteins involved in cell signalling (a) A ligand-gated channel. The particular example shown, a muscle cell acetylcholine receptor, must bind a ligand molecule at two sites for the channel to open. (b) A G protein–coupled receptor. Details of the molecular interactions symbolized by double-headed arrows are discussed later in this chapter. (c) Enzyme-enzyme-linked receptors are themselves enzymes or, when activated, interact directly with other membrane proteins that are enzymes. One way or the other, binding with the ligand activates an enzyme catalytic site inside the cell. The example shown is the atrial natriuretic peptide receptor, which is partly (d)


Mediátor
Ca^{2+}
Vezikul
Recep-
tor
G-
protein
Adenylát-
cykláza
GTP
GDP
ATP
cAMP
Na^+,Ca^{2+}
a) kanálová
propustnost
Proteinkináza
b) aktivace
enzymů
Proteiny
Fosforylace
PO_4
Proteiny
Enzymatické pochody
ATP
ADP
Exprese genů


Extracellular fluid
Epinephrine (first messenger)
Inactive adenylate cyclase
Active adenylate cyclase
Activated active site
Receptor
G protein
GDP
GTP
GDP
GTP
Cyclic AMP
ATP
Inactive cAMP-dependent protein kinase molecules dissociates when molecules of cAMP bind to one of its molecular subunits.
Inactive cAMP-dependent protein kinase
cAMP
cAMP
cAMP
cAMP
... and two of the subunits released are catalytically active enzyme units.
Amplification occurs in each of these steps because the active forms of the enzymes catalyze formation of many product molecules.
Active cAMP-dependent protein kinase
ATP
ADP
Inactive glycogen phosphorylase kinase
Active cAMP-dependent kinase units are protein kinases and activate their target protein by phosphorylating it using phosphate groups ($-PO_4^{2-}$) drawn from ATP. Moreover...
Active glycogen phosphorylase kinase
PO_4^{2-}
ATP
ADP
Inactive glycogen phosphorylase
Active glycogen phosphorylase
PO_4^{2-}
Cytoplasm
... active glycogen phosphorylase kinase molecules are also protein kinases and activate their target protein in the same way.
Glycogen
Glucose
KEY
Amplification step; multiple product molecules generated per initiating molecule


Extracellular fluid
Adenylate cyclase
Guanylate cyclase
Nitric oxide (NO)
Phospholipase C
G protein-coupled receptor
ATP
GTP
Other effects
Nitric oxide (NO)
Diacylglycerol (DAG)
Activation of membrane protein kinases
Phosphorylation of proteins
Inositol trisphosphate (IP_3)
Cyclic AMP
Cyclic GMP
Cytoplasmic guanylate cyclase
GTP
Activation of cAMP-dependent protein kinases
Activation of cGMP-dependent protein kinases
Phosphorylation of proteins
Phosphorylation of proteins
Ca^{2+}
Calmodulin
Ca^{2+}
Ca^{2+}
Ca^{2+}
Ca^{2+}
Ca^{2+}–calmodulin complex
IP_3
IP_3
IP_3-gated calcium channel
Ca^{2+}
Endoplasmic or sarcoplasmic reticulum
Activation of calmodulin-dependent protein kinases or other enzymes
Cytoplasm
KEY
Activating interaction

Působení hormonů a hmyz



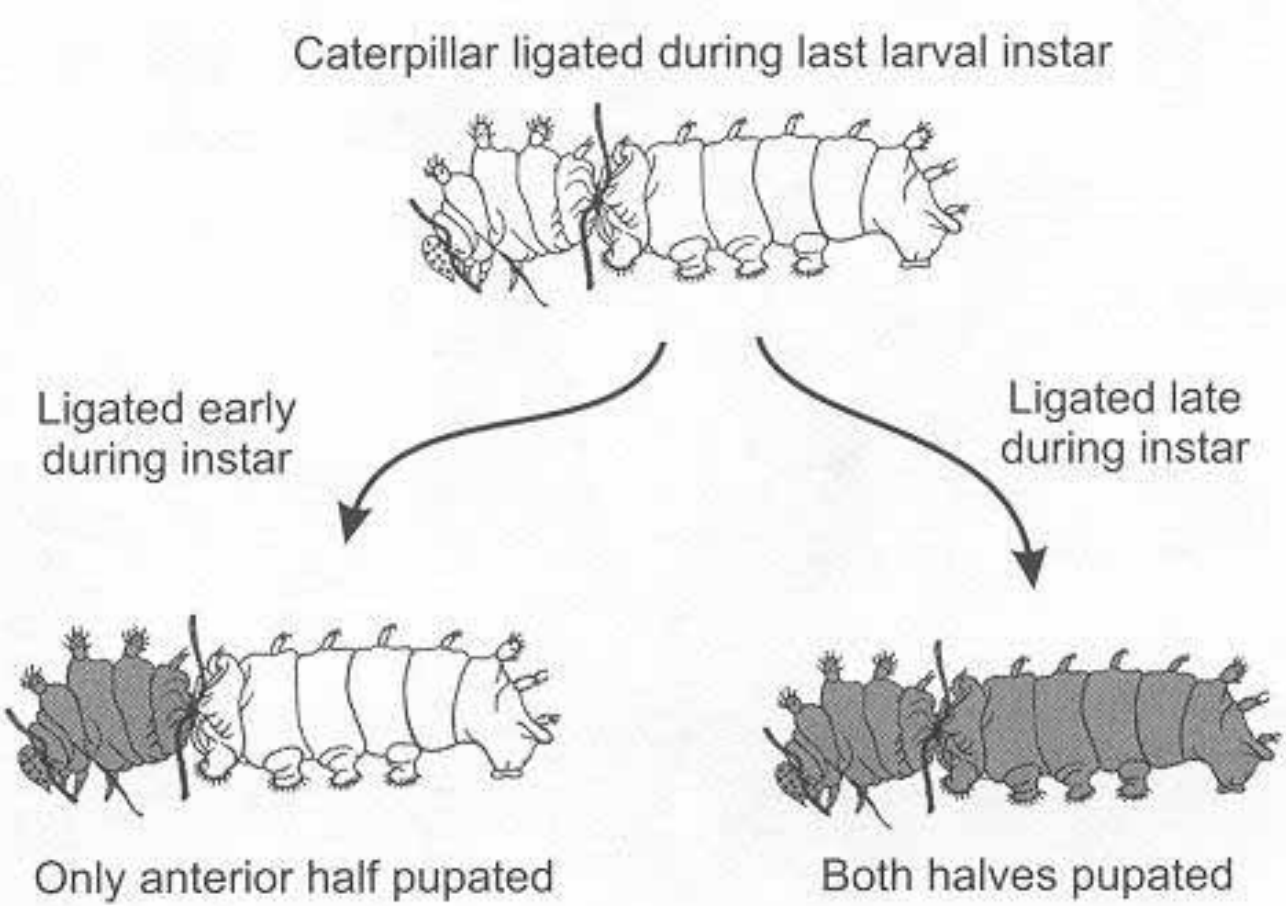
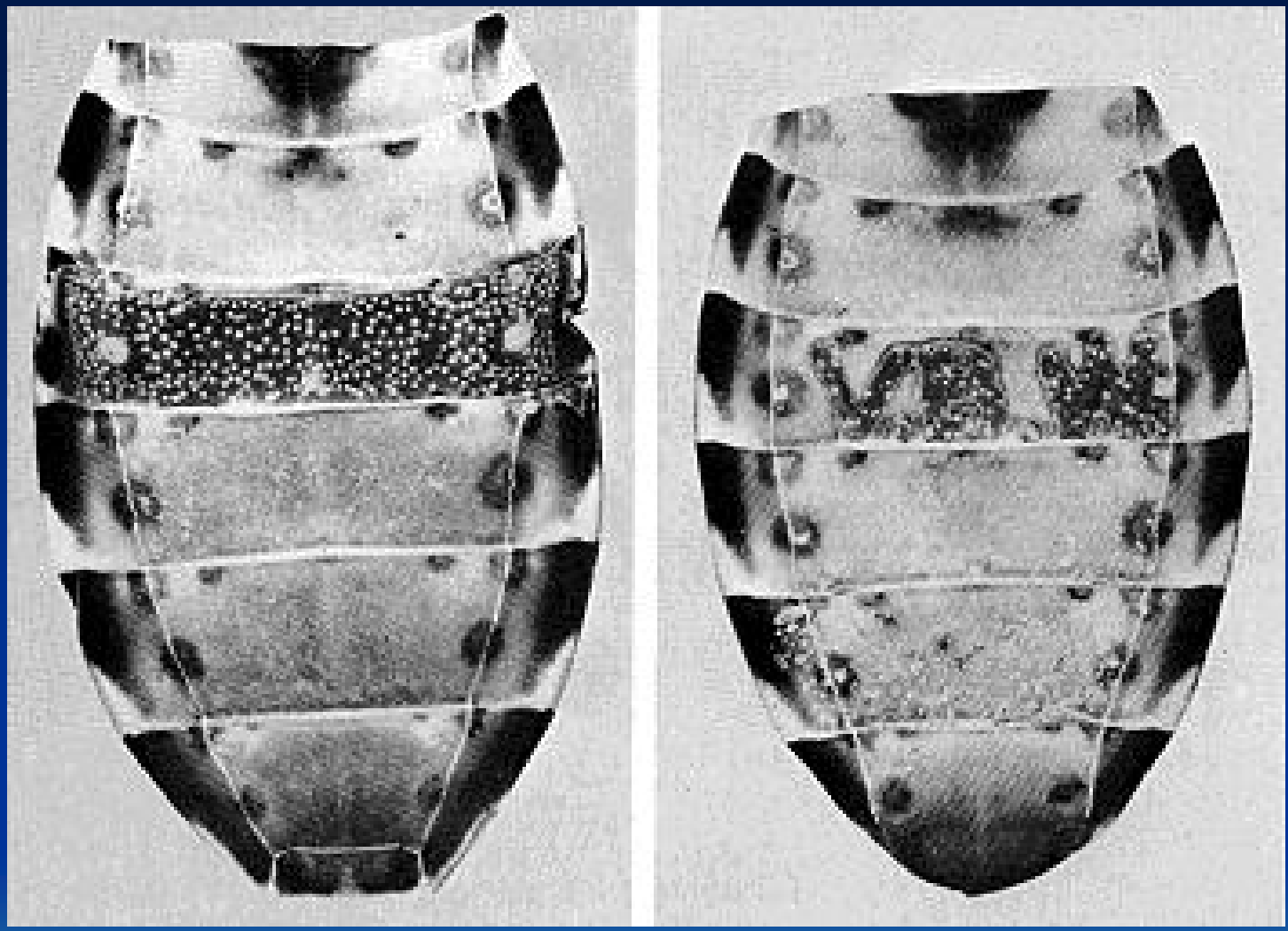
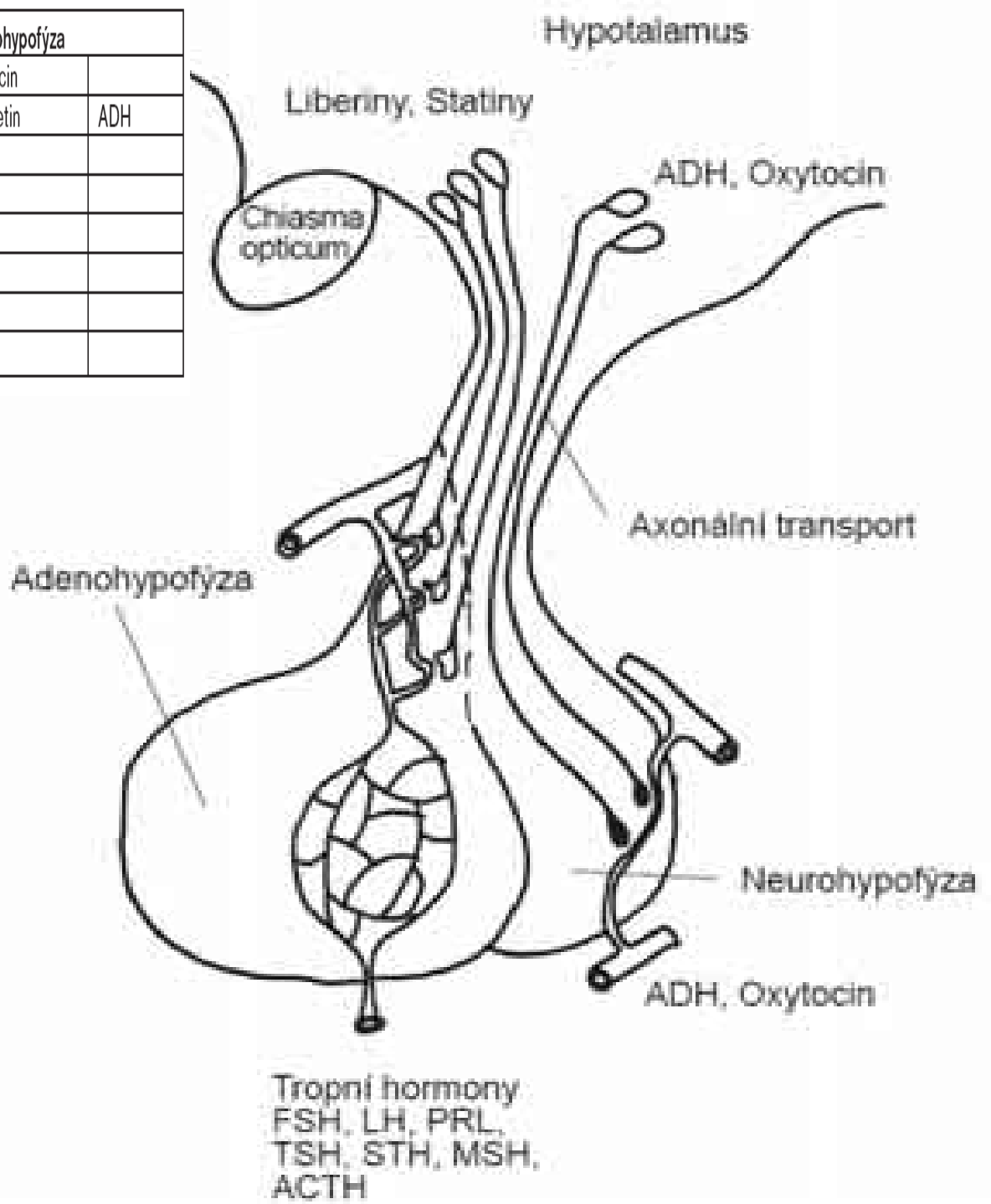


