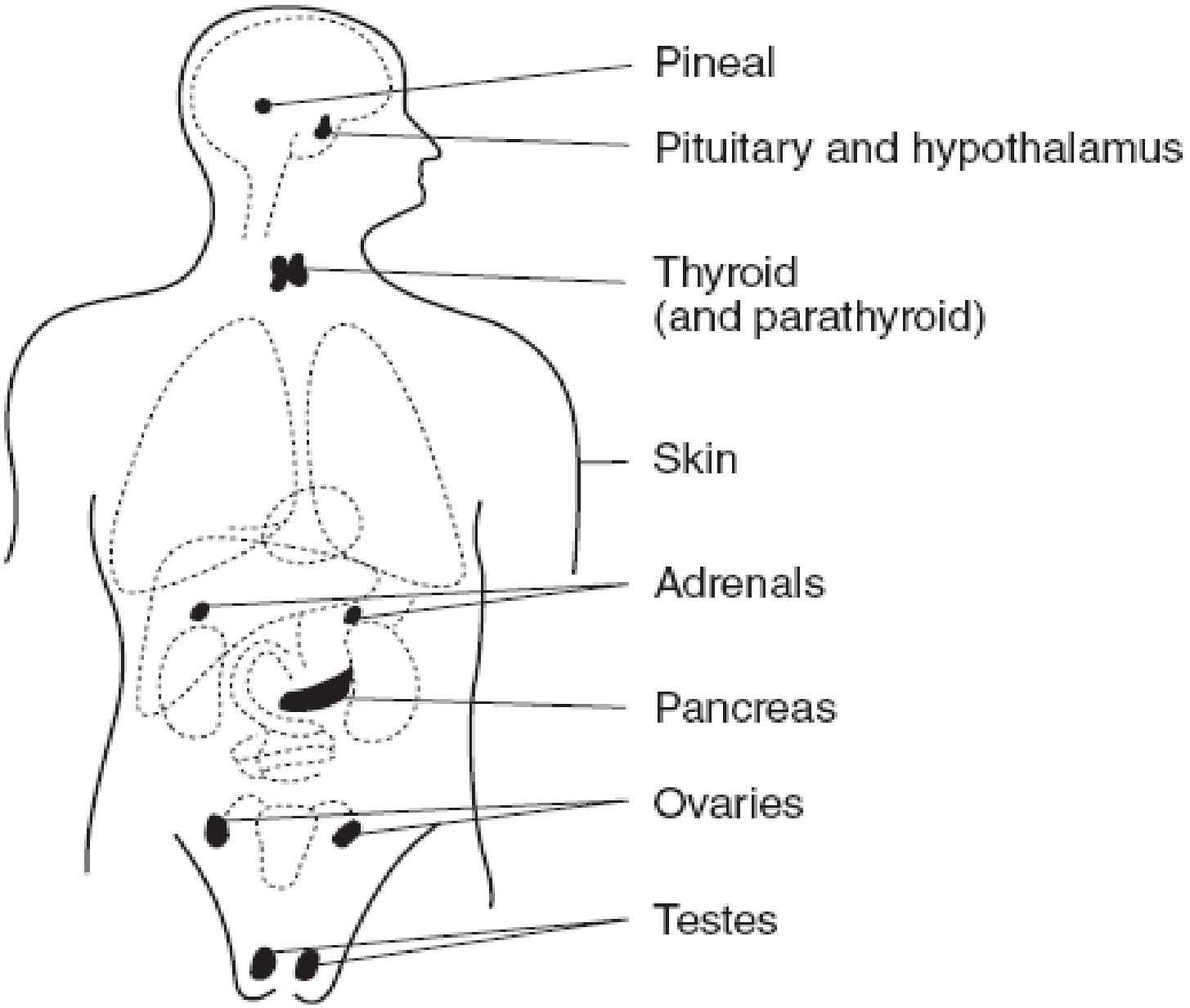
Biokimia Hormon

Blok 1.4

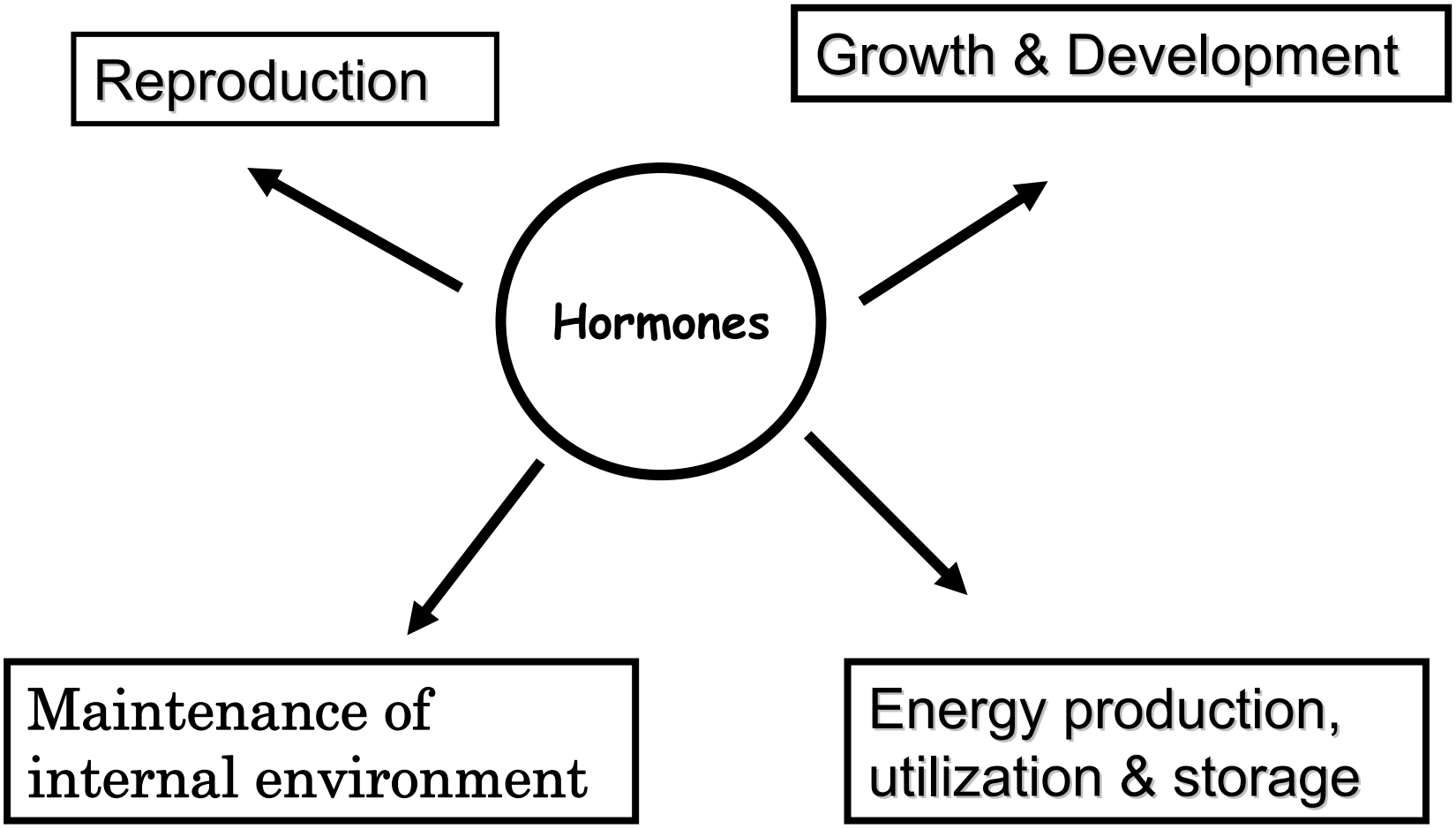
Biokimia FK Unand

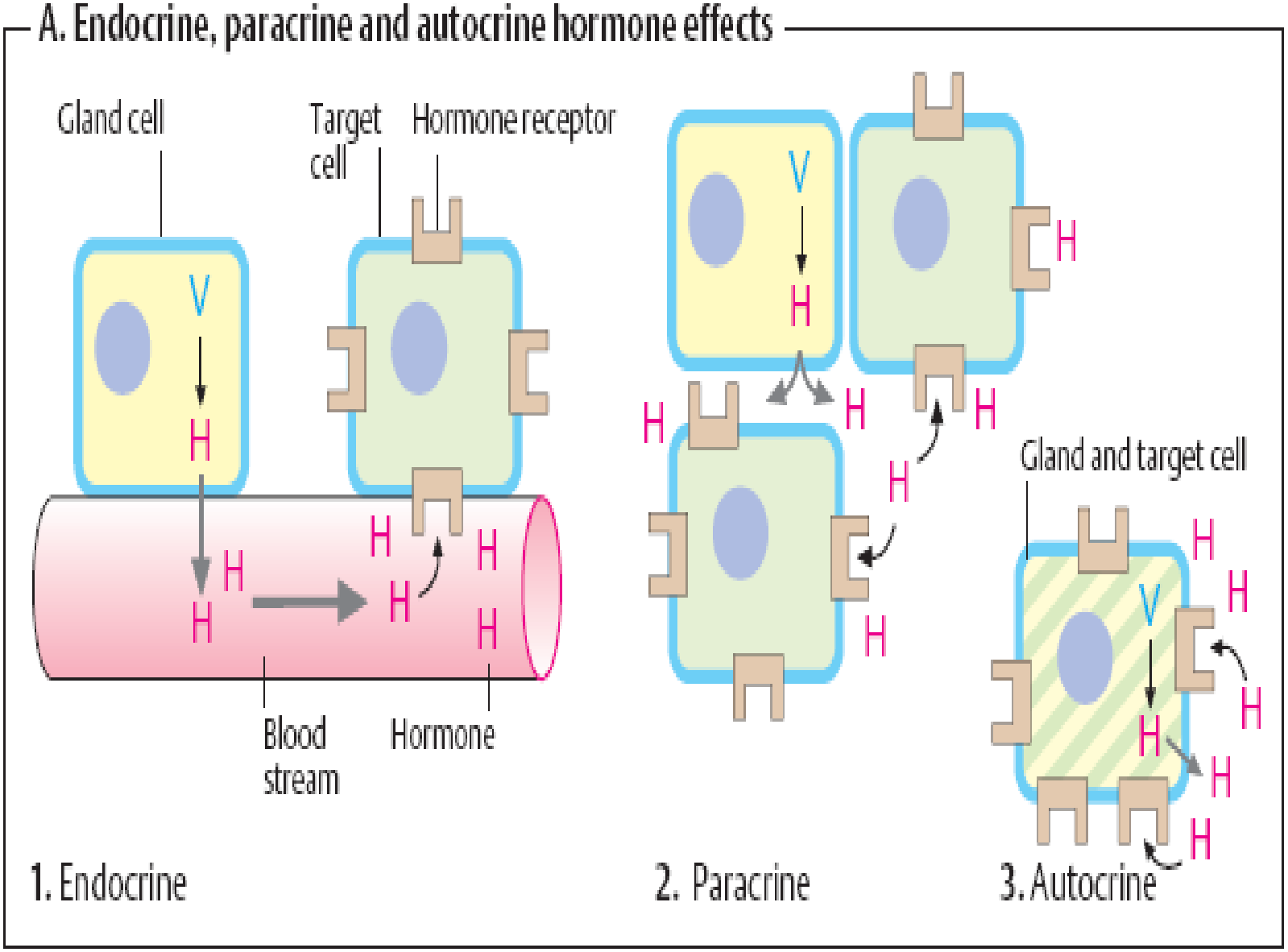
Hormon

- Hormon: senyawa kimia yang disekresikan oleh ***specific glands atau cell*** dan berperan sebagai ***chemical messenger*** atau ***signal molecule***
- Hormon dalam sirkulasi darah sangat rendah (10^{-12} - 10^{-7} mol L^{-1}).

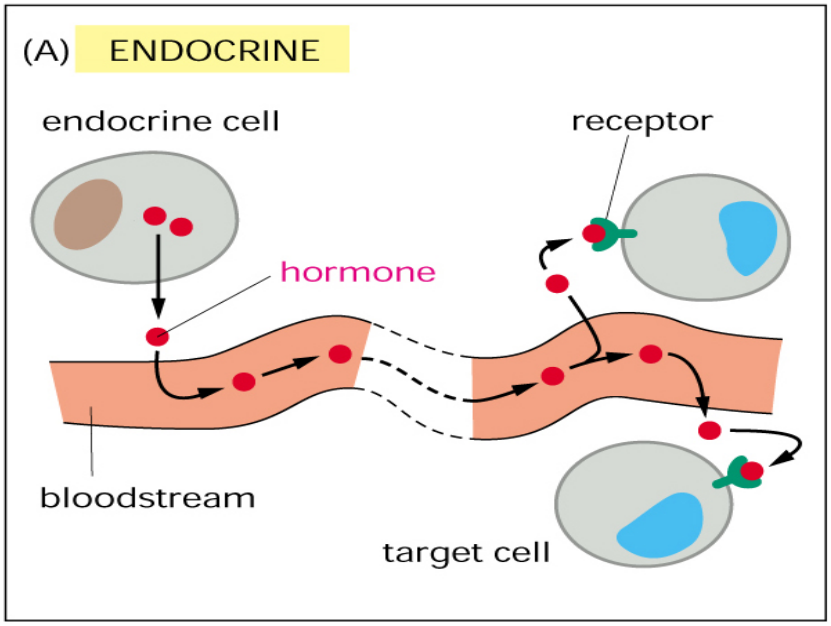

Pineal
Pituitary and hypothalamus
Thyroid
(and parathyroid)
Skin
Adrenals
Pancreas
Ovaries
Testes

