Skin as an endocrine organ

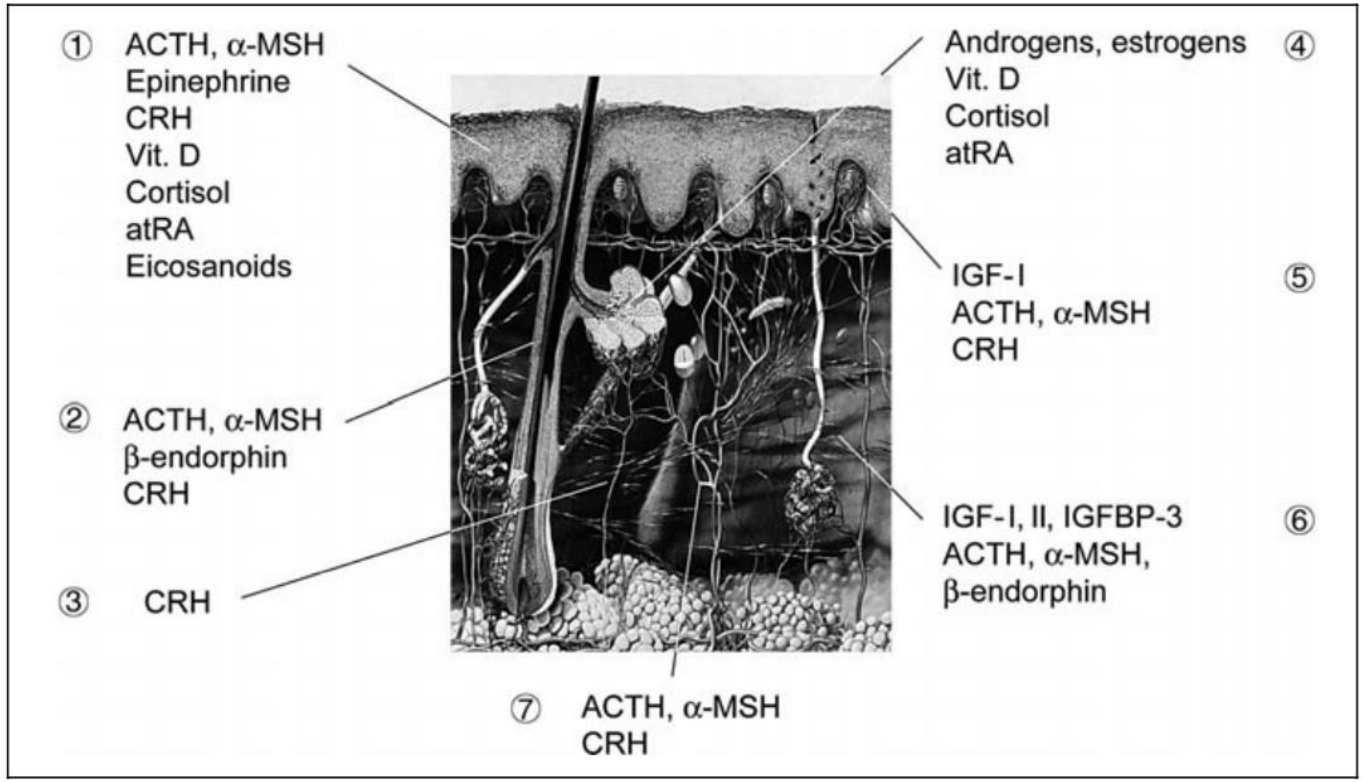
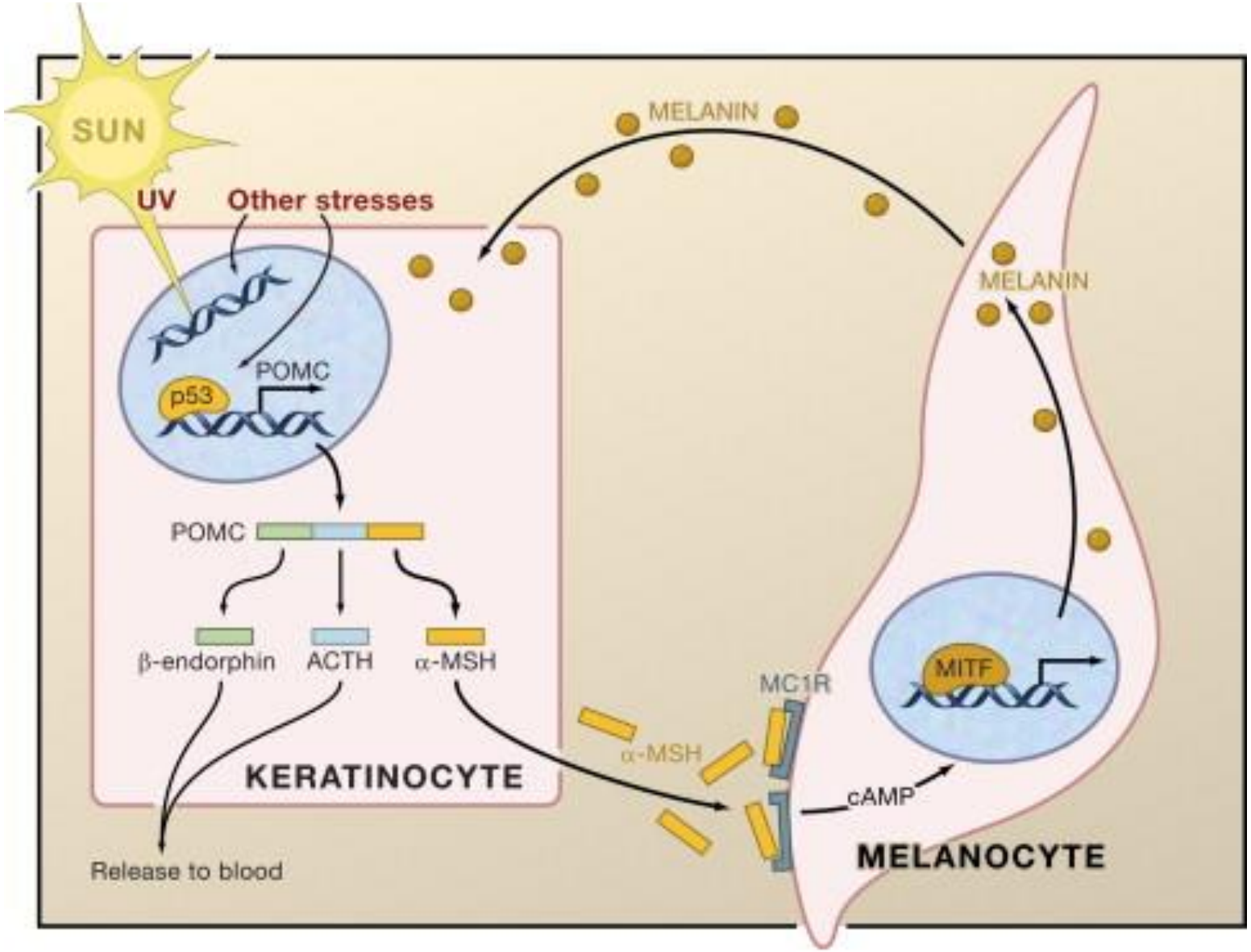