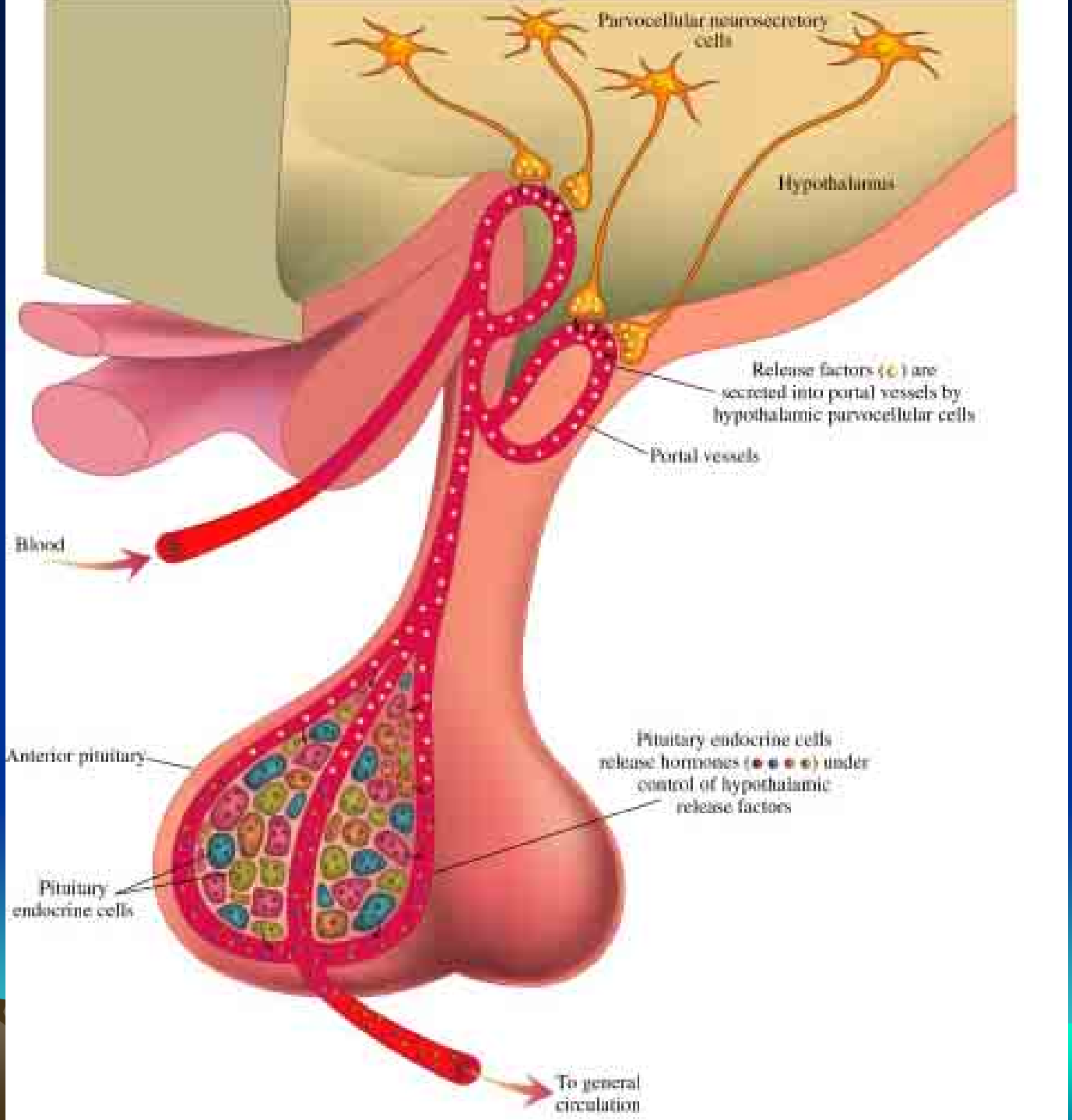
FIGURE 1.2 An experiment performed by Kopeć. When a caterpillar was ligated early during the last larval instar, only the anterior half later pupated. However, when ligated late during the last larval instar, both halves pupated. Adapted from Cymborowski (1992). Reprinted with permission.

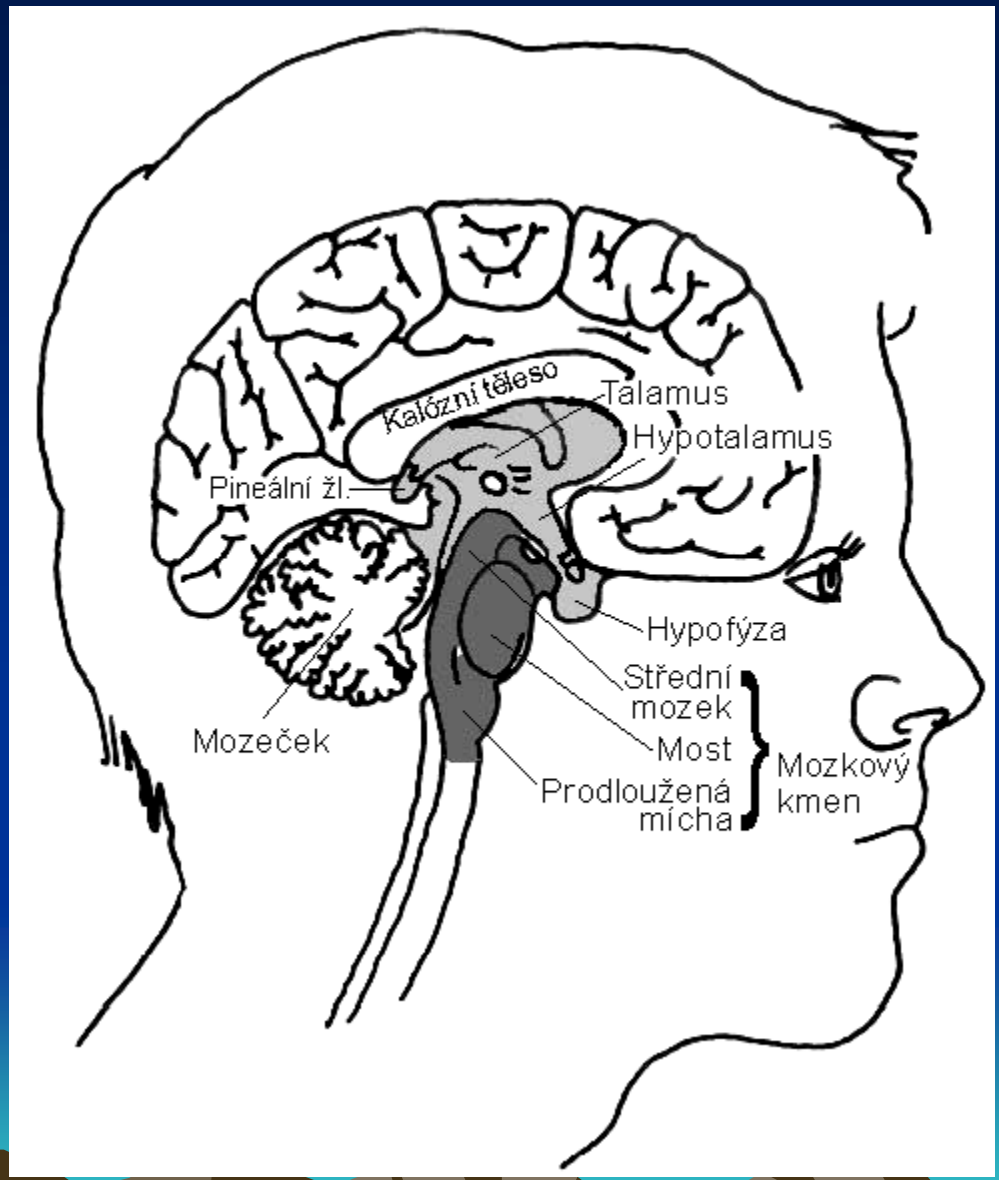


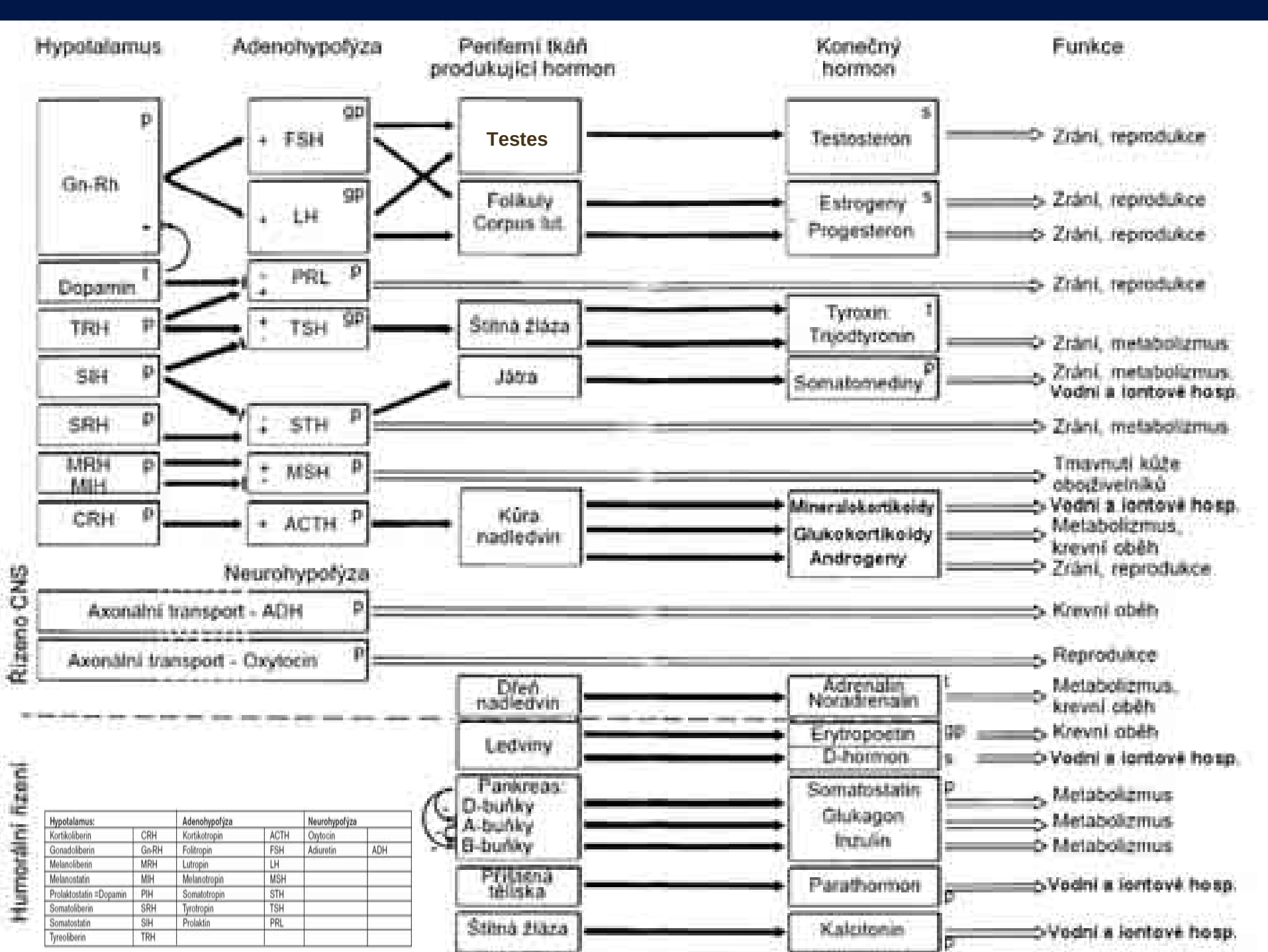
sir Vincent B. Wigglesworth

Hypotalamus:		Adenohypofýza		Neurohypofýza	
Kortikoliberin	CRH	Kortikotropin	ACTH	Oxytocin	
Gonadoliberin	Gn-RH	Folitropin	FSH	Adiuretin	ADH
Melanoliberin	MRH	Lutropin	LH		
Melanostatin	MIH	Melanotropin	MSH		
Prolaktostatin =Dopamin	PIH	Somatotropin	STH		
Somatoliberin	SRH	Tyrotropin	TSH		
Somatostatin	SIH	Prolaktin	PRL		
Tyreoliberin	TRH				