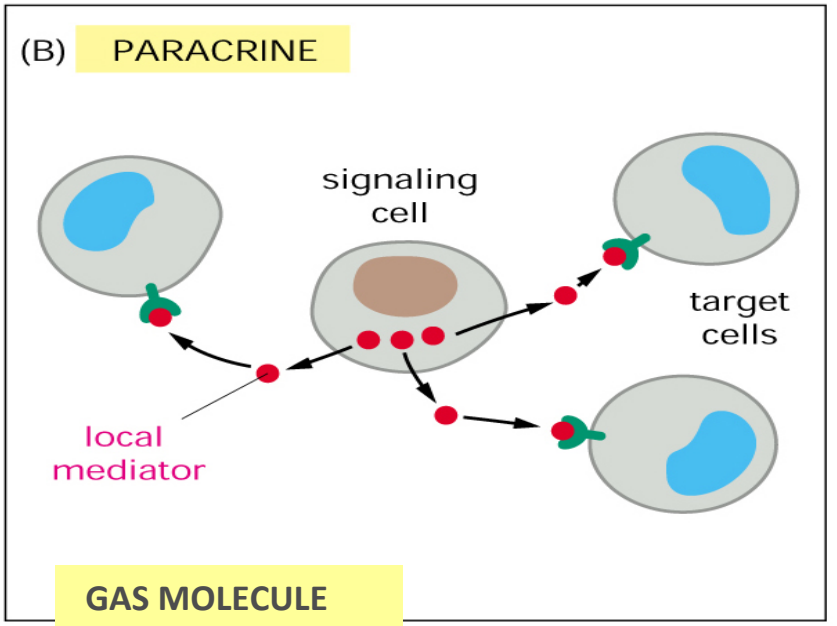
Fungsi Hormon

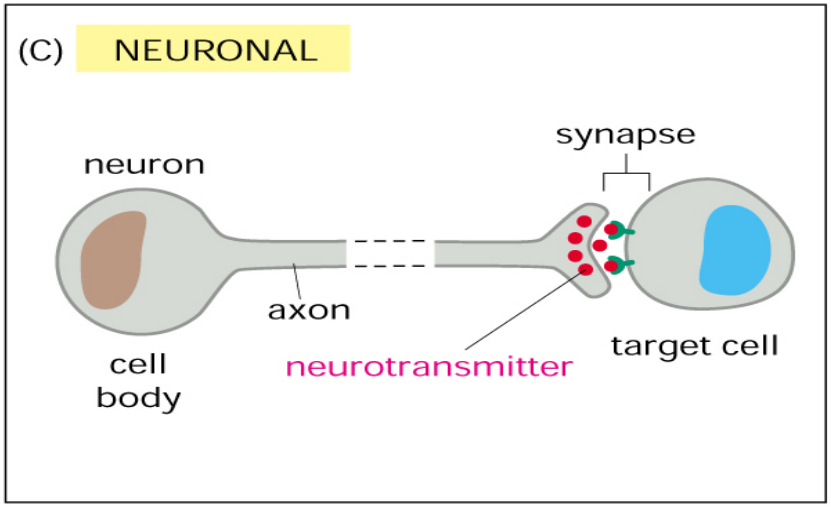


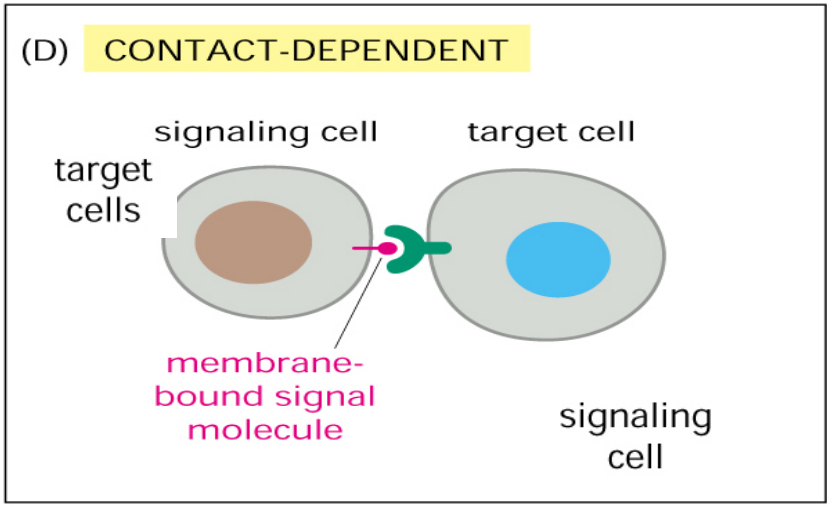

A. Endocrine, paracrine and autocrine hormone effects
Gland cell
Target cell
Hormone receptor
V
H
Blood stream
Hormone
1. Endocrine
2. Paracrine
Gland and target cell
3. Autocrine