Fig. 2. Synthesis of hormones in human skin. ① Keratinocytes; ② hair follicles; ③ cutaneous nerves; ④ sebaceous glands; ⑤ melanocytes; ⑥ fibroblasts; ⑦ endothelial cells. ACTH = Adrenocorticotropic hormone; α-MSH = α-melanocyte stimulating hormone; CRH = corticotropin releasing hormone; Vit. D = vitamin D; atRA = all-*trans* retinoic acid; IGF-I = insulin-like growth factor I; IGFBP-3 = insulin-like growth factor binding protein-3.

CRH – stimulation of sebaceous lipogenesis, inhibition of proliferation of keratinocytes; ACTH, alfa-MSH – activity of melanocytes, pigmentation, stimulation of proliferation of keratinocytes, synthesis of collagenase and MMP enzymes; GH, IGF-1 – homeostatic regulation of cell proliferation and differentiation; androgenes – stimulation of proliferation of sebocytes and dermal papilla cells; estrogenes – regulation of cell proliferation, effect on scalp hair growth period; glucocorticoids – hair growth, sebocyte proliferation, skin atrophy; vitamin D – conversions of estrogenes, growth-promoting activity on keratinocytes.

Skin and CRH-ACTH axis



Cardiovascular endocrinology

- Myocardium
- Endothelium

Vasoconstricting	Vasodilating
Sodium-retention effect	Natriuretic
Growth stimulation	Growth inhibition
Proatherogenic	Antiatherogenic