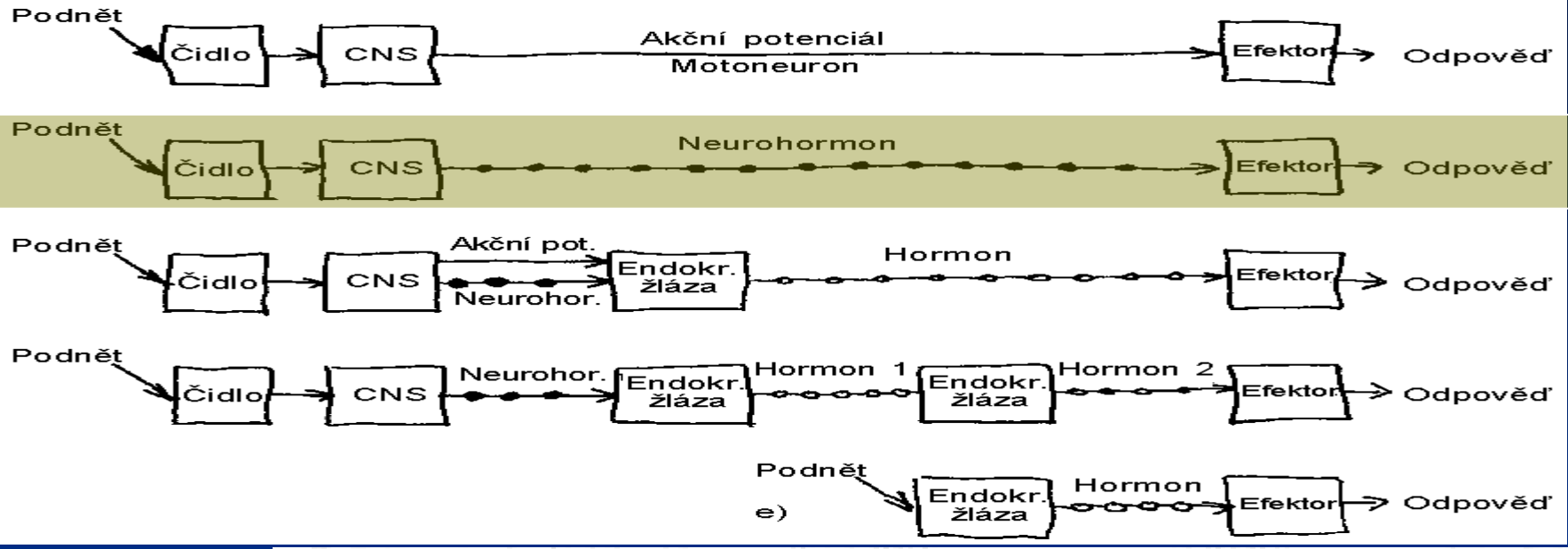


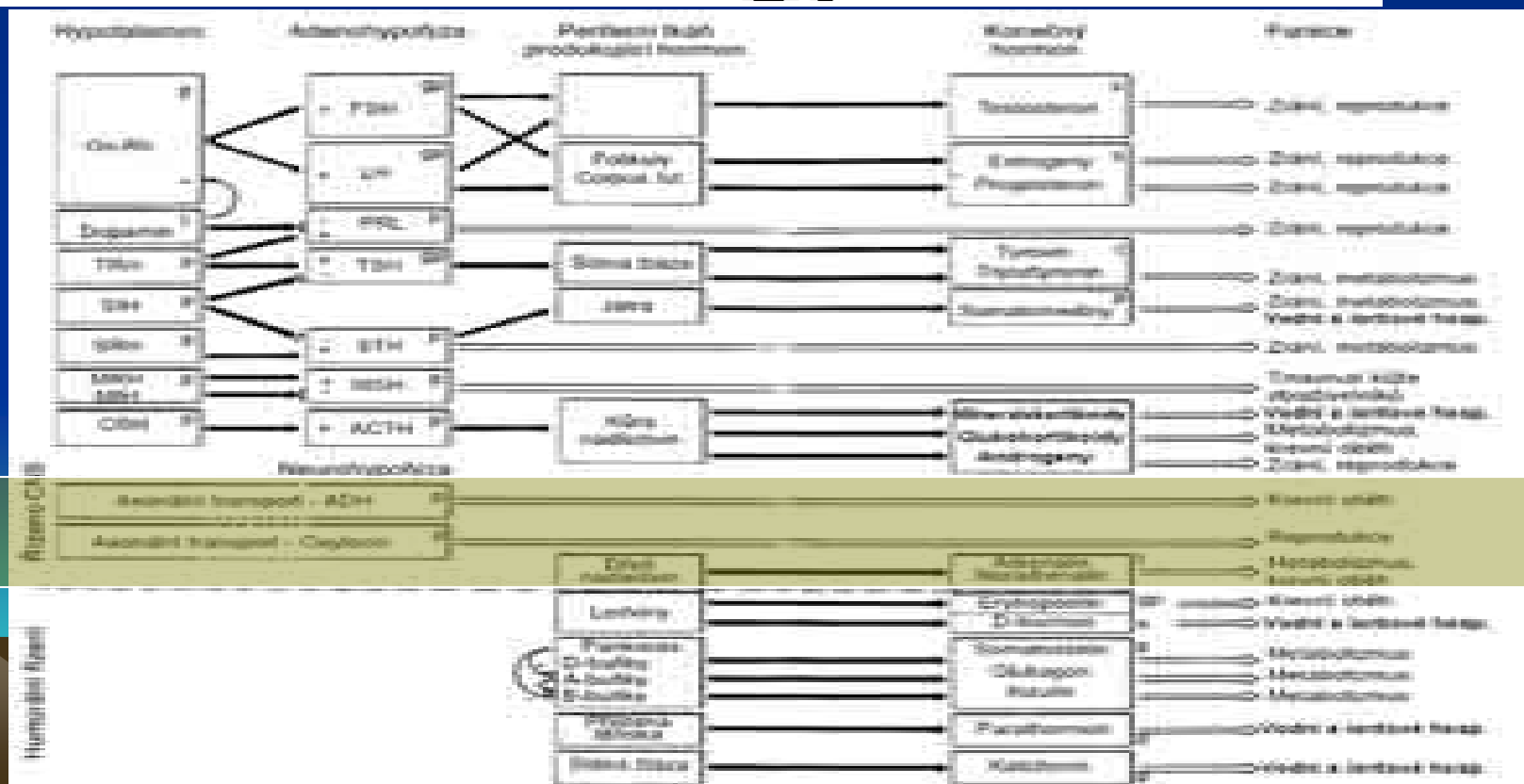

Parvocellular neurosecretory cells
Hypothalamus
Release factors (●) are secreted into portal vessels by hypothalamic parvocellular cells
Portal vessels
Blood
Anterior pituitary
Pituitary endocrine cells release hormones (● ● ● ●) under control of hypothalamic release factors
Pituitary endocrine cells
To general circulation

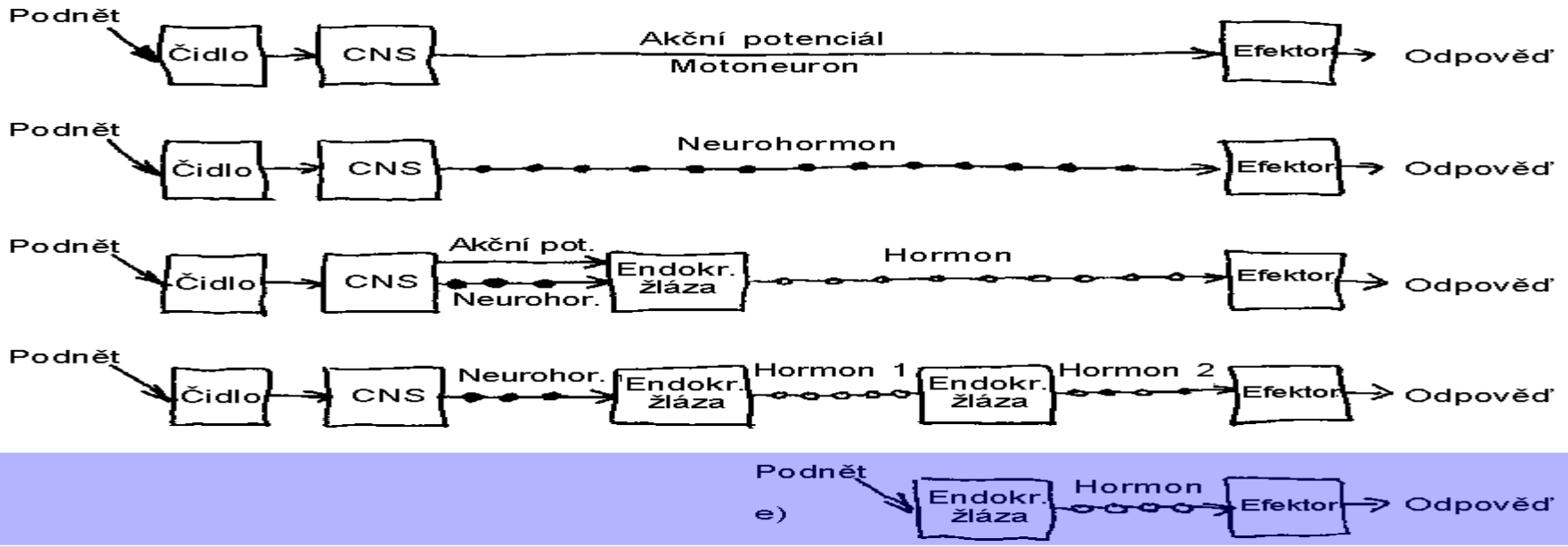

Kalózní těleso
Talamus
Hypotalamus
Pineální žl.
Hypofýza
Střední mozek
Most
Prodloužená mícha
Mozkový kmen
Mozeček

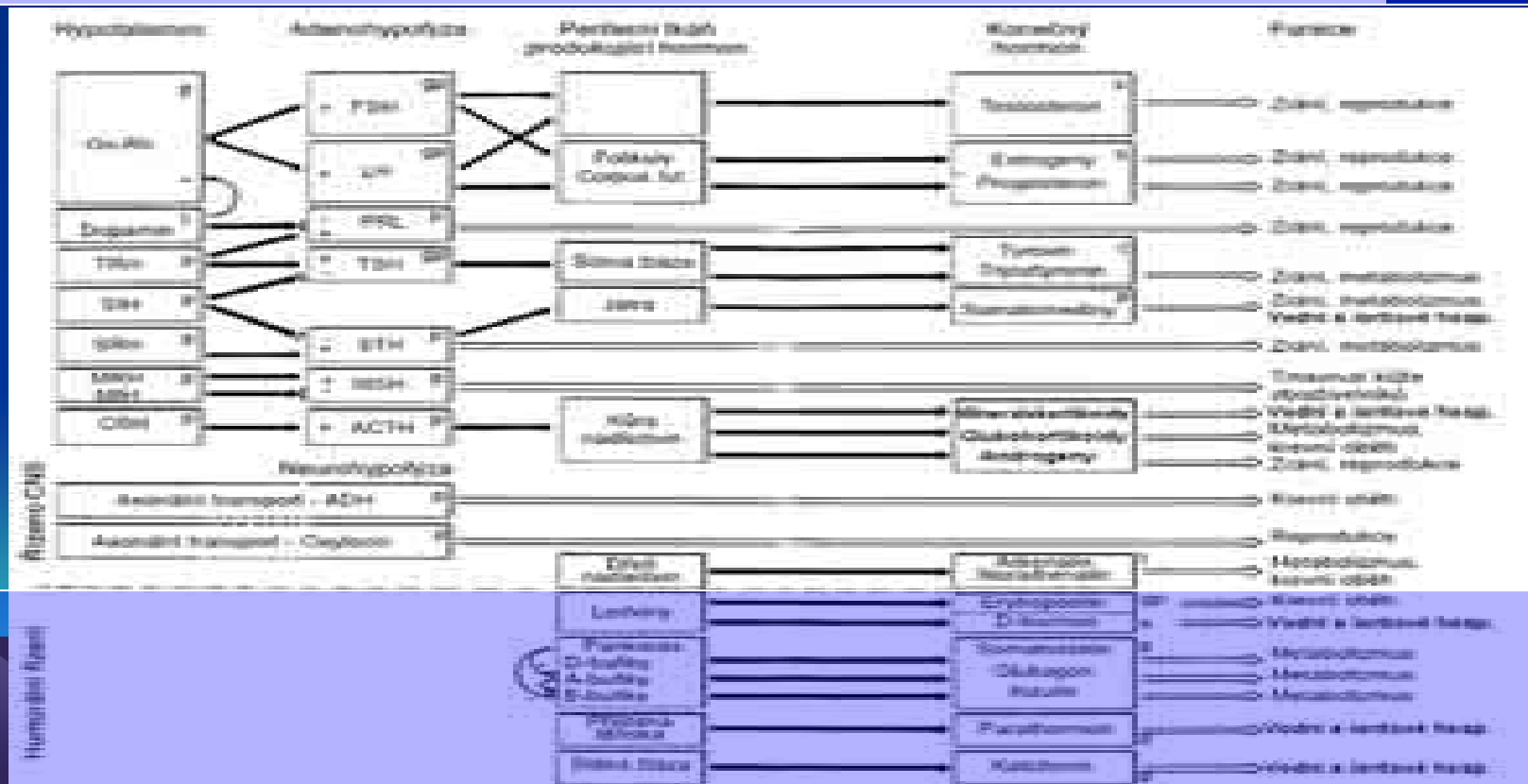


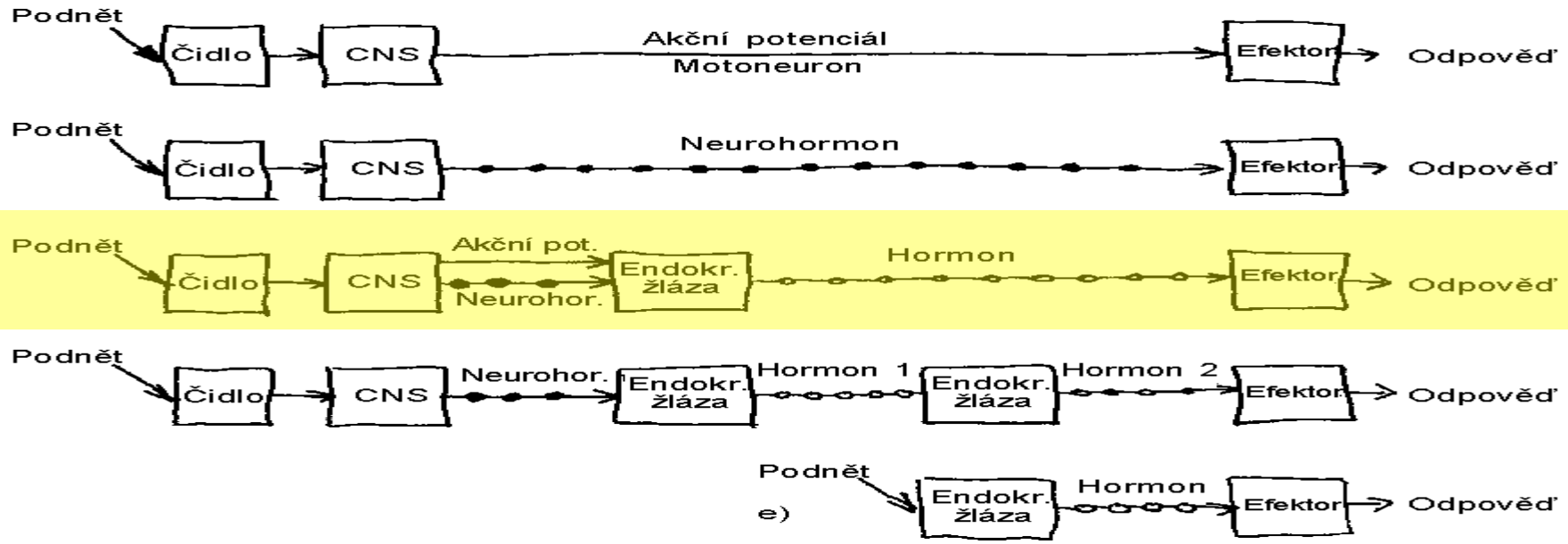
Hypotalamus:		Adenohypofýza		Neurohypofýza	
Kortikoliberin	CRH	Kortikotropin	ACTH	Oxytocin	
Gonadoliberin	Gn-RH	Folitropin	FSH	Adiuretin	ADH
Melanoliberin	MRH	Lutropin	LH		
Melanostatin	MIH	Melanotropin	MSH		
Prolaktostatin =Dopamin	PIH	Somatotropin	STH		
Somatoliberin	SRH	Tyrotropin	TSH		
Somatostatin	SIH	Prolaktin	PRL		
Tyreoliberin	TRH				

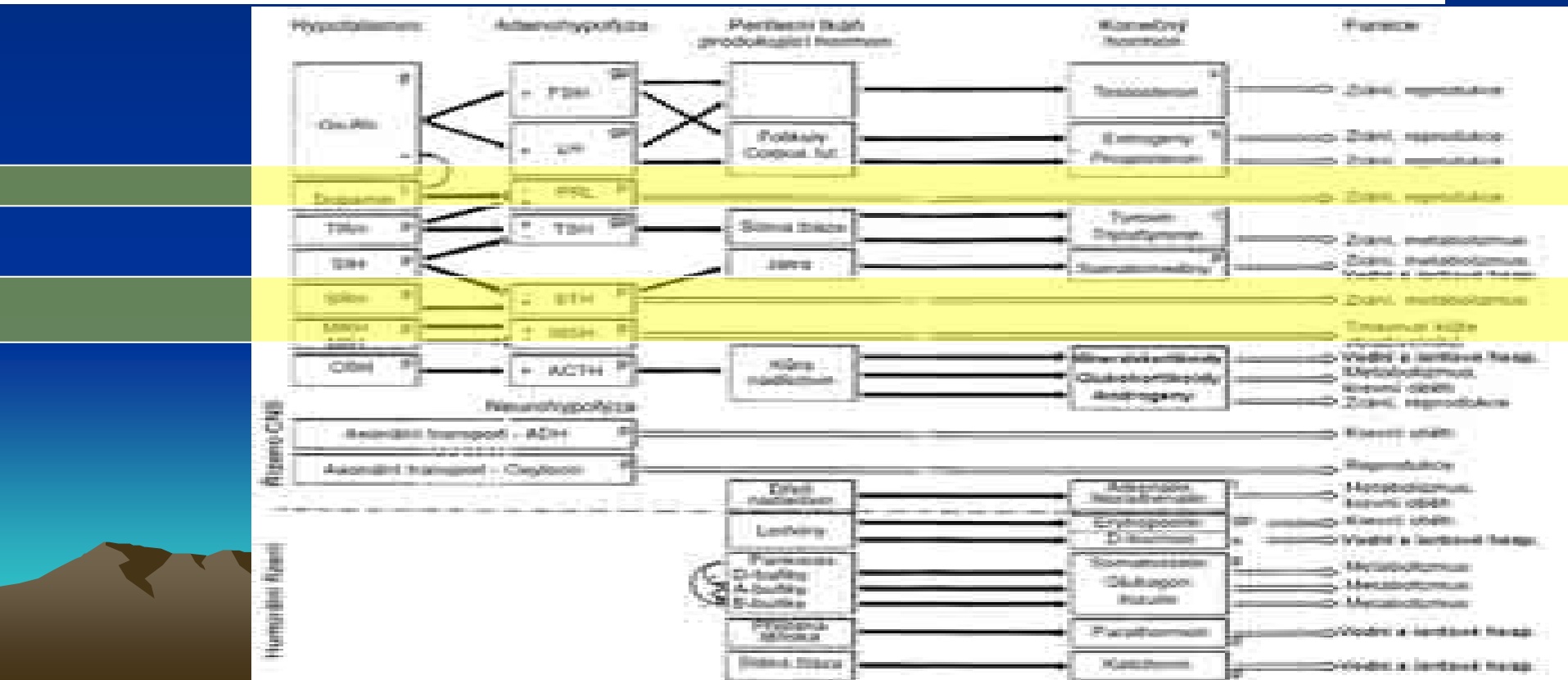

Podnět
Čidlo
CNS
Akční potenciál
Motoneuron
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Akční pot.
Neurohor.
Endokr. žláza
Hormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohor.
Endokr. žláza
Hormon 1
Endokr. žláza
Hormon 2
Efektor
Odpověď
Podnět
e)
Endokr. žláza
Hormon
Efektor
Odpověď