Cell Communication

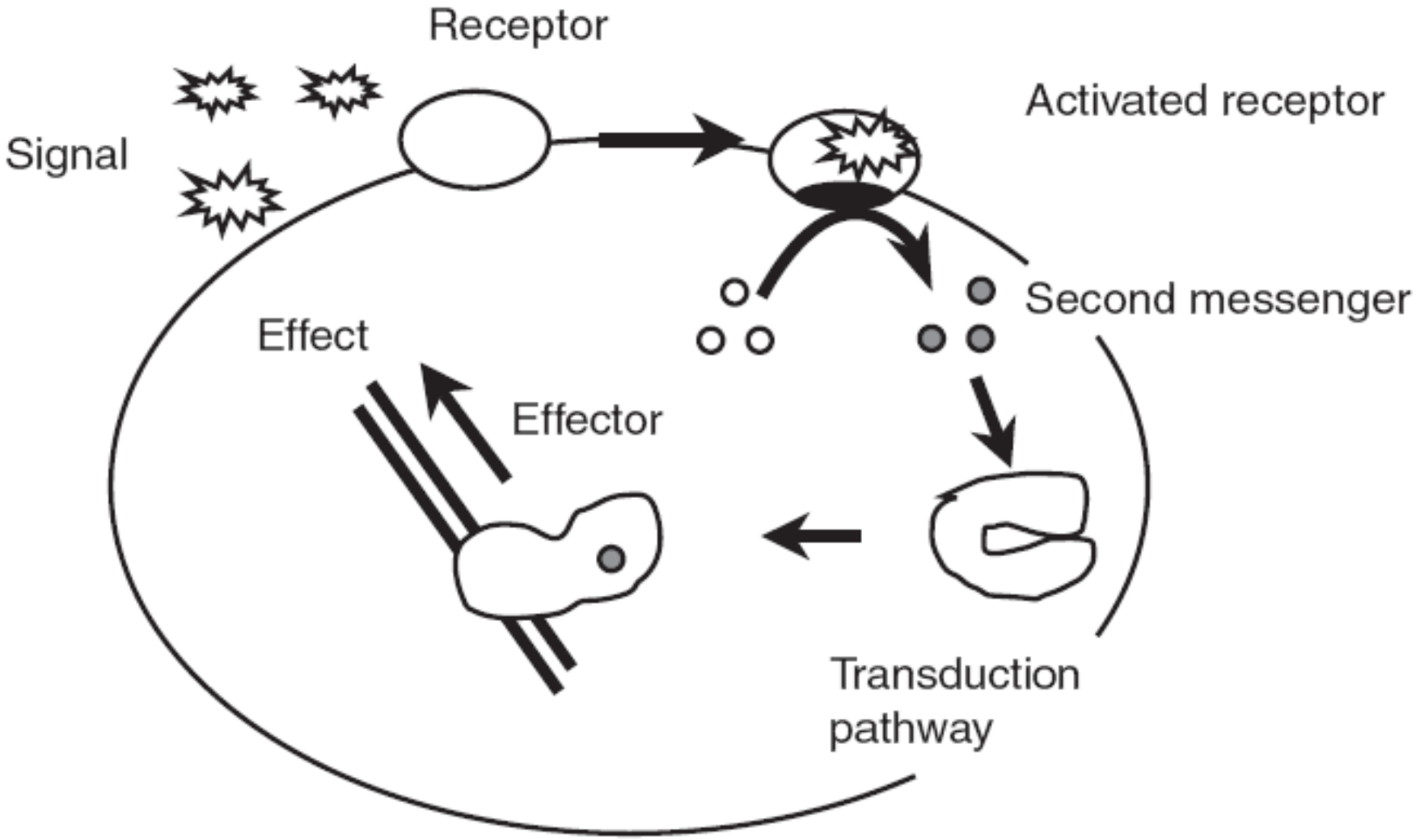


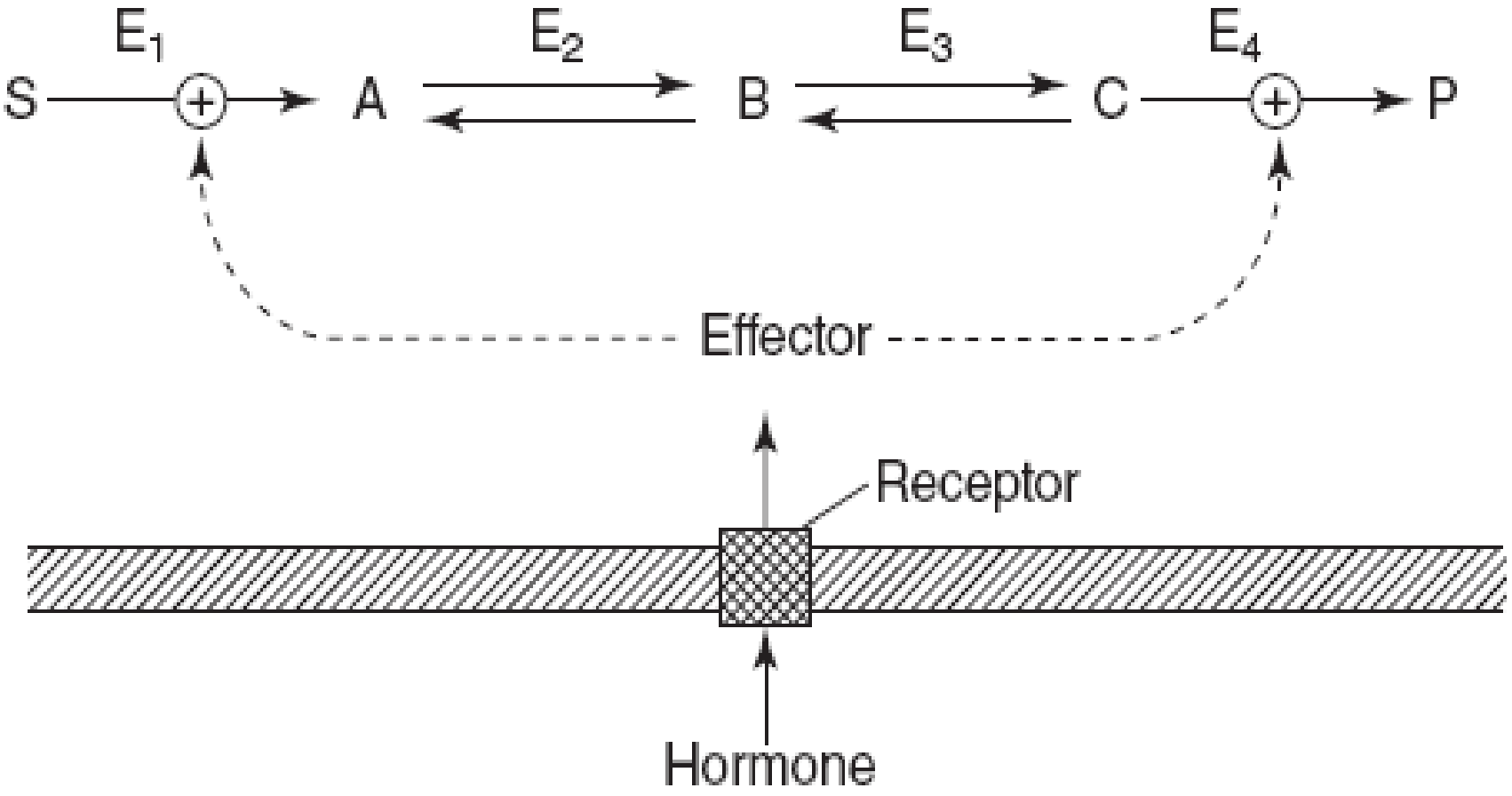




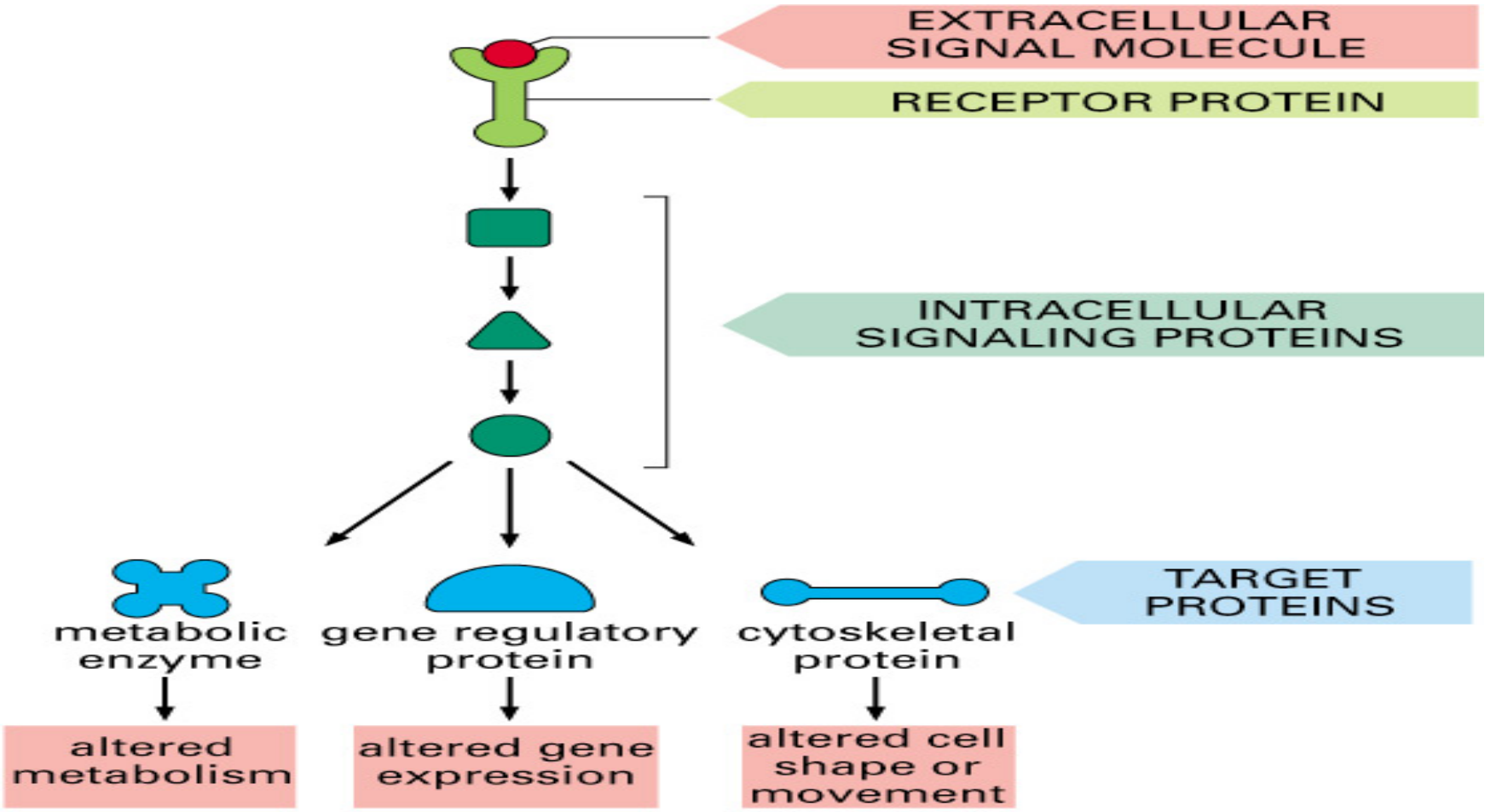


Generalized Signal Transduction Pathway




E1
E2
E3
E4
S
A
B
C
P
Effector
Receptor
Hormone

Simple Intracellular & Extracelluler Signaling



Receptor

Receptor: *specific membrane protein*, dapat mengenal dan berikatan dengan *corresponding ligand molecules*, aktiv, dan *transduce signal* ke *next signaling molecules:*