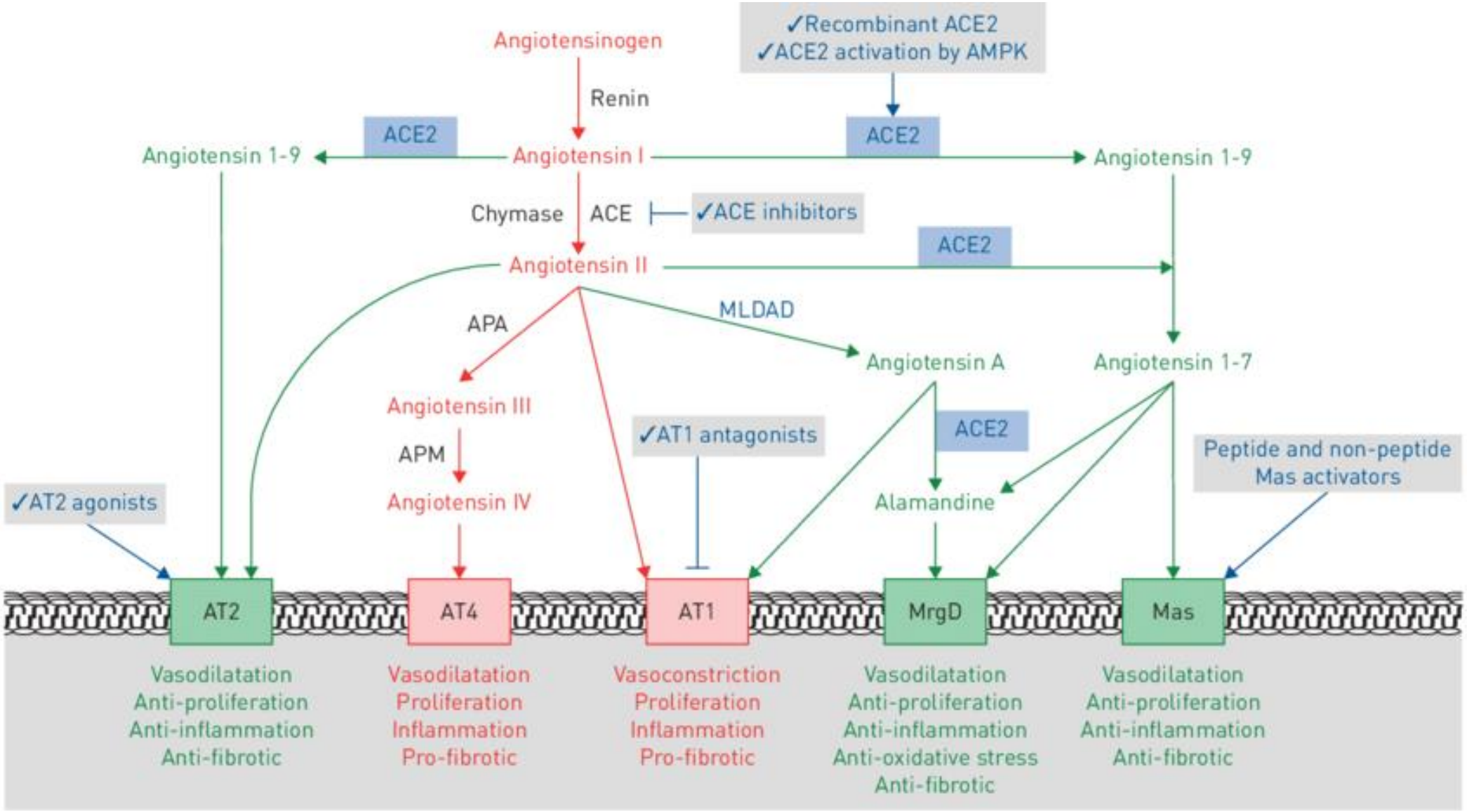
Endothelial dysfunction is derminated by an imbalance between vasoconstrictor and vasodilator factors.

RAAS system

- Blood pressure, volume of circulationg fluids
- Circulating versus local components of RAAS
- Intermediary RAAS (angiotensinogen, ACE, AT1, AT2, ATR1, ATR2)