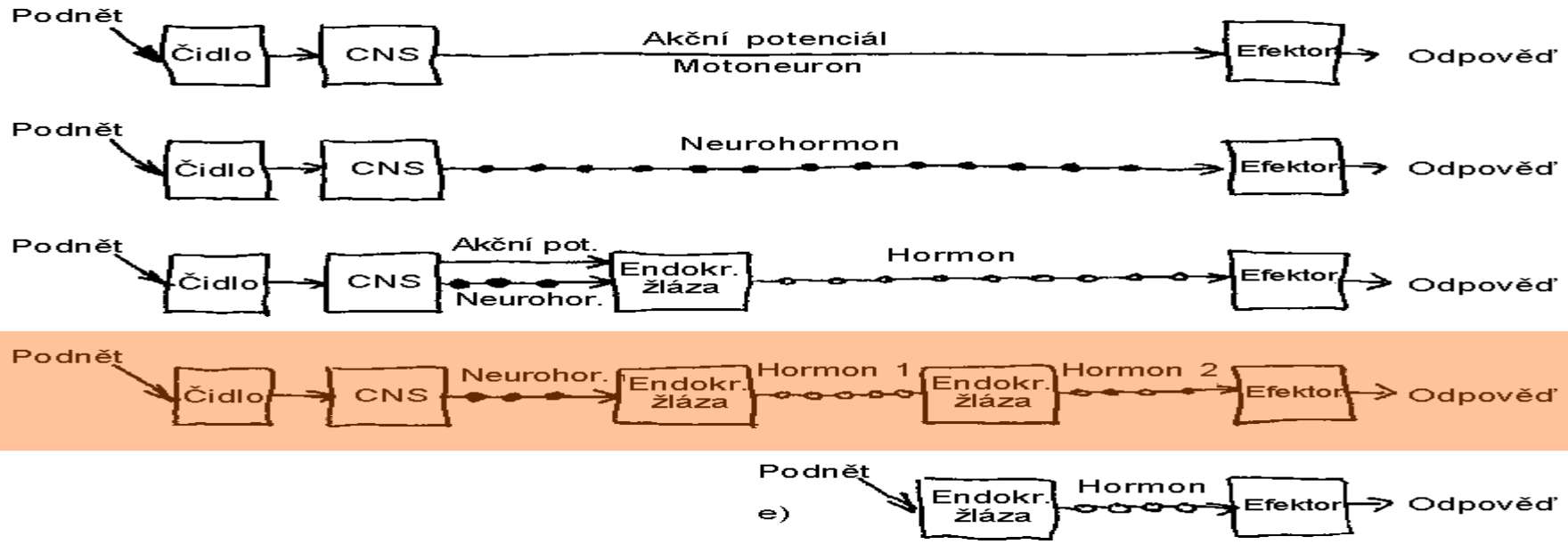

Hypothalamus
Adenohypofýza
Periferní tkáň
Koncový hormon
Funkce
Neurohypofýza

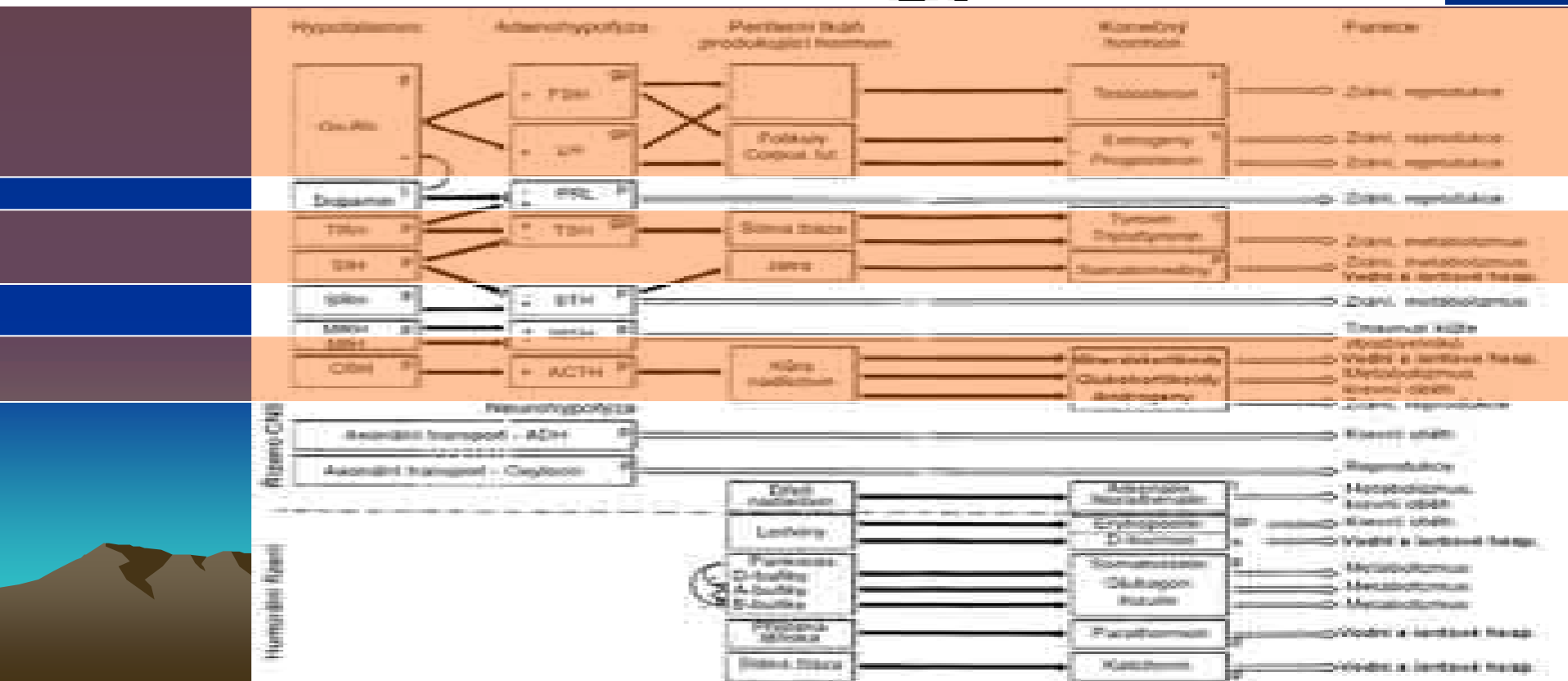

Podnět
Čidlo
CNS
Akční potenciál
Motoneuron
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Akční pot.
Neurohor.
Endokr. žláza
Hormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohor.
Endokr. žláza
Hormon 1
Endokr. žláza
Hormon 2
Efektor
Odpověď
Podnět
e)
Endokr. žláza
Hormon
Efektor
Odpověď

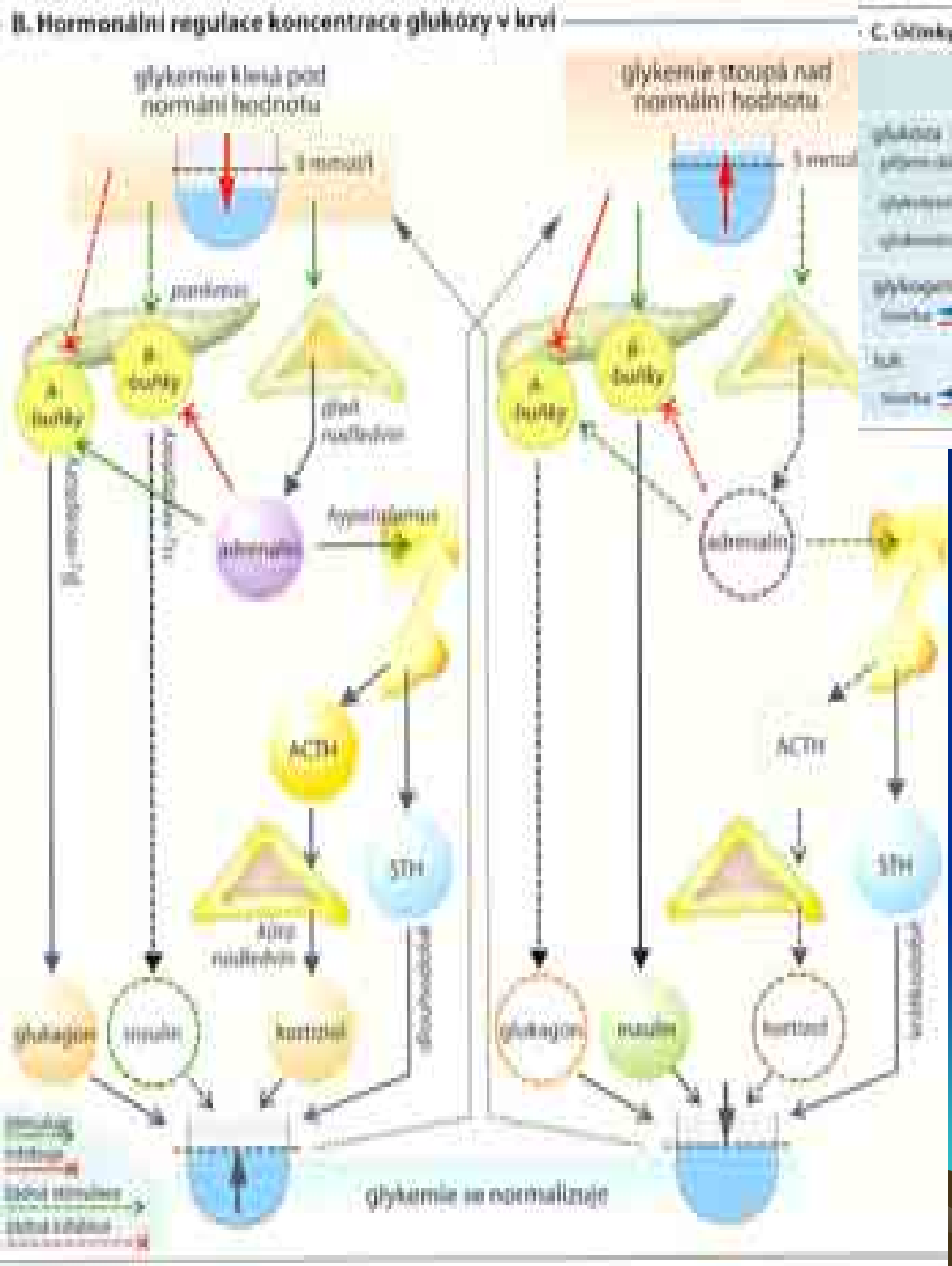



Podnět
Čidlo
CNS
Akční potenciál
Motoneuron
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Akční pot.
Neurohor.
Endokr. žláza
Hormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohor.
Endokr. žláza
Hormon 1
Endokr. žláza
Hormon 2
Efektor
Odpověď
Podnět
e)
Endokr. žláza
Hormon
Efektor
Odpověď

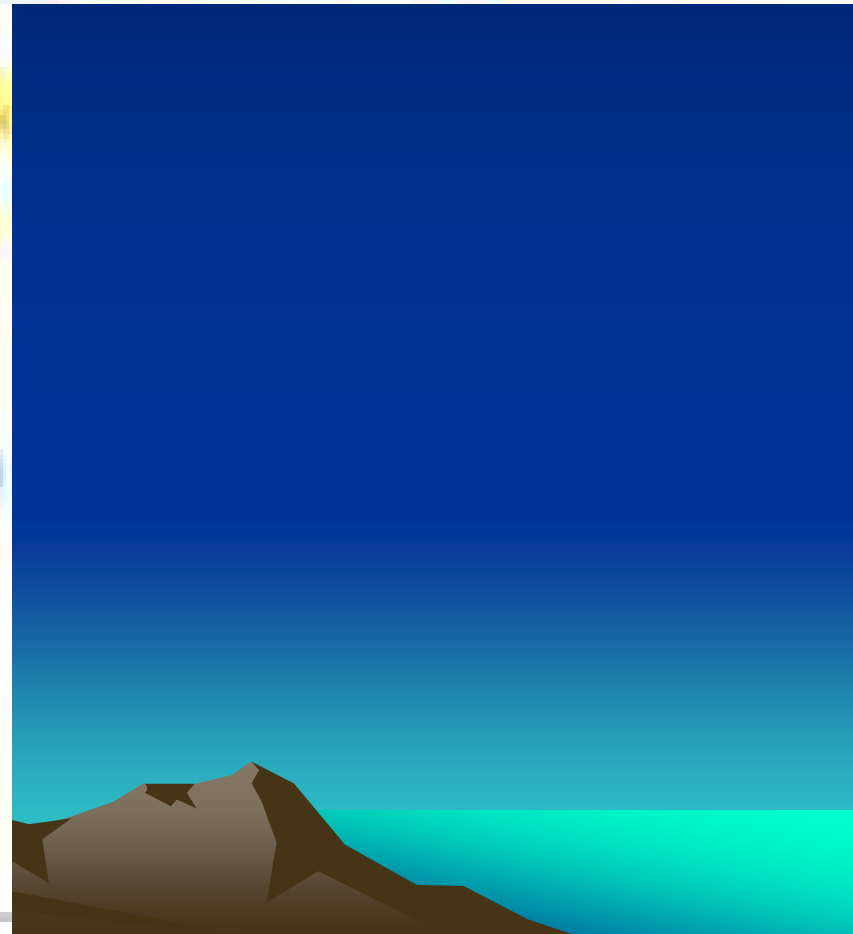



Podnět
Čidlo
CNS
Akční potenciál
Motoneuron
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Akční pot.
Neurohor.
Endokr. žláza
Hormon
Efektor
Odpověď
Podnět
Čidlo
CNS
Neurohor.
Endokr. žláza
Hormon 1
Endokr. žláza
Hormon 2
Efektor
Odpověď
Podnět
e)
Endokr. žláza
Hormon
Efektor
Odpověď