A. Membran

B. Intra Sel

Glycoprotein atau Lipoprotein

Hormon - Receptor

- highly specificity
- highly affinity
- saturation
- reversible binding
- special function model

Pengaturan receptor

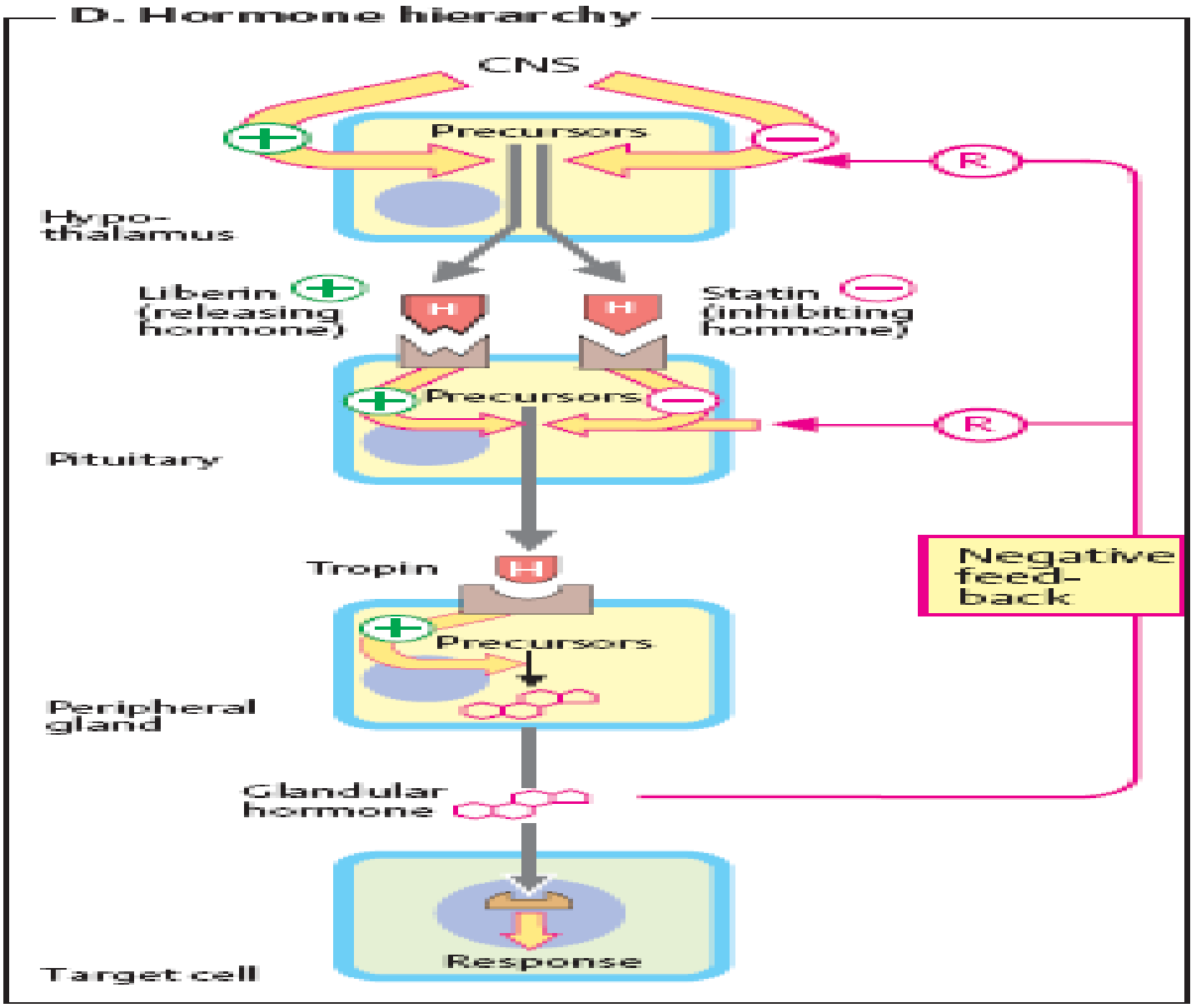
- Phosphorylation atau dephosphorylation dari Receptor
- Phospholipid membran
- Enzyme catalyzed hydrolysis
- G protein