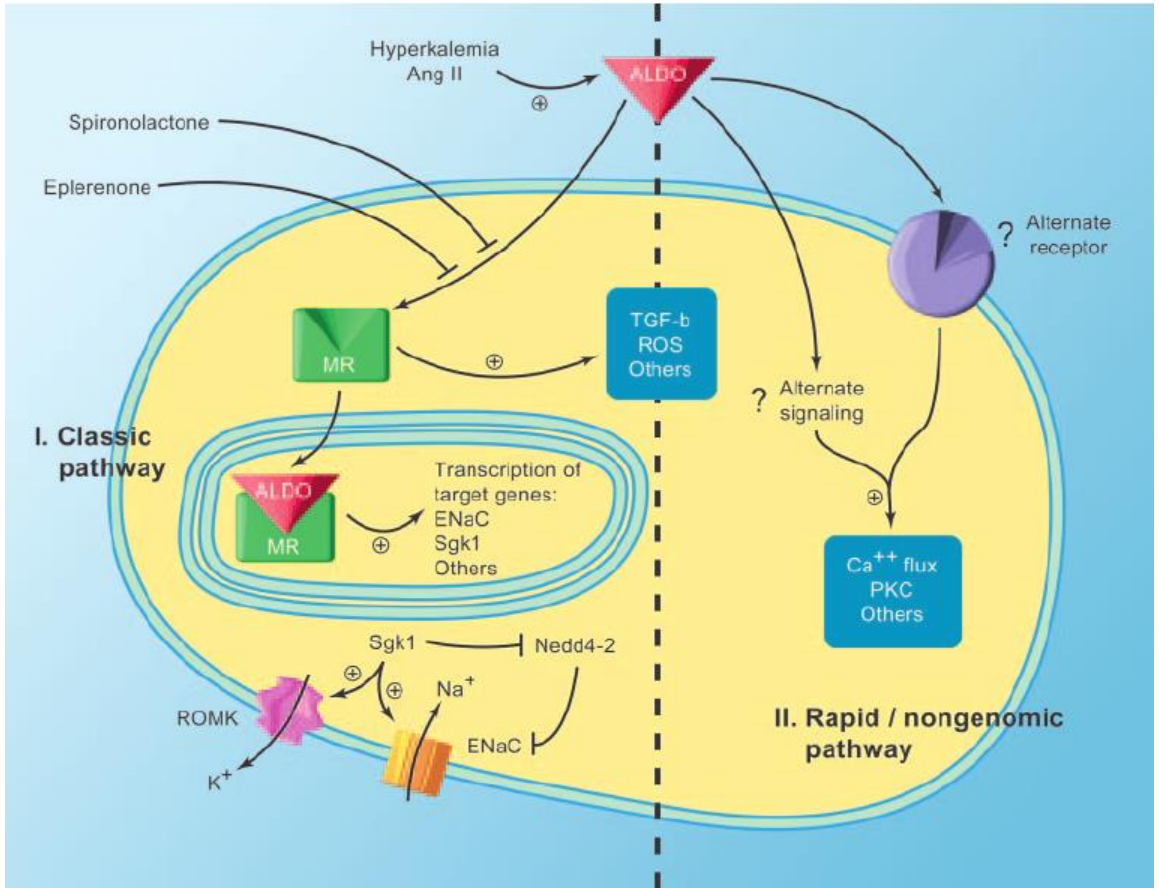
AT1R	AT2R
All tissues	Prenatally in all tissues
Vasoconstriction, positive inotropic ef.	Embryonal differentiation
Secretion of aldosterone, catecholamines, ADH	Physiological development of the cardiovascular system
Inhibition of renin (negative feedback)	Change in receptor density and distribution is dependent on age, sex and pregnancy
Reabsorption of sodium	In repairing tissues after damage
Regulation of the feeling of thirst	
Proliferation, hypertrophy, remodelation	
Stimulation of fibroblasts - fibrosis	
Amplification of prooxidative and proinflammatory processes	

RAAS system

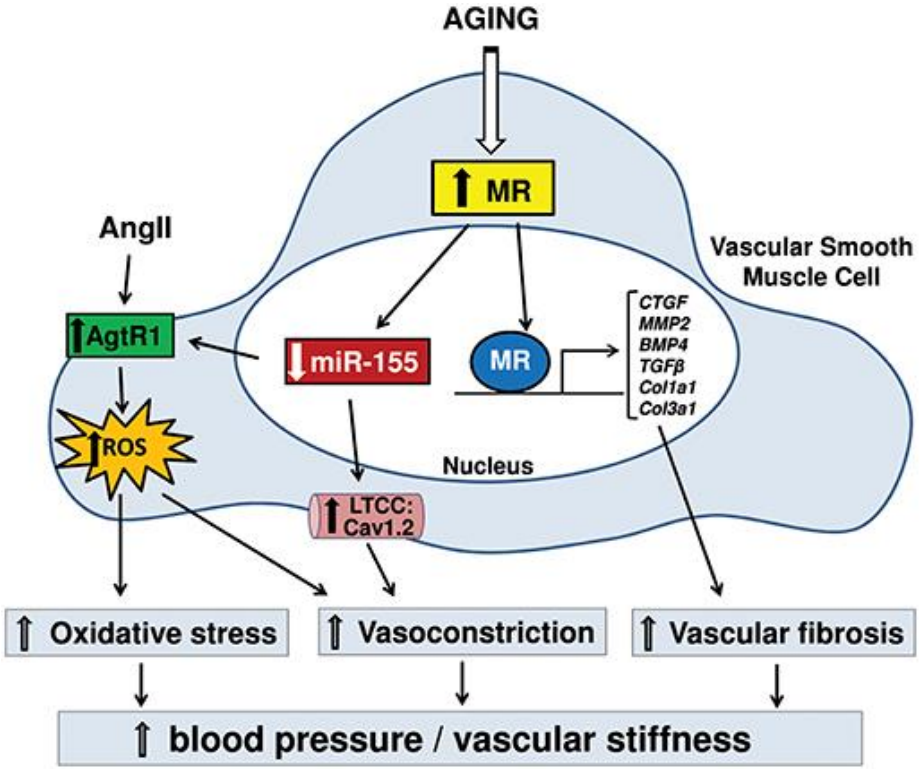

Angiotensinogen
✓Recombinant ACE2
✓ACE2 activation by AMPK
Renin
ACE2
ACE2
Angiotensin 1-9
Angiotensin I
Angiotensin 1-9
Chymase
ACE
✓ACE inhibitors
ACE2
Angiotensin II
APA
MLDAD
Angiotensin A
Angiotensin 1-7
Angiotensin III
✓AT1 antagonists
ACE2
APM
Peptide and non-peptide
Mas activators
✓AT2 agonists
Angiotensin IV
Alamandine
AT2
AT4
AT1
MrgD
Mas
Vasodilatation
Anti-proliferation
Anti-inflammation
Anti-fibrotic
Vasodilatation
Proliferation
Inflammation
Pro-fibrotic
Vasoconstriction
Proliferation
Inflammation
Pro-fibrotic
Vasodilatation
Anti-proliferation
Anti-inflammation
Anti-oxidative stress
Anti-fibrotic
Vasodilatation
Anti-proliferation
Anti-inflammation
Anti-fibrotic