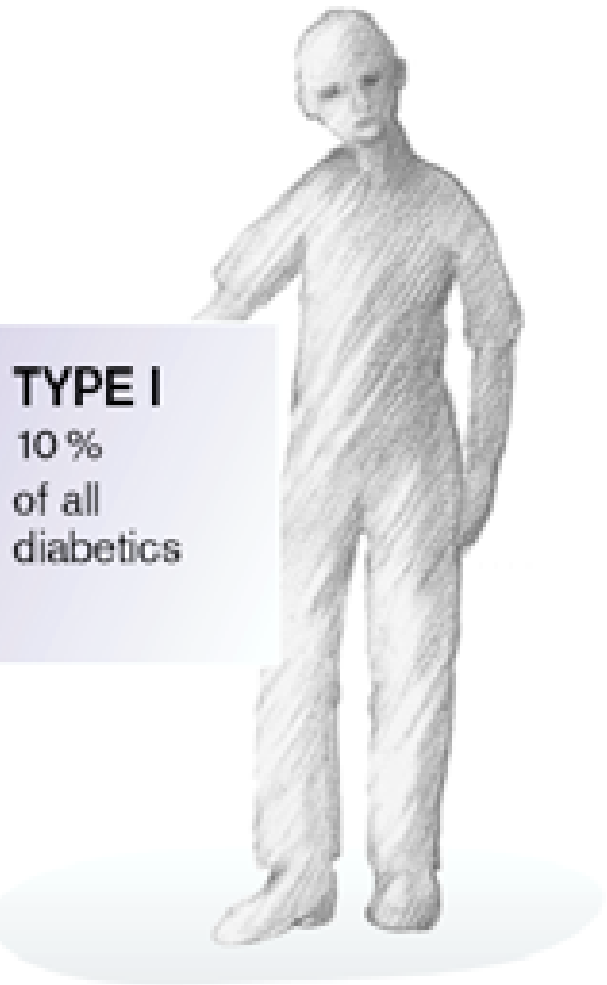



B. Hormonální regulace koncentrace glukózy v krvi
glykemie klesá pod normální hodnotu
5 mmol/l
pankreas
β-buňky
α-buňky
játra
hypotalamus
adrenalin
ACTH
STH
kortizol
glukagon
inzulin
glykemie se normalizuje
glykemie stoupá nad normální hodnotu
5 mmol/l
pankreas
β-buňky
α-buňky
játra
hypotalamus
adrenalin
ACTH
STH
glukagon
inzulin
kortizol