Fungsi receptor

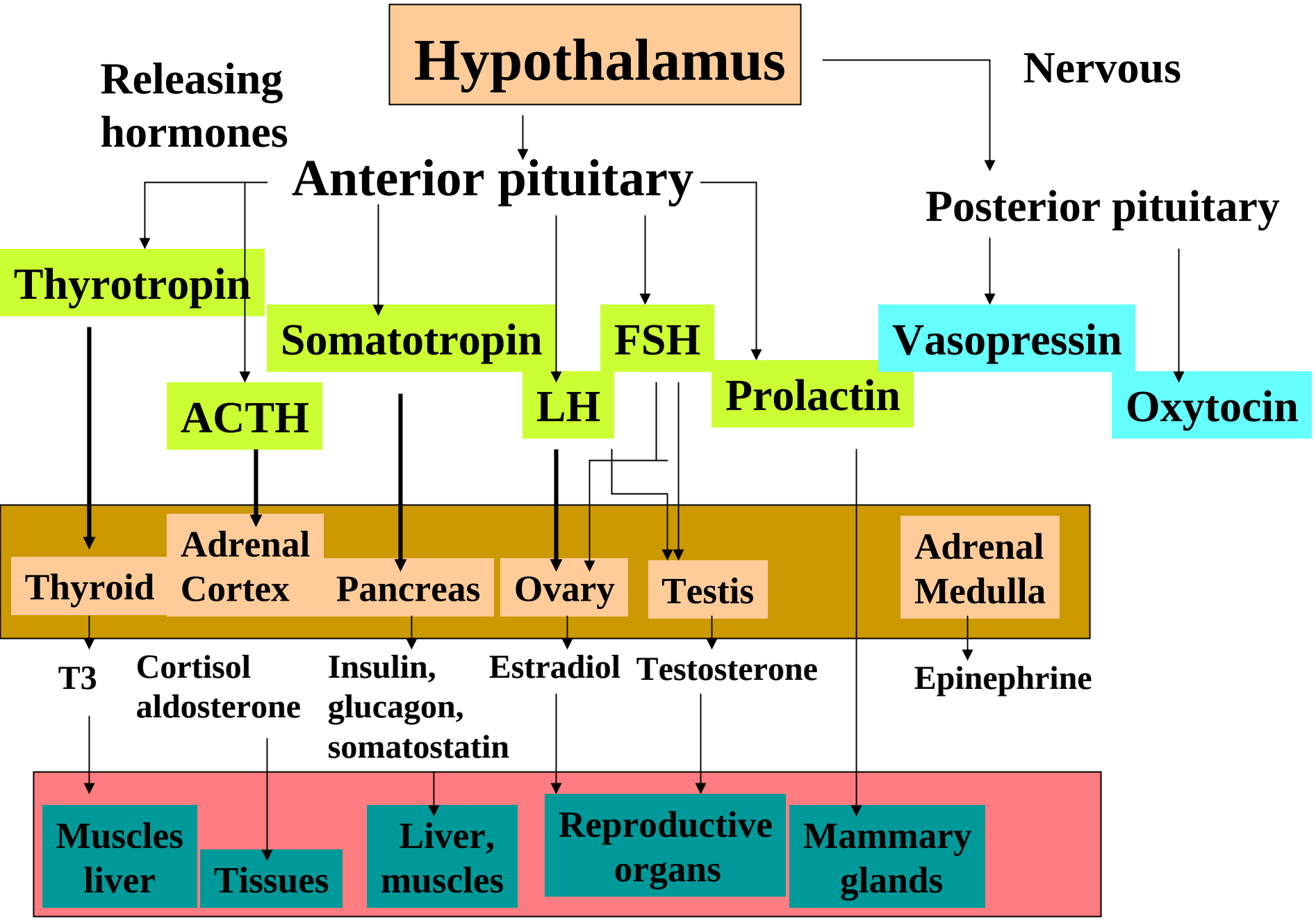
(1) Recognize the special ligand

(2) Binding to special ligand

(3) Signal transduction ⟶ biological effect



Koolman, Color Atlas of Biochemistry, 2nd edition © 2005 Thieme

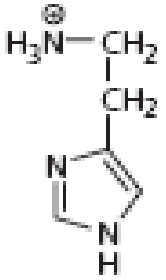
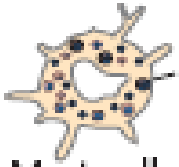
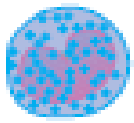
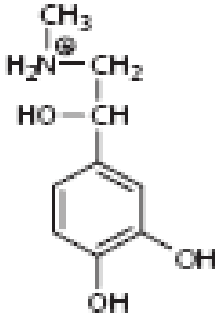
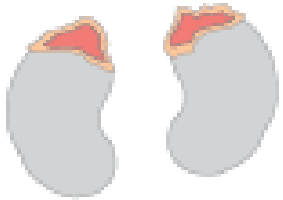
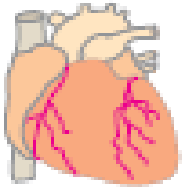
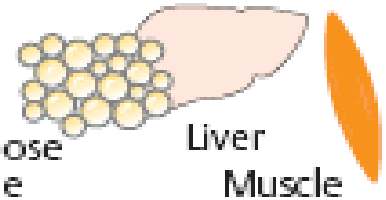

Hypothalamus
Releasing hormones
Nervous
Anterior pituitary
Posterior pituitary
Thyrotropin
Somatotropin
FSH
Vasopressin
ACTH
LH
Prolactin
Oxytocin
Thyroid
Adrenal Cortex
Pancreas
Ovary
Testis
Adrenal Medulla
T3
Cortisol aldosterone
Insulin, glucagon, somatostatin
Estradiol
Testosterone
Epinephrine
Muscles liver
Tissues
Liver, muscles
Reproductive organs
Mammary glands