Aldosterone

Renal effects

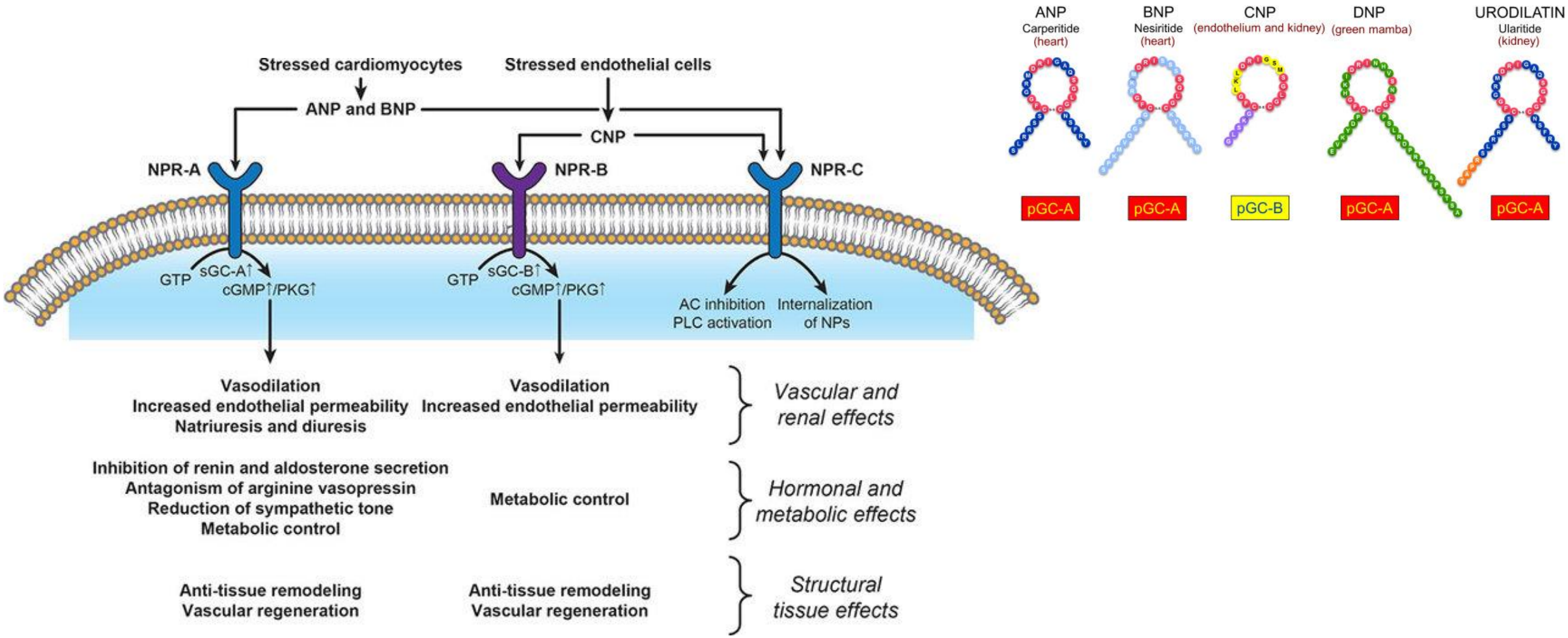


Extrarenal effects

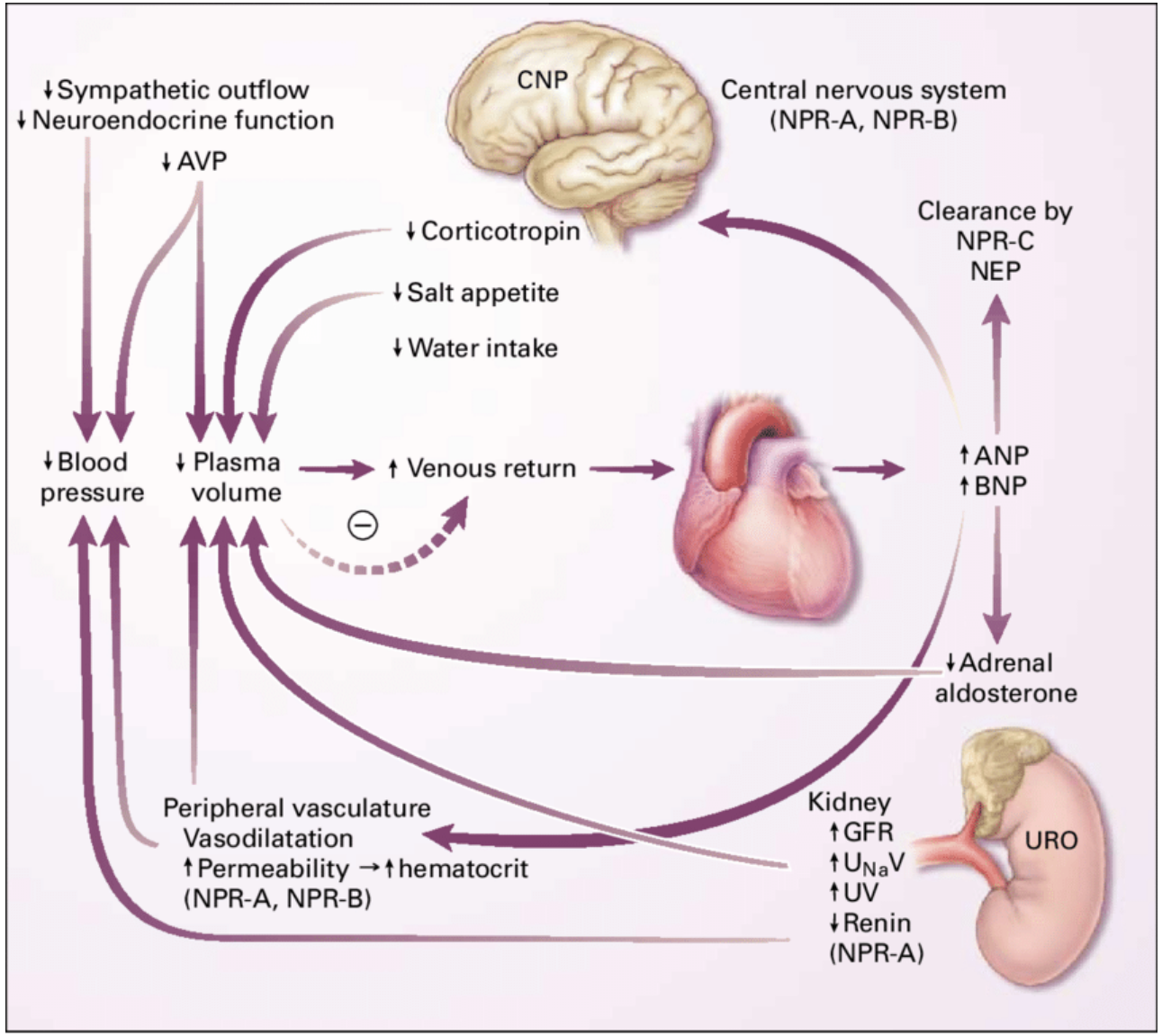


Increase of collagen synthesis, changes in rigidity of vessels, fibrotic changes, direct pro-arythmogenic effect (ion dysbalance, endothelial dysfunction, decrease of coronary perfusion, increase of sympathetic activity etc.)