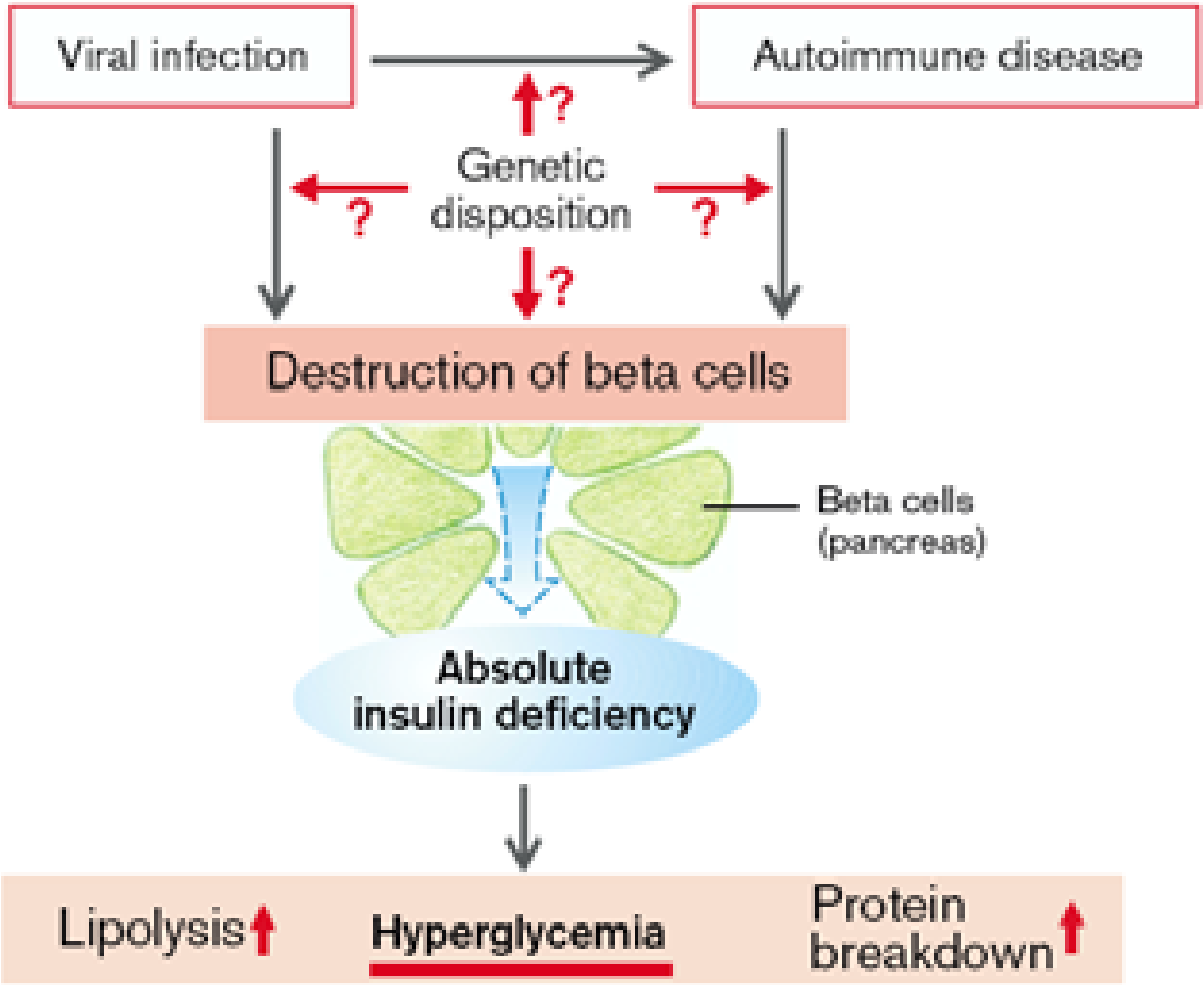

C. Účinky hormonů na metabolismus sacharidů a tuků
hormon
buňka
inzulin
glukagon
adrenalin
kortizol
glukóza
glykogen
tuk



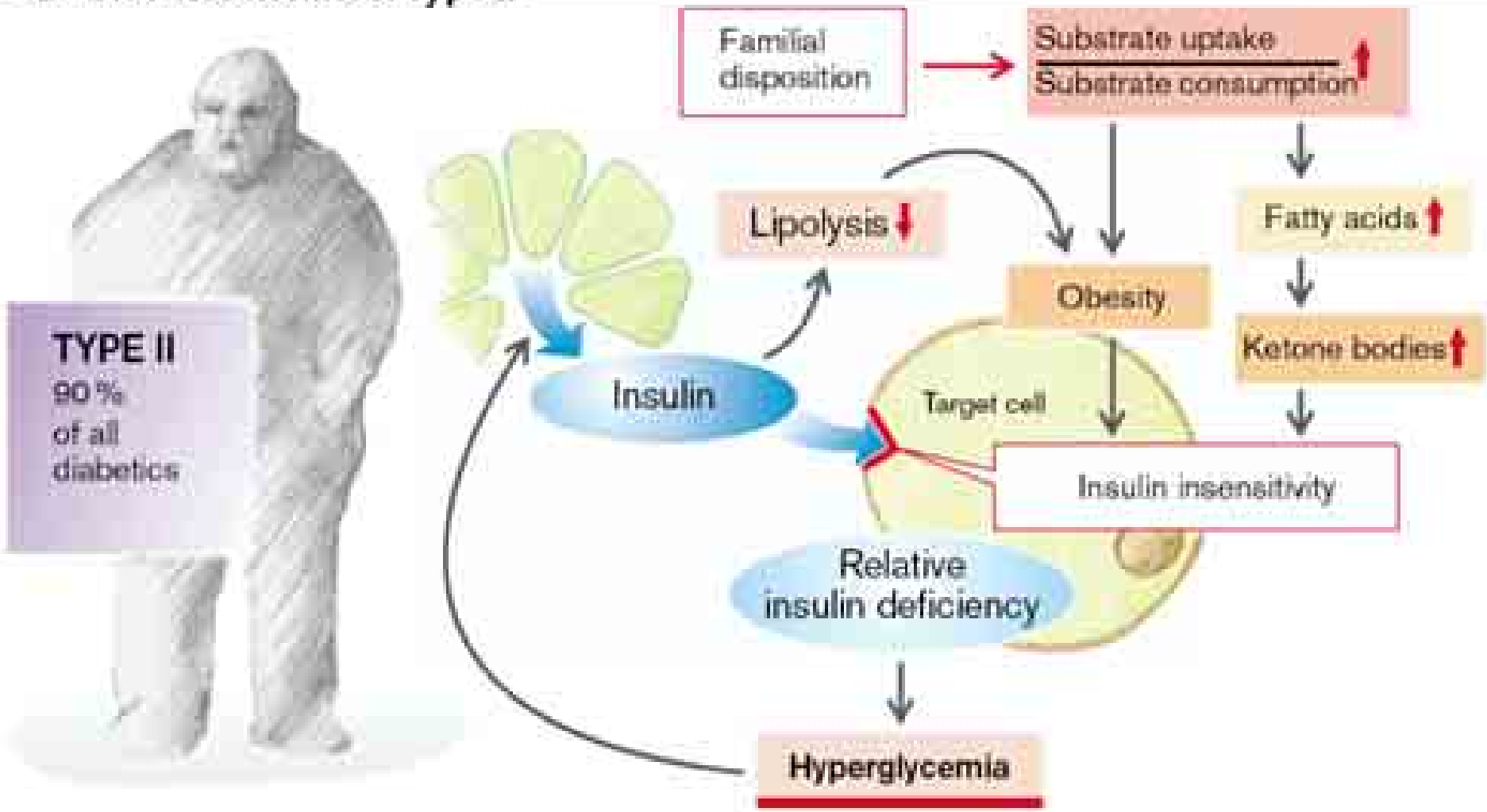
A. Diabetes Mellitus: Type I

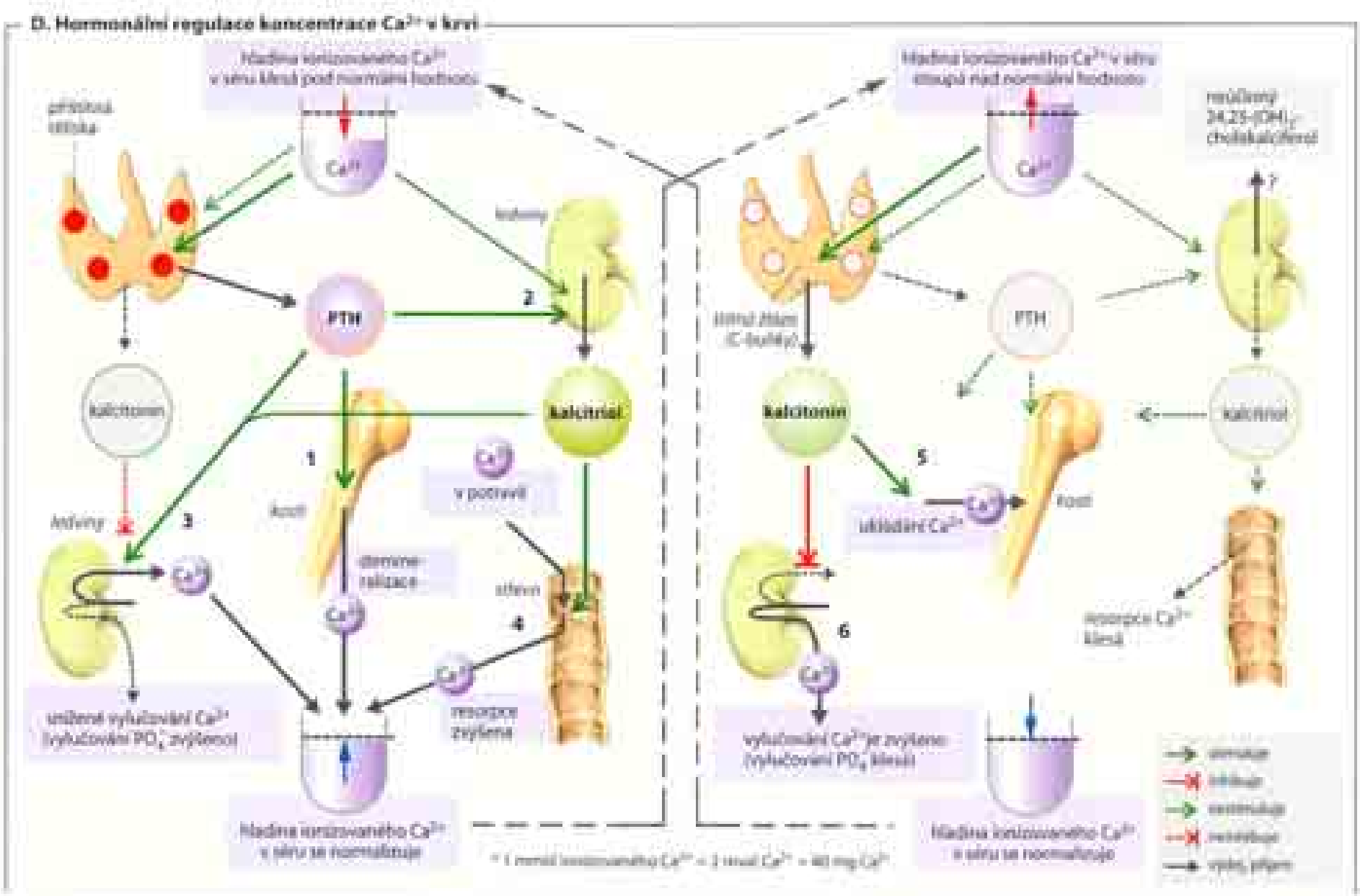


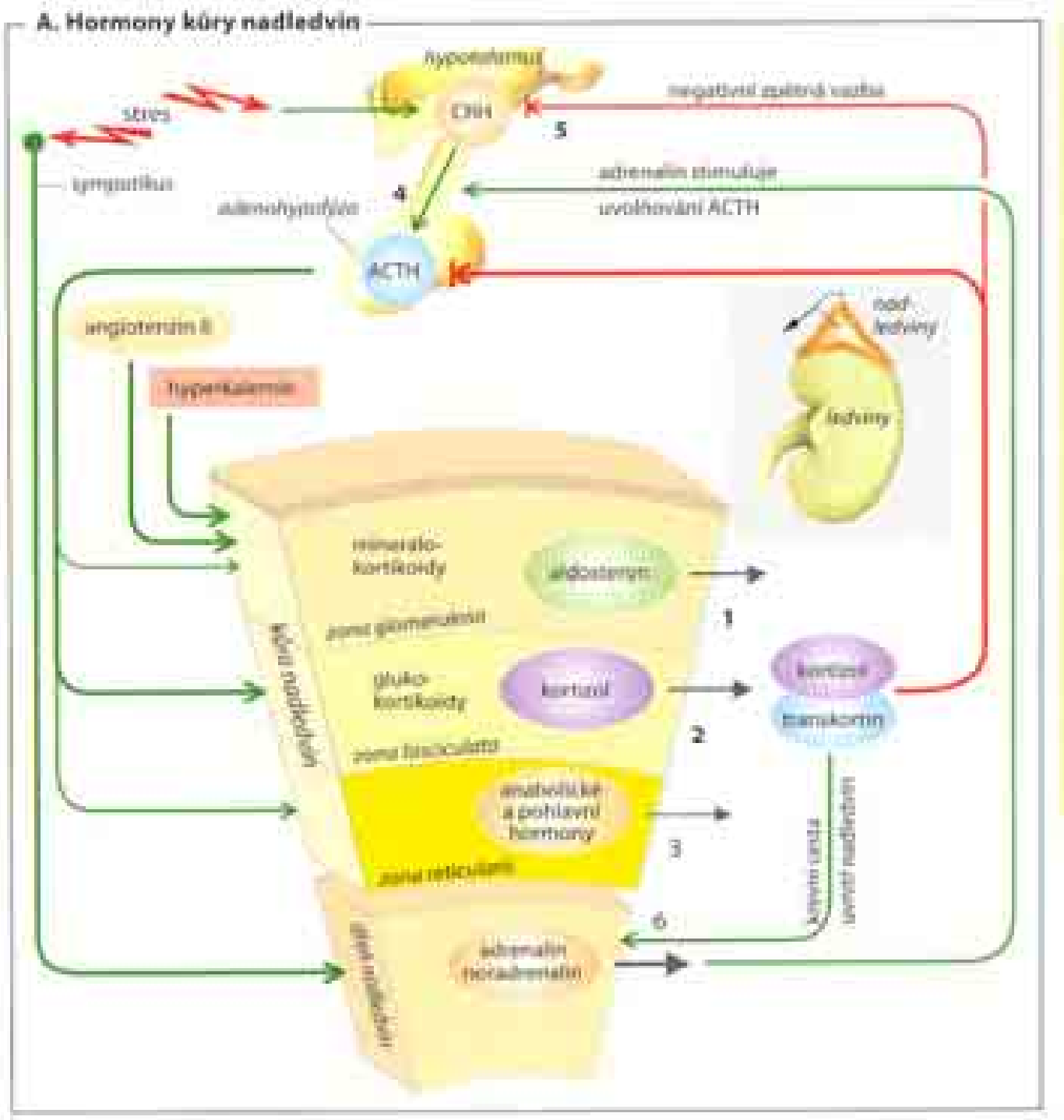
TYPE I
10 %
of all
diabetics

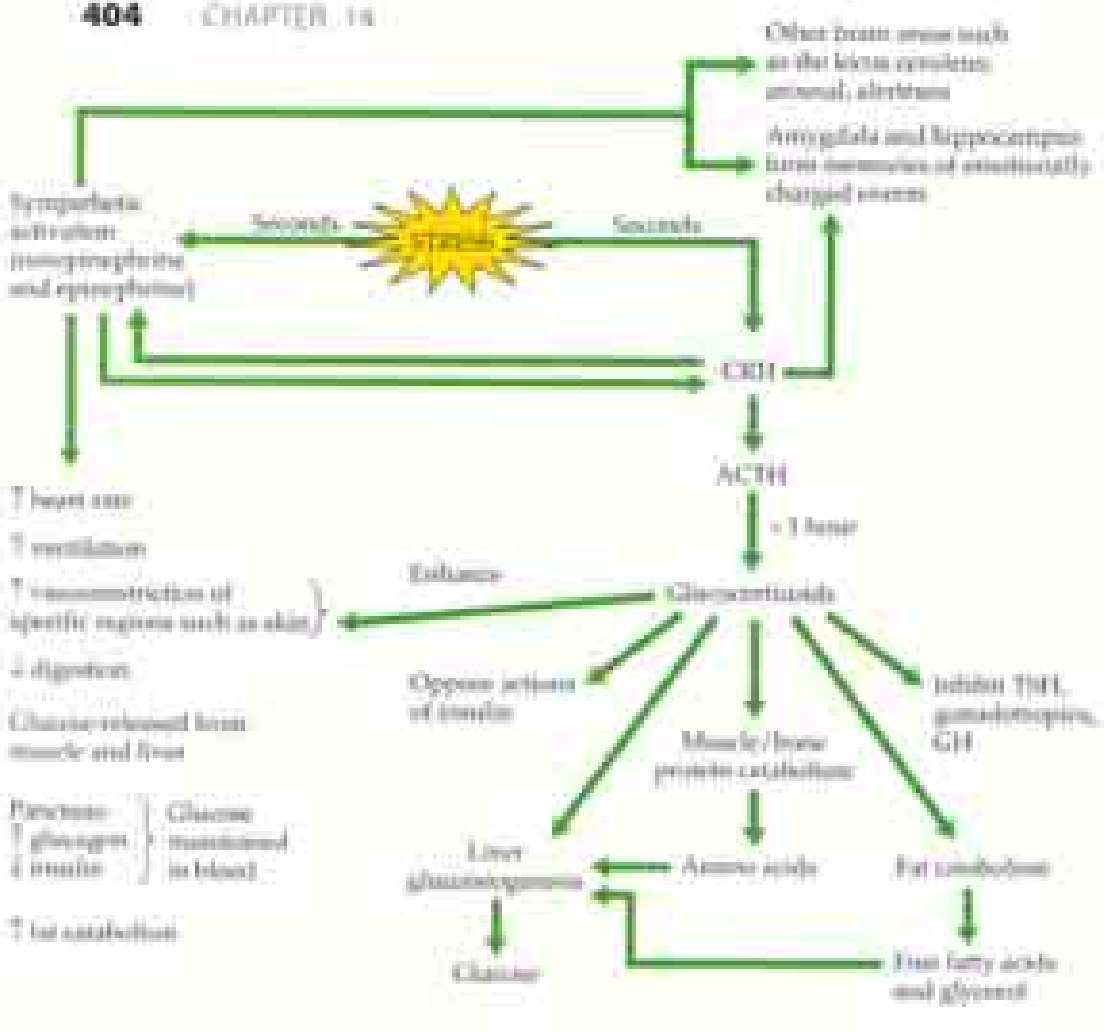


B. Diabetes Mellitus: Type II



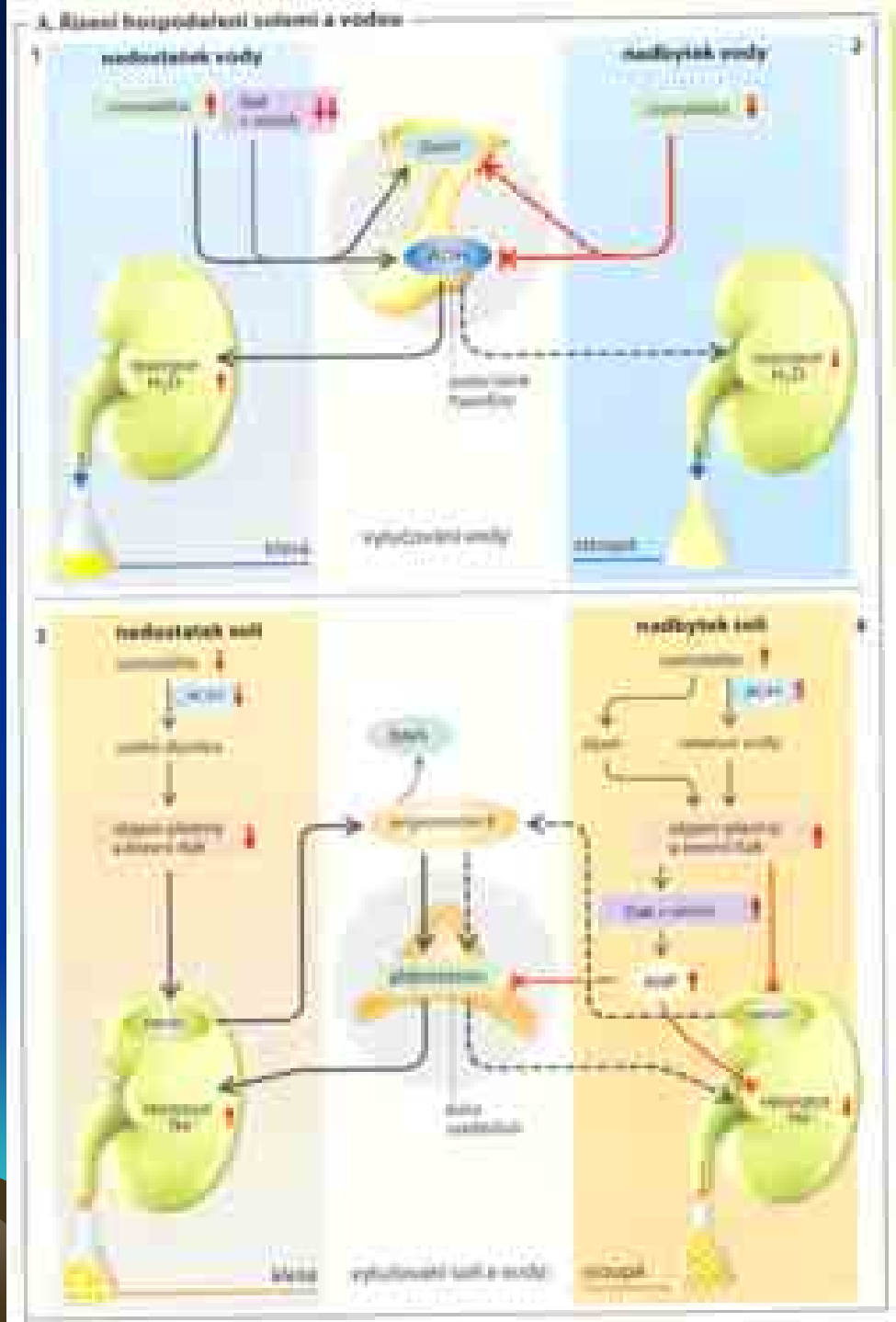

D. Hormonální regulace koncentrace Ca2+ v krvi
Hladina ionizovaného Ca2+ v séru klesá pod normální hodnotu
přištítná tělíska
PTH
kalcitonin
kalcitriol
ledviny
kosti
střevo
v potravě
1
2
3
4
5
6
zmenšené resorpce
zvýšená resorpce
snížené vylučování Ca2+ (vylučování PO43- zvýšené)
Hladina ionizovaného Ca2+ v séru se normalizuje
Hladina ionizovaného Ca2+ v séru stoupá nad normální hodnotu
štítná žláza (C-buňky)
ukládání Ca2+
vylučování Ca2+ je zvýšené (vylučování PO43- klesá)
Hladina ionizovaného Ca2+ v séru se normalizuje
zvýšený 24,25-(OH)2-cholekalciferol
resorpce Ca2+ klesá
stimuluje
inhibuje
1 mmol ionizovaného Ca2+ = 2 ekvivalenty Ca2+ = 40 mg Ca2+

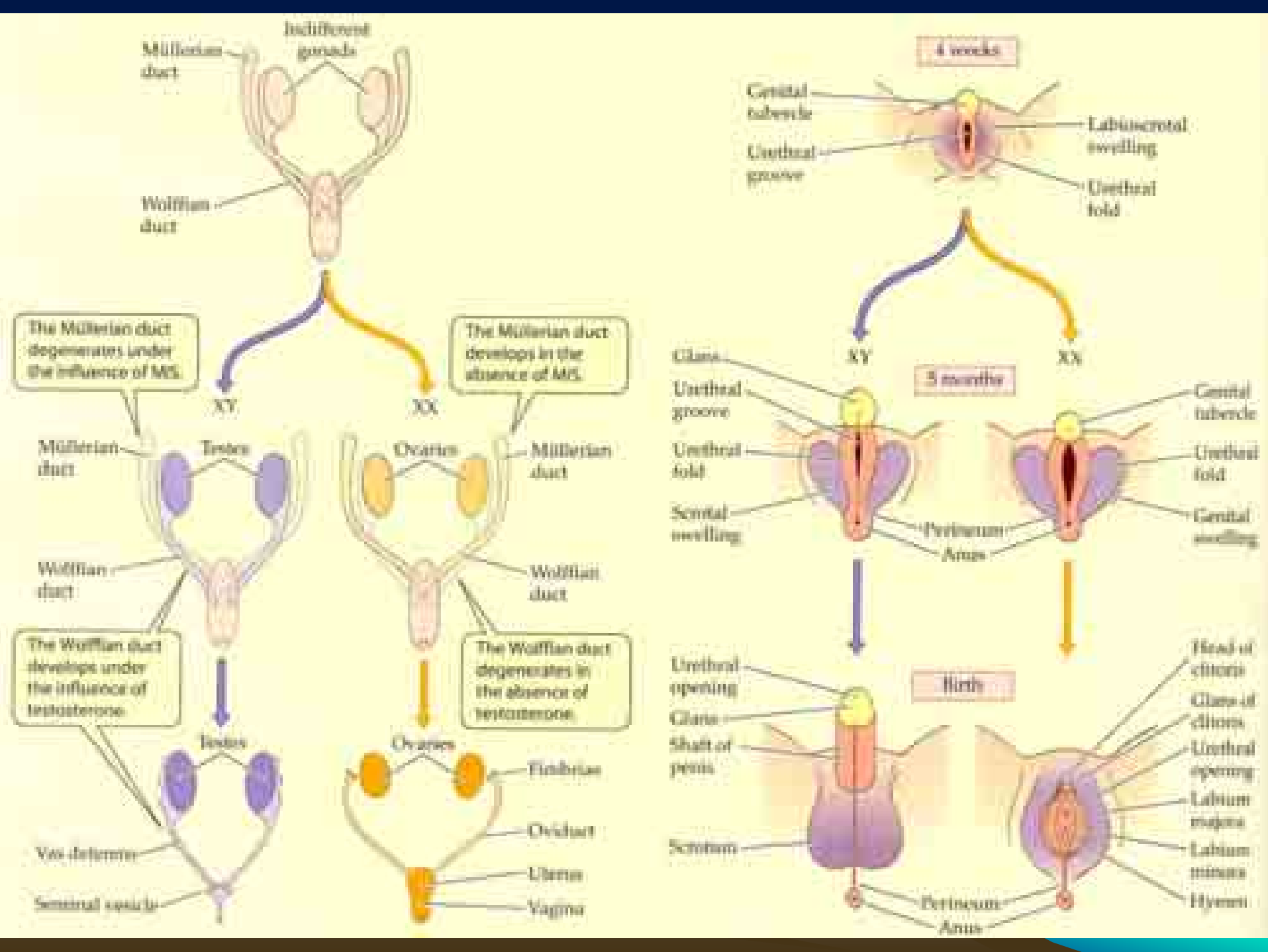

A. Hormony kůry nadledvin
hypothalamus
stres
CRH
negativní zpětná vazba
5
sympatikus
adrenalin stimuluje
uvolňování ACTH
4
adenohypofýza
ACTH
angiotenzin II
ledvina
hyperkalemie
mineralo-
kortikoidy
aldosteron
zona glomerulosa
1
gluko-
kortikoidy
kortizol
kortizol
transkortin
2
zona fasciculata
zona reticularis
3
adrenalin
noradrenalin
6



Hypotalamus:		Adenohypofýza		Neurohypofýza	
Kortikoliberin	CRH	Kortikotropin	ACTH	Oxytocin	
Gonadoliberin	Gn-RH	Folitropin	FSH	Adiuretin	ADH
Melanoliberin	MRH	Lutropin	LH		
Melanostatin	MIH	Melanotropin	MSH		
Prolaktostatin =Dopamin	PIH	Somatotropin	STH		
Somatoliberin	SRH	Tyrotropin	TSH		
Somatostatin	SIH	Prolaktin	PRL		
Tyreoliberin	TRH				