Struktur Kimia Hormon

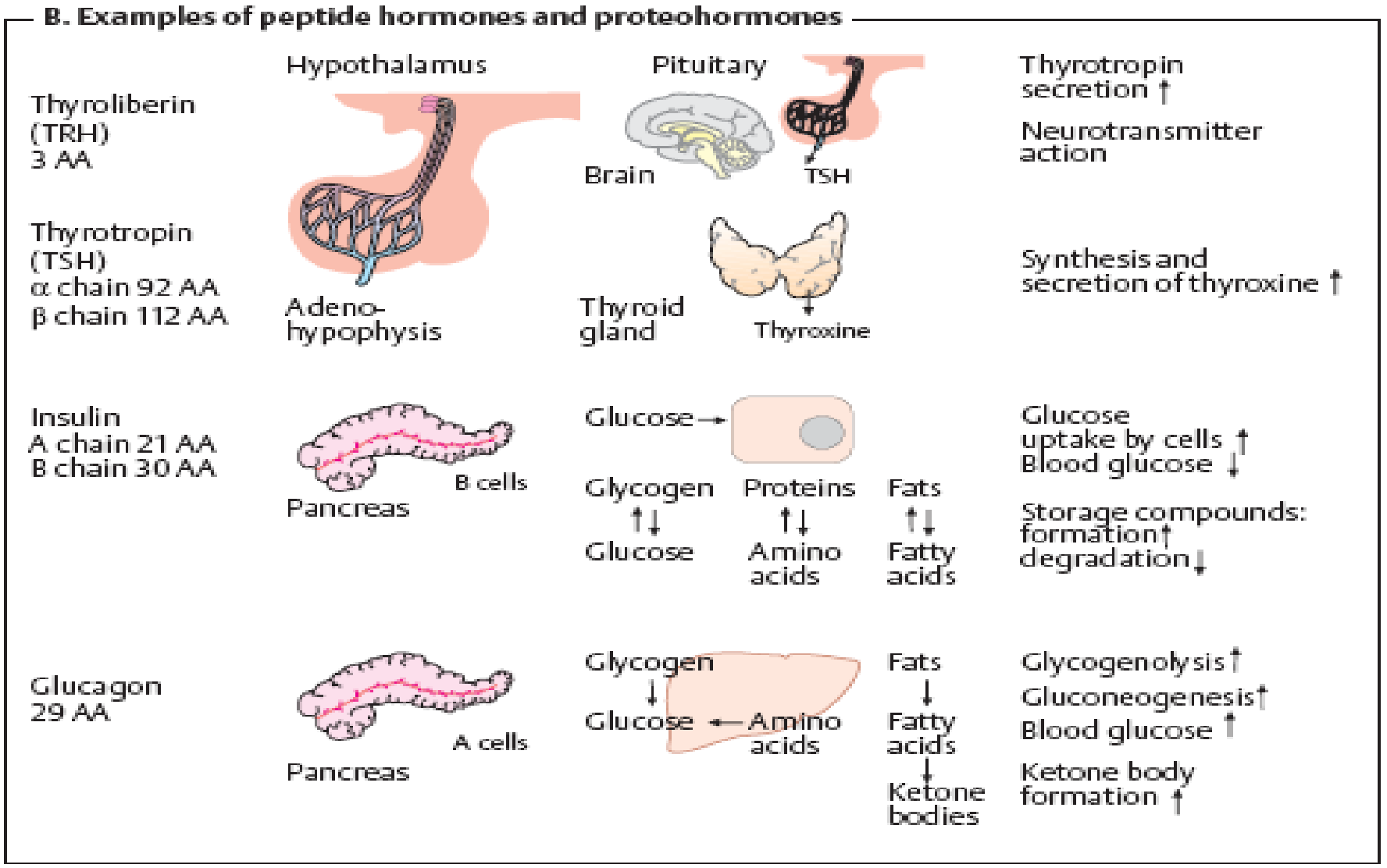
1. Derived from amino acids (Hydrophilic)	
Amino acid derivatives	thyroxine Histamine, serotonin, melatonin, and the catecholamines, dopa, dopamine, norepinephrine, and epinephrine are known as “biogenic amines.”
Tripeptides	TRH
Small peptides	VP (ADH), somatostatin
Intermediate-size peptides	insulin, parathyroid hormone
Complex polypeptides and glycoproteins	gonadotropins, TSH

A. Signaling substances derived from amino acids

A. Signaling substances derived from amino acids

Hormone	Sites of formation	Sites of action	Actions
 Histamine	 Mast cell  Basophilic granulocyte	Lungs Stomach	Width of bronchi ↓ Capillaries: width ↑ permeability ↑ Gastric acid secretion by parietal cells ↑
 Epinephrine	Adrenal glands (medulla) 	Heart   Adipose tissue, Liver, Muscle	Cardiac output ↑ Width of blood vessels ↓ Blood pressure ↑ Metabolism: Glycogenolysis ↑ Blood glucose ↑ Lipolysis ↑

B. peptide hormones dan proteohormones

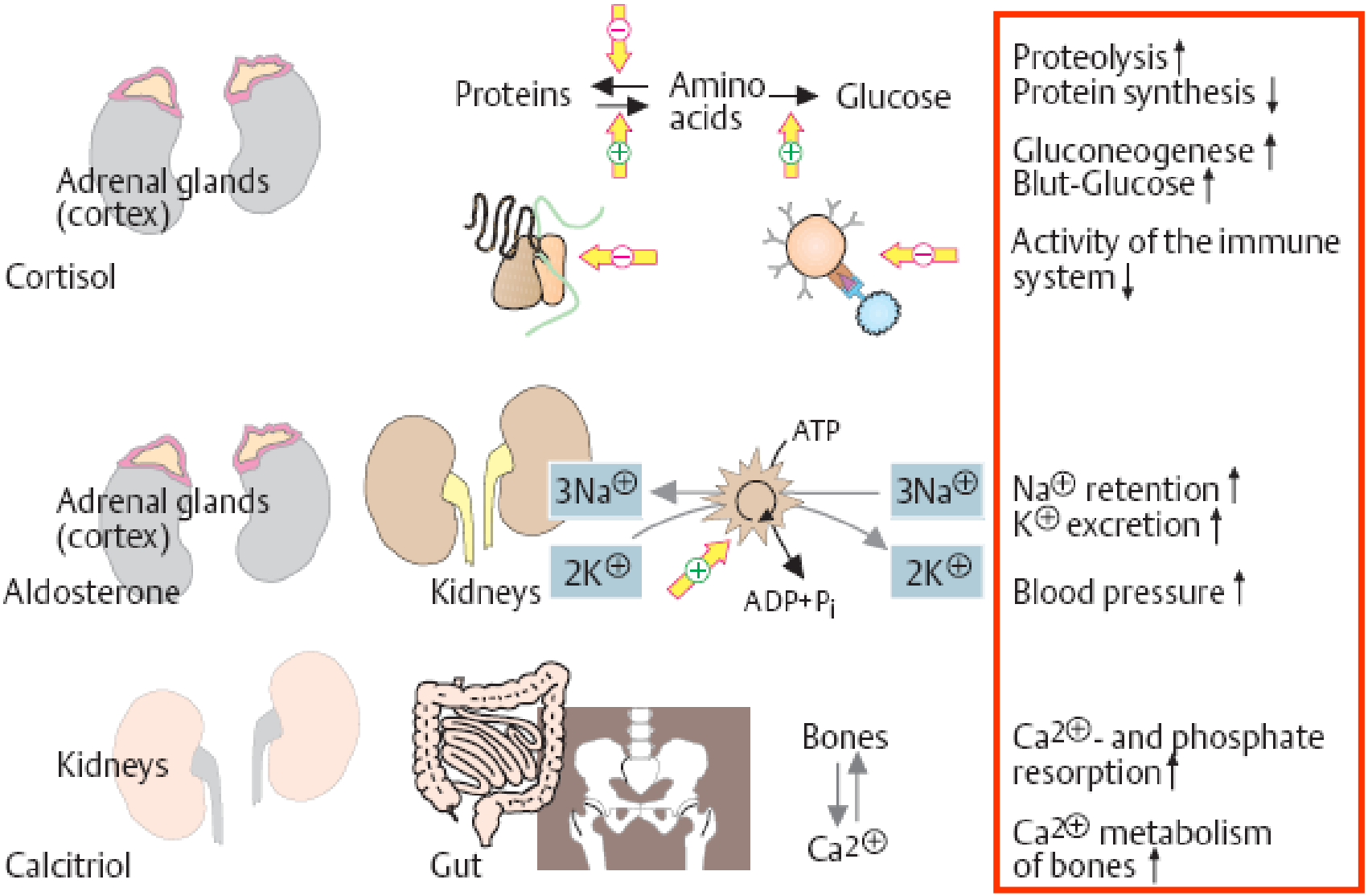


2. lipid precursors	
Cholesterol derivatives	cortisol, testosterone, vitamin D , estradiol
Fatty acid derivatives	prostaglandins, leukotrienes
Phospholipid derivative	platelet-activating factor

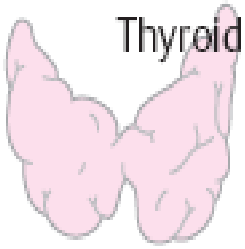
Lipophilic hormones

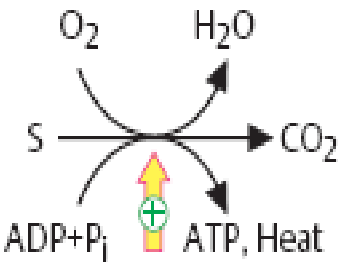
Hormone	Site of formation	Sites of action	Actions
Progesterone	Ovaries	Uterus	Prepares uterus for pregnancy Promotes implantation of fertilized egg	Maintenance of pregnancy ↑ Development of mammary glands ↑
Estradiol	Ovaries	Uterus and other organs	Stimulates proliferation of endometrium	Menstrual cycle Bone development ↑ Development of secondary female sex characteristics e.g., fat distribution, breasts, body hair ↑
Testosterone	Testes		Causes: Sexual differentiation to male phenotype Formation of ejaculate Spermatogenesis	Development of secondary male sex characteristics e.g., skeleton, muscles, body hair ↑ Protein synthesis ↑