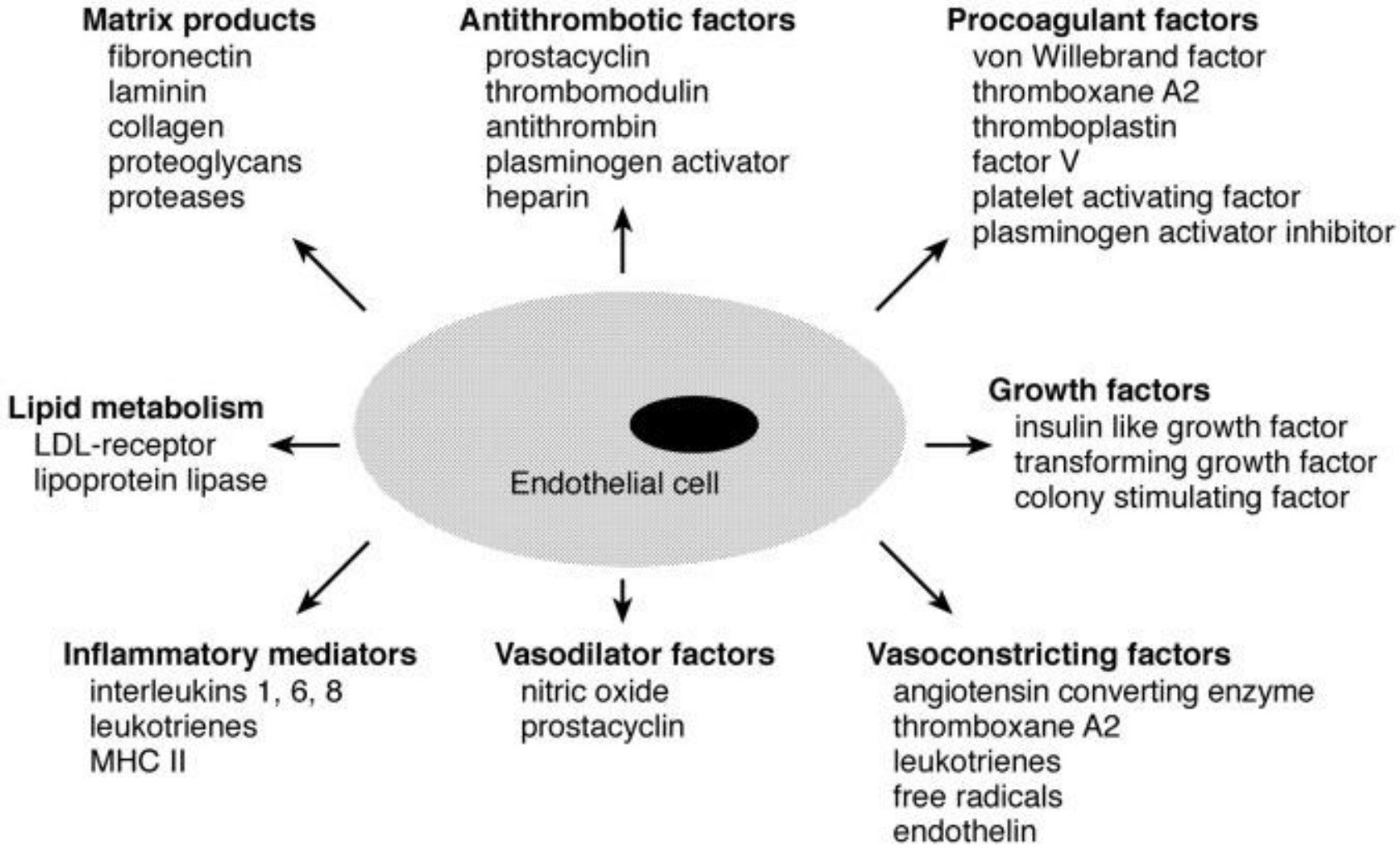
Natriuretic peptides – ANP, BNP, CNP



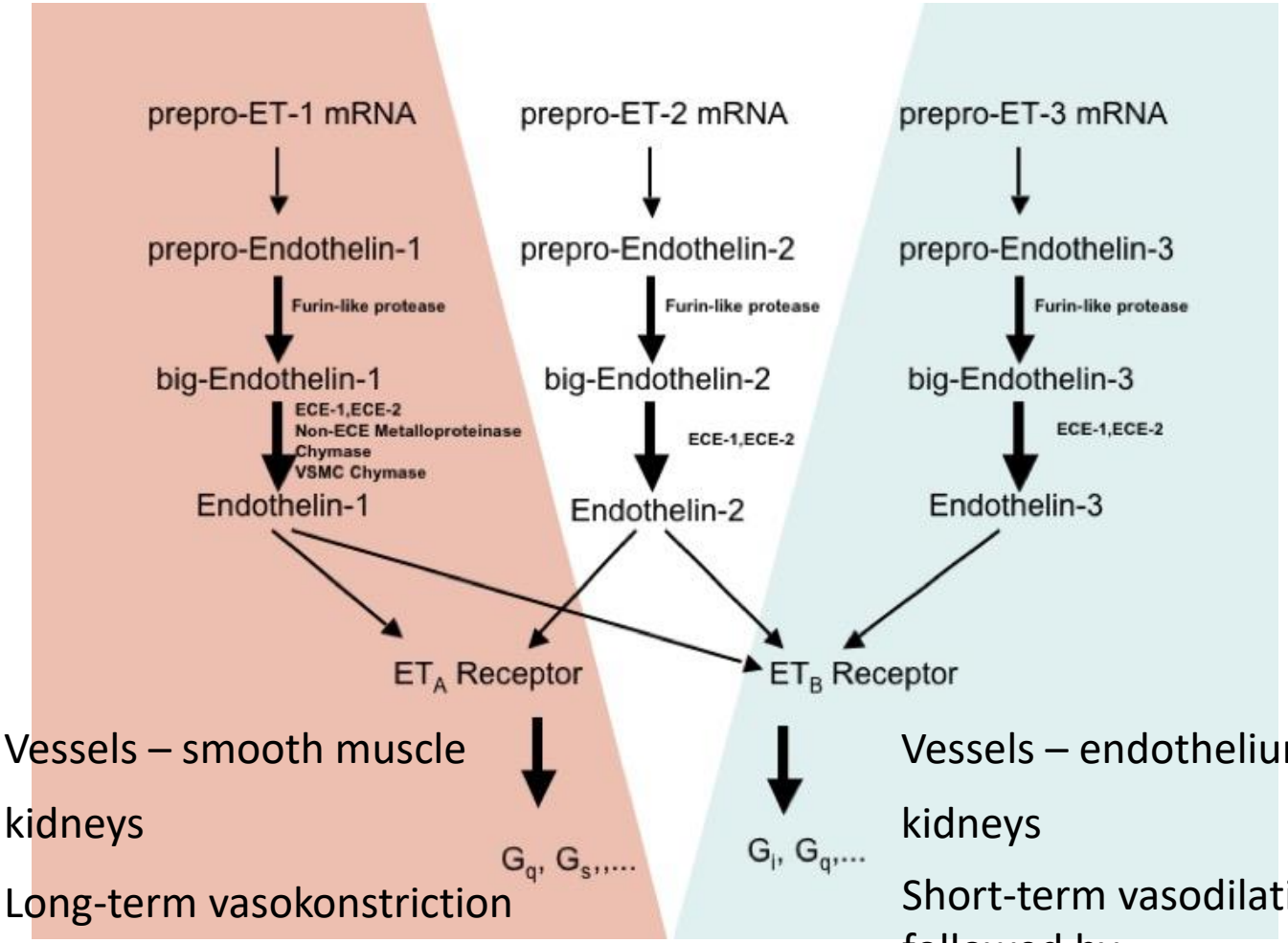
Natriuretic peptides – ANP, BNP, CNP