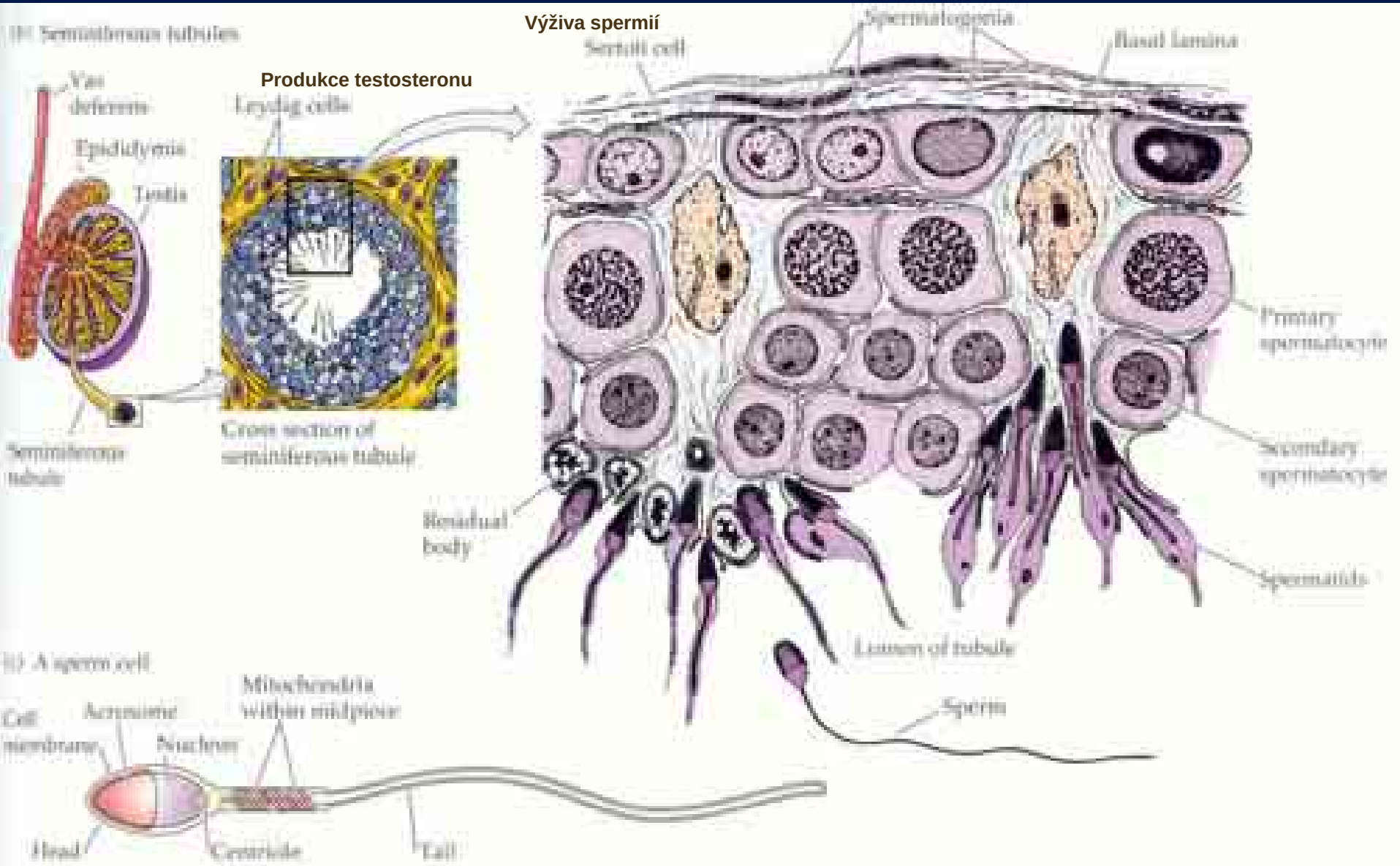
Figure 14.10 The mammalian stress response The stress response includes activation of both the sympathetic nervous system and the HPA axis.

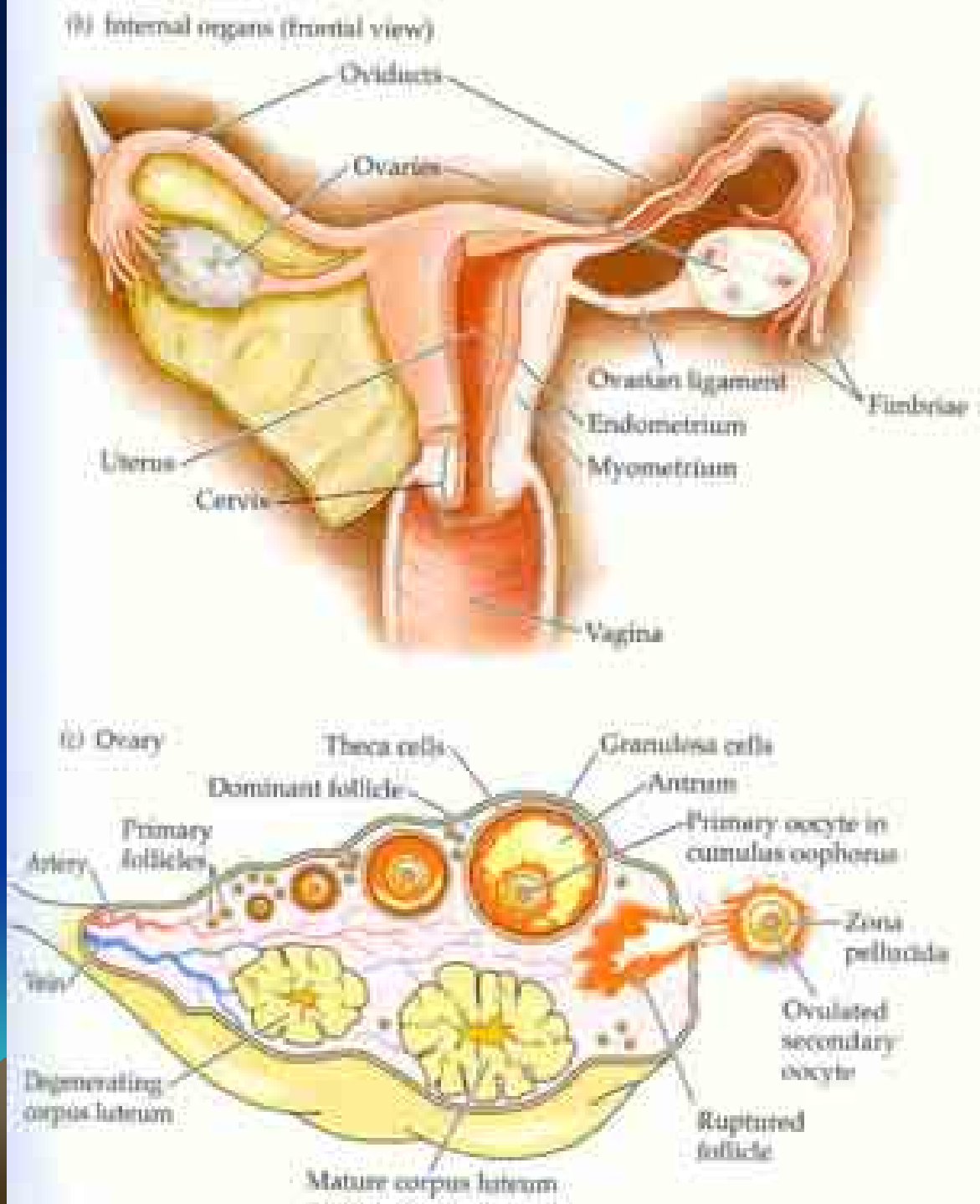

A. Řízení homeostázy solutů a vody
1
nedostatek vody
2
nadbytek vody
3
nedostatek solí
4
nadbytek solí

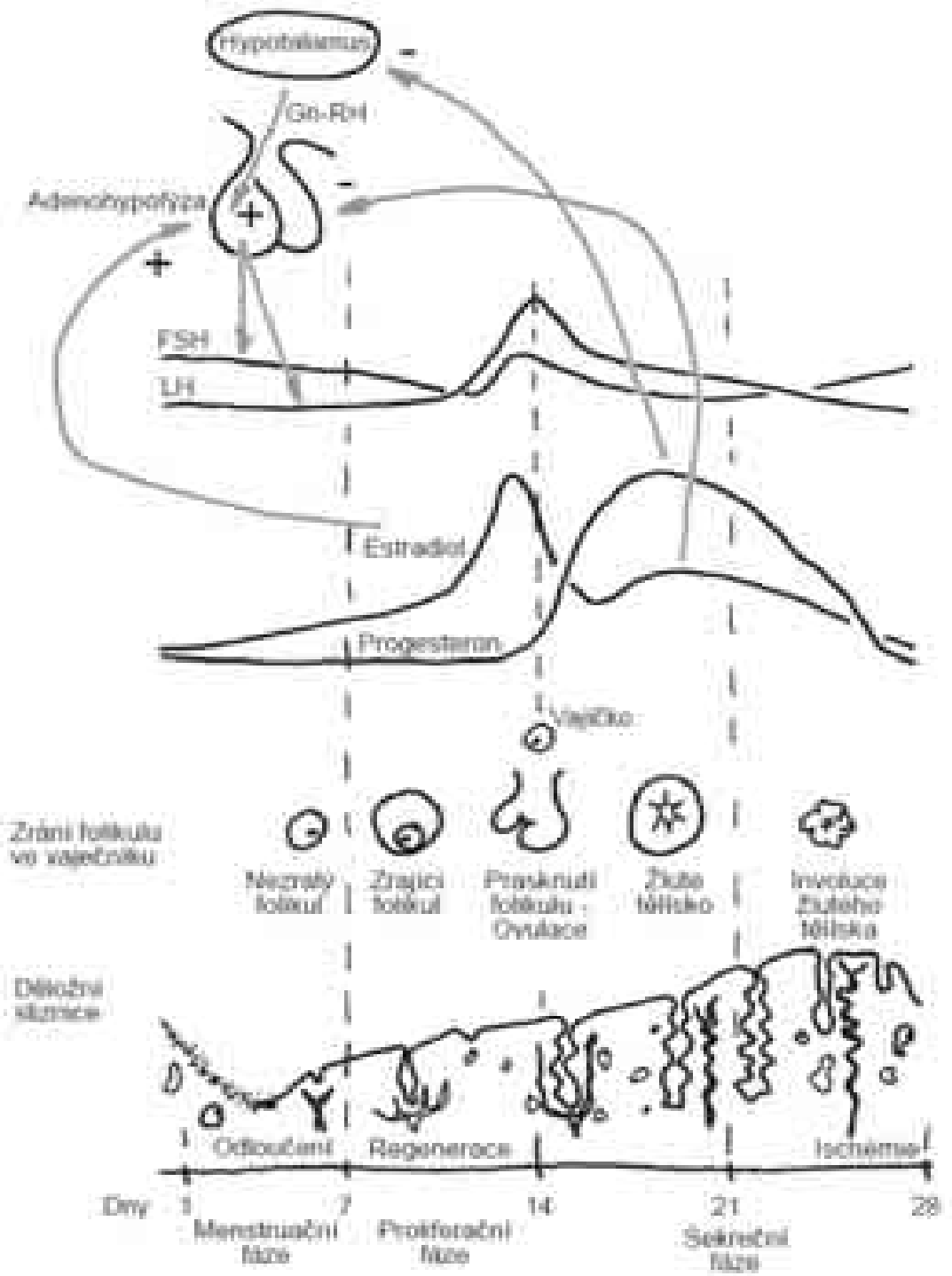

Müllerian duct
Indifferent gonads
Wolffian duct
The Müllerian duct degenerates under the influence of MIS
The Müllerian duct develops in the absence of MIS
XY
XX
Müllerian duct
Testes
Ovaries
Müllerian duct
Wolffian duct
Wolffian duct
The Wolffian duct develops under the influence of testosterone
The Wolffian duct degenerates in the absence of testosterone
Testes
Ovaries
Fimbriae
Oviduct
Uterus
Vagina
Vas deferens
4 weeks
Genital tubercle
Labioscrotal swelling
Urethral groove
Urethral fold
XY
XX
3 months
Glans
Urethral groove
Urethral fold
Scrotal swelling
Perineum
Anus
Genital tubercle
Urethral fold
Genital swelling
Birth
Urethral opening
Glans
Shaft of penis
Scrotum
Perineum
Anus
Head of clitoris
Glans of clitoris
Urethral opening
Labium majora
Labium minora
Hymen

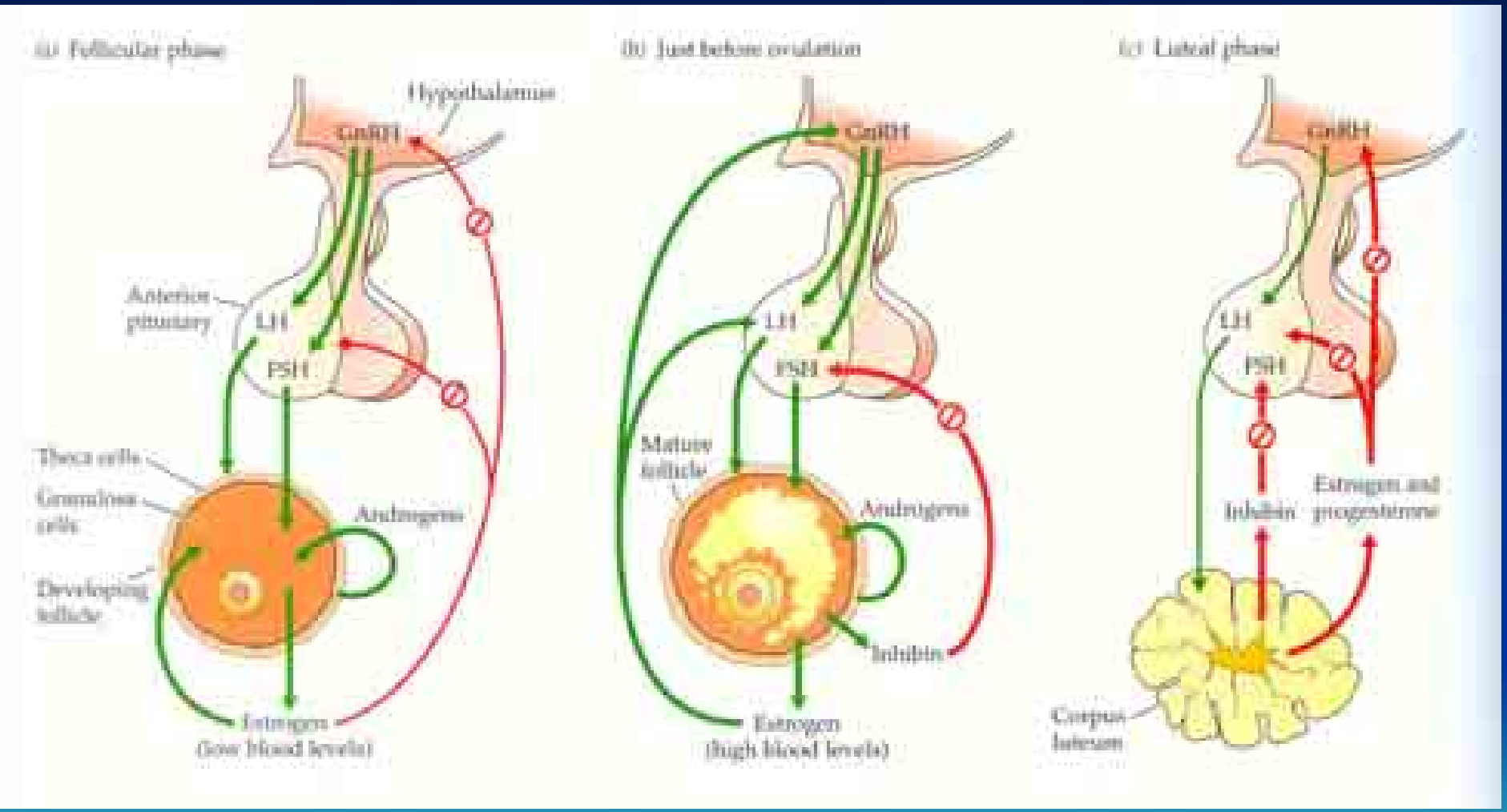
Výživa spermií

Produkce testosteronu




(b) Internal organs (frontal view)
Oviducts
Ovaries
Ovarian ligament
Fimbriae
Endometrium
Myometrium
Uterus
Cervix
Vagina
(c) Ovary
Theca cells
Granulosa cells
Dominant follicle
Antrum
Primary oocyte in cumulus oophorus
Primary follicles
Artery
Zona pellucida
Vein
Ovulated secondary oocyte
Degenerating corpus luteum
Ruptured follicle
Mature corpus luteum