Hormone	Site of formation	Sites of action	Actions
Cortisol	Adrenal glands (cortex)	Proteins, Amino acids, Glucose; Immune system	Proteolysis ↑ Protein synthesis ↓ Gluconeogenese ↑ Blut-Glucose ↑ Activity of the immune system ↓
Aldosterone	Adrenal glands (cortex)	Kidneys	$Na^{\oplus}$ retention ↑ $K^{\oplus}$ excretion ↑ Blood pressure ↑
Calcitriol	Kidneys	Gut, Bones	$Ca^{2\oplus}$- and phosphate resorption ↑ $Ca^{2\oplus}$ metabolism of bones ↑

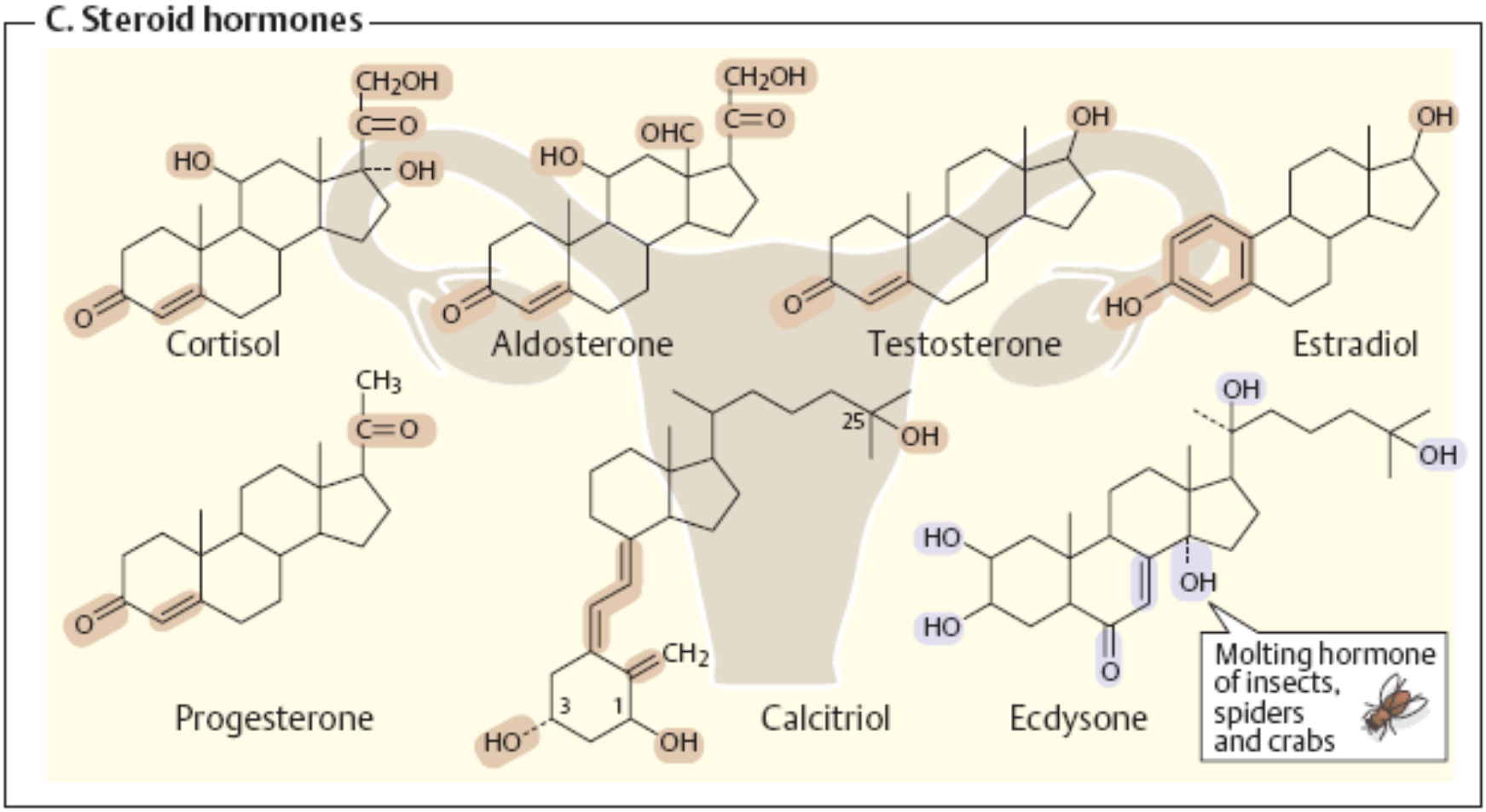


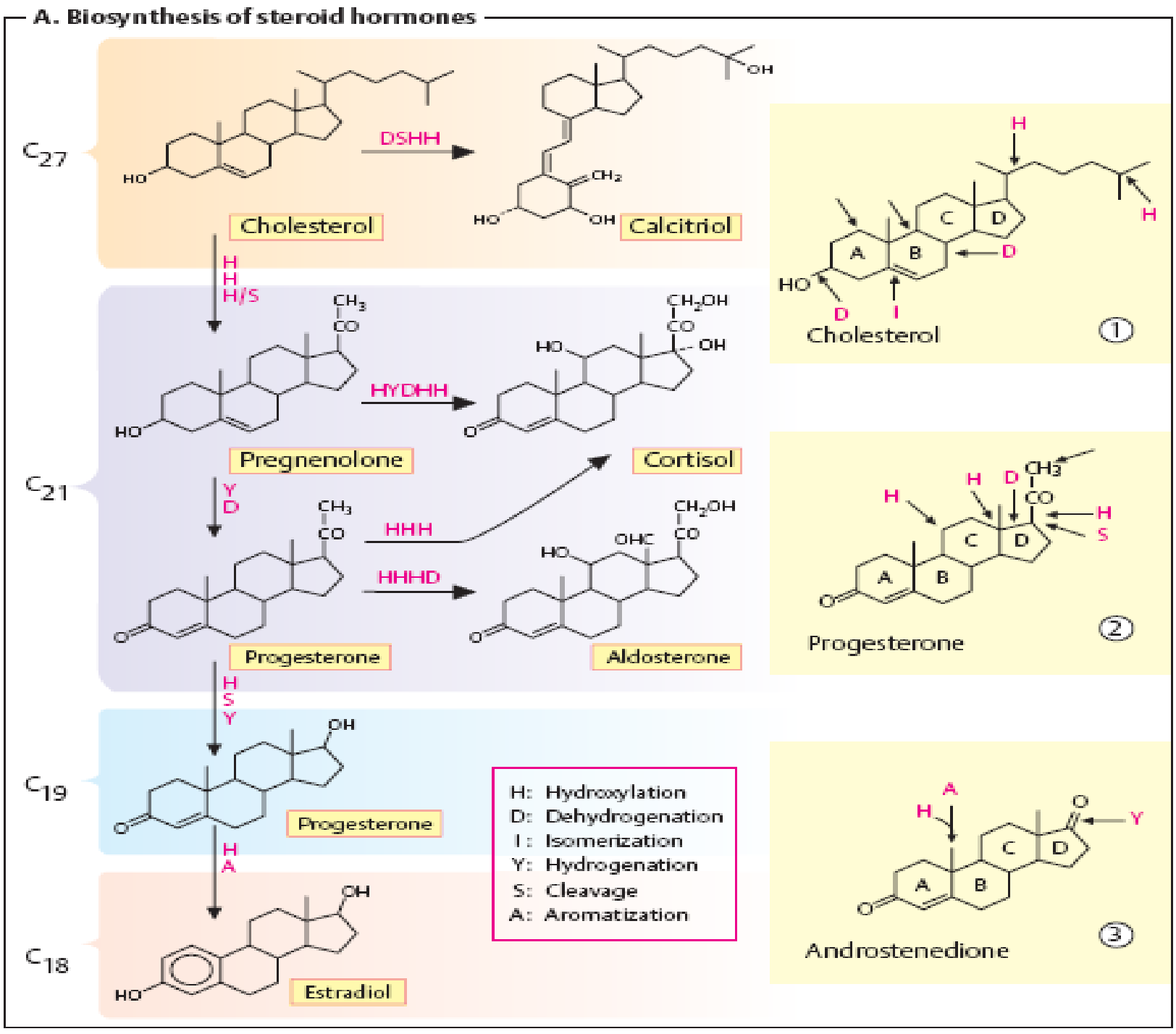
Hormone	Site of formation	Sites of action	Actions
Thyroxine	Thyroid gland	Embryo Intermediary metabolism	Fetal development, growth, and maturation ↑ Basal metabolic rate ↑ Heat generation ↑ O_2 consumption ↑