Endothelium physiology



Endothelins and their receptors



Vessels – smooth muscle

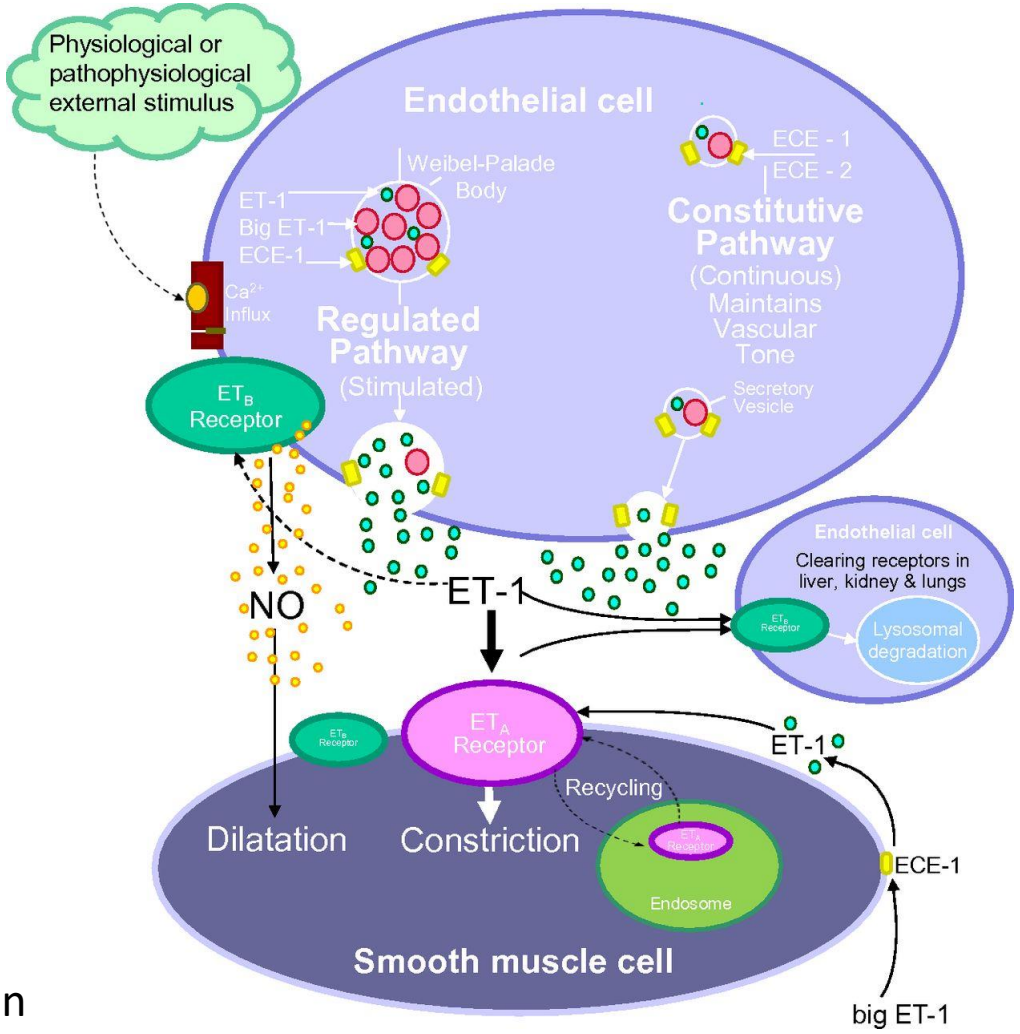
kidneys

Long-term vasokonstriction