Hypotalamus
GnRH
Adenohypofýza
FSH
LH
Estradiol
Progesteron
Vajíčko
Zrání folikulu
vo vaječníku
Nezralý folikul
Zrající folikul
Prasknutí folikulu - Ovulace
Žluté tělísko
Involuce žlutého tělíska
Děložní sliznice
Odloučení
Regenerace
Ischémie
Dny
1
7
14
21
28
Menstruační fáze
Proliferační fáze
Sekreční fáze


(a) Follicular phase
Hypothalamus
GnRH
Anterior pituitary
LH
FSH
Theca cells
Granulosa cells
Androgens
Developing follicle
Estrogen
(low blood levels)
(b) Just before ovulation
GnRH
LH
FSH
Mature follicle
Androgens
Inhibin
Estrogen
(high blood levels)
(c) Luteal phase
GnRH
LH
FSH
Inhibin
Estrogen and progesterone
Corpus luteum

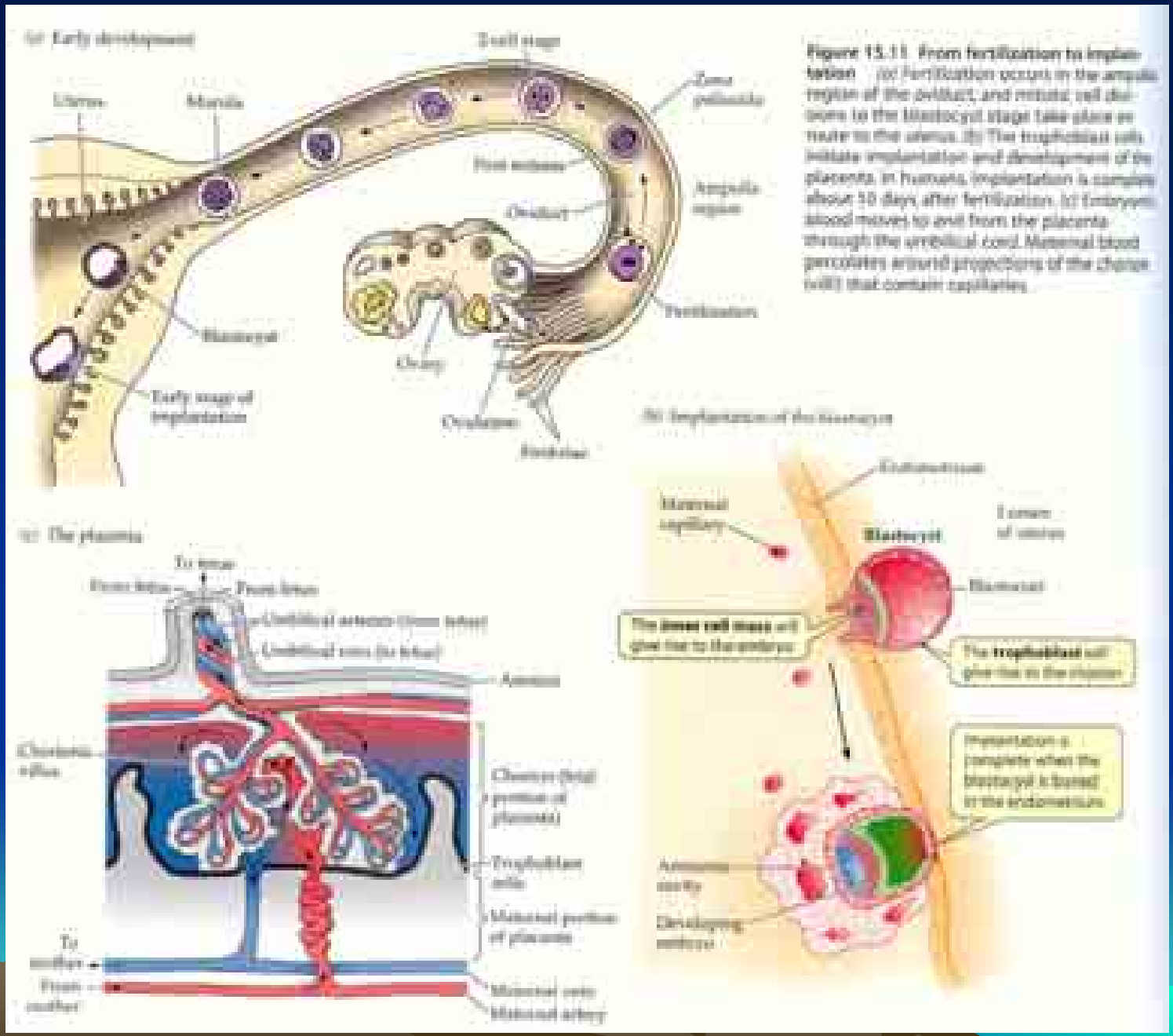
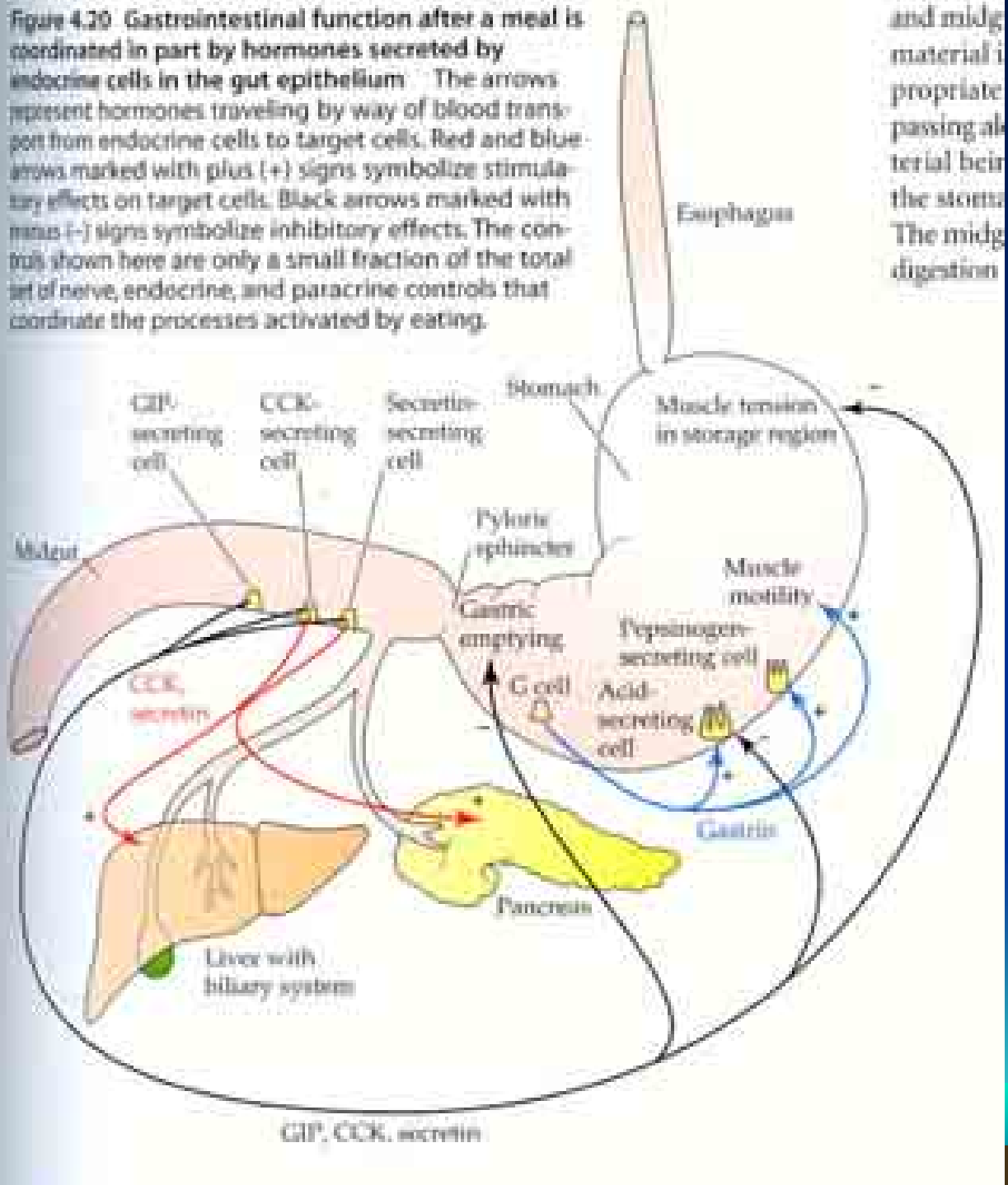
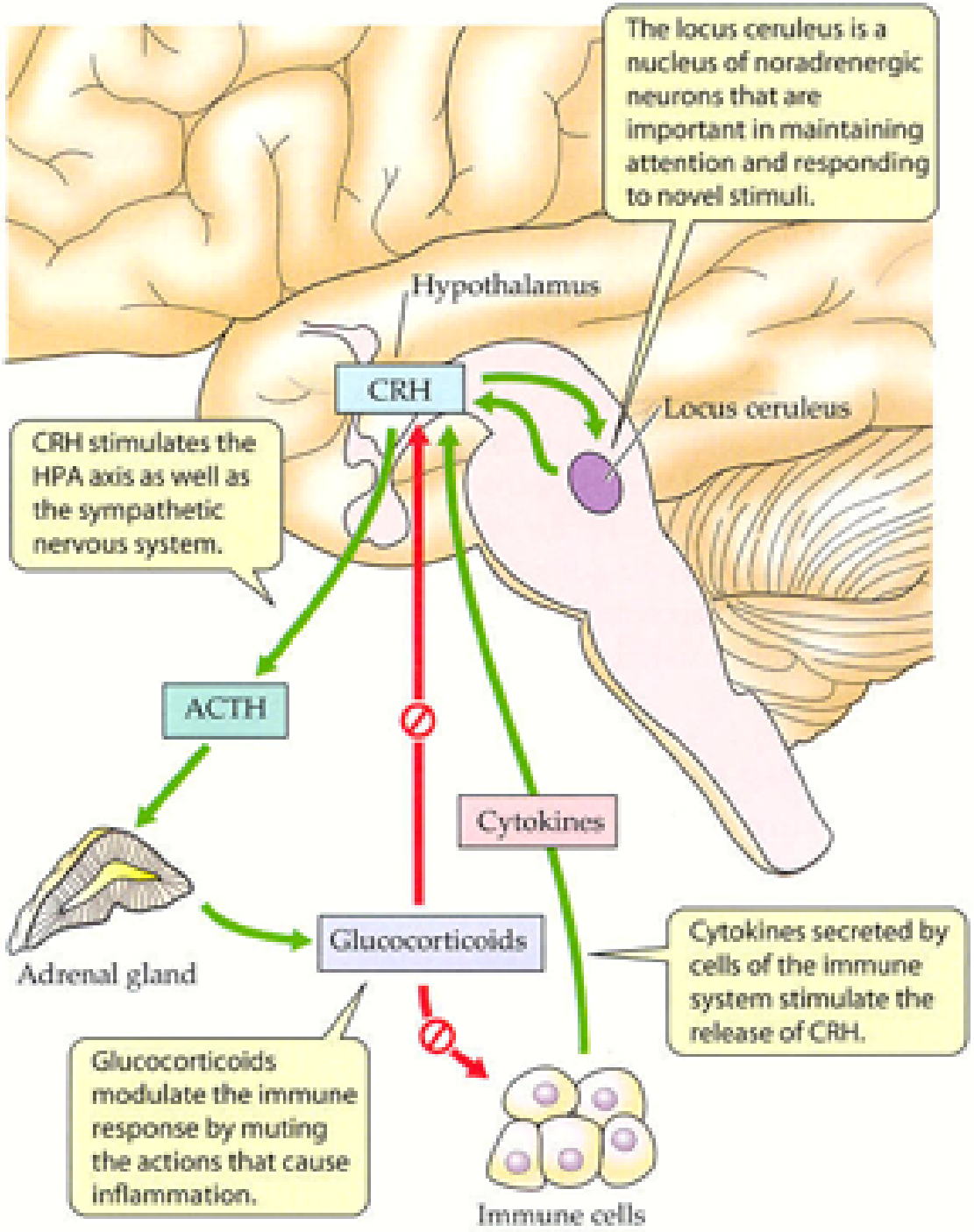


Figure 15.11 From fertilization to implantation (a) Fertilization occurs in the ampulla region of the oviduct, and mitotic cell divisions to the blastocyst stage take place en route to the uterus. (b) The trophoblast cells initiate implantation and development of the placenta. In humans, implantation is complete about 10 days after fertilization. (c) Embryonic blood moves to and from the placenta through the umbilical cord. Maternal blood percolates around projections of the chorion (villi) that contain capillaries.

Figure 4.20 Gastrointestinal function after a meal is coordinated in part by hormones secreted by endocrine cells in the gut epithelium The arrows represent hormones traveling by way of blood transport from endocrine cells to target cells. Red and blue arrows marked with plus (+) signs symbolize stimulatory effects on target cells. Black arrows marked with minus (–) signs symbolize inhibitory effects. The controls shown here are only a small fraction of the total set of nerve, endocrine, and paracrine controls that coordinate the processes activated by eating.




The locus ceruleus is a nucleus of noradrenergic neurons that are important in maintaining attention and responding to novel stimuli.
Hypothalamus
CRH
Locus ceruleus
CRH stimulates the HPA axis as well as the sympathetic nervous system.
ACTH
Cytokines
Adrenal gland
Glucocorticoids
Cytokines secreted by cells of the immune system stimulate the release of CRH.
Glucocorticoids modulate the immune response by muting the actions that cause inflammation.
Immune cells