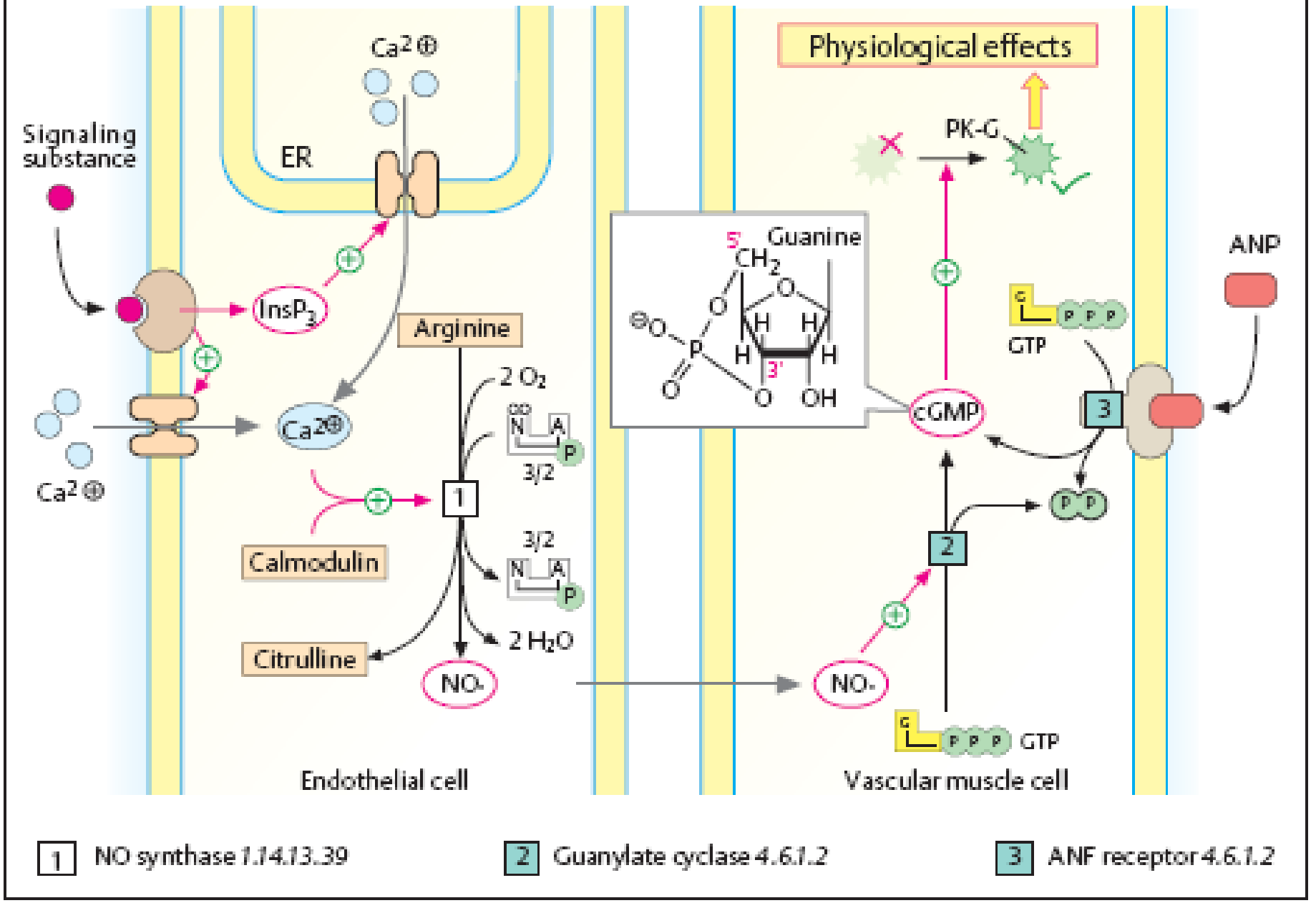


Steroid hormones




A. Biosynthesis of steroid hormones
C27
C21
C19
C18
DSHH
Cholesterol
Calcitriol
H
H
H/S
HYDHH
Pregnenolone
Cortisol
Y
D
HHH
HHHD
Progesterone
Aldosterone
H
S
Y
Progesterone
H
A
Estradiol
H: Hydroxylation
D: Dehydrogenation
I : Isomerization
Y: Hydrogenation
S: Cleavage
A: Aromatization
Cholesterol
1
Progesterone
2
Androstenedione
3

3. Derived from other chemicals (mediator)	
Purines	adenosine
Gases	nitric oxide


B. Nitrogen monoxide (NO) as a mediator
Physiological effects
PK-G
Signaling substance
ER
Ca2⊕
InsP3
Arginine
2 O2
Ca2⊕
Calmodulin
3/2
3/2
2 H2O
Citrulline
NO·
Guanine
5'
CH2
3'
OH
cGMP
GTP
ANP
3
2
1
NO·
GTP
Endothelial cell
Vascular muscle cell
1 NO synthase 1.14.13.39
2 Guanylate cyclase 4.6.1.2
3 ANF receptor 4.6.1.2

Hormon Pituitary - hypothalamic

S.N.	*Pituitary Hormones*	*Hypothalamic Releasing Factors**
1.	Thyrotropin, TSH	Thyrotropin-releasing factor, TRF
2.	Corticotropin, ACTH	Corticotropin-releasing factor, CRF
3.	Follicle-stimulating hormone, FSH	Follicle-stimulating hormone-releasing factor, FSH-RF
4.	Luteinizing hormone, LH	Luteinizing hormone-releasing factor, LH-RF
5	Prolactin, PL	Prolactin-releasing factor, PRF
6.	Growth hormone, GH	Growth hormone-releasing factor, GH-RF
7.	Melanocyte-stimulating hormone, MSH	Melanocyte-stimulating hormone-releasing factor, MRF

Klasifikasi: Mekanisme Kerja

- ***Hormones : bind to intracellular receptors***
- ***Hormones : bind to cell surface receptors***
  - **second messenger : cAMP**
  - **second messenger : cGMP**
- **second messenger : calcium atau phosphatidylinositols (or both)**
- **second messenger : a kinase atau phosphatase cascade**

I. Hormones : intracellular receptors

- Androgens
- Calcitriol (1,25[OH]2-D3)
- Estrogens
- Glucocorticoids
- Mineralocorticoids
- Progestins
- Retinoic acid
- Thyroid hormones (T3 and T4)

II. Hormones : cell surface receptors

A. The second messenger is cAMP:

- α2-Adrenergic catecholamines
- β-Adrenergic catecholamines
- Adrenocorticotropic hormone
- Antidiuretic hormone
- Calcitonin
- Chorionic gonadotropin, human
- Corticotropin-releasing hormone
- Follicle-stimulating hormone
- Glucagon
- Lipotropin
- Luteinizing hormone
- Melanocyte-stimulating hormone
- Parathyroid hormone
- Somatostatin
- Thyroid-stimulating hormone

B. The second messenger is cGMP:

- Atrial natriuretic factor
- Nitric oxide

II. Hormones …..

C. The second messenger is calcium or phosphatidylinositols (or both):

- Acetylcholine (muscarinic)
- α1-Adrenergic catecholamines
- Angiotensin II
- Antidiuretic hormone (vasopressin)
- Cholecystokinin
- Gastrin
- Gonadotropin-releasing hormone
- Oxytocin
- Platelet-derived growth factor
- Substance P
- Thyrotropin-releasing hormone

D. The second messenger is a kinase or phosphatase cascade:

- Chorionic somatomammotropin
- Epidermal growth factor
- Erythropoietin
- Fibroblast growth factor
- Growth hormone
- Insulin
- Insulin-like growth factors I and II
- Nerve growth factor
- Platelet-derived growth factor
- Prolactin

Referensi

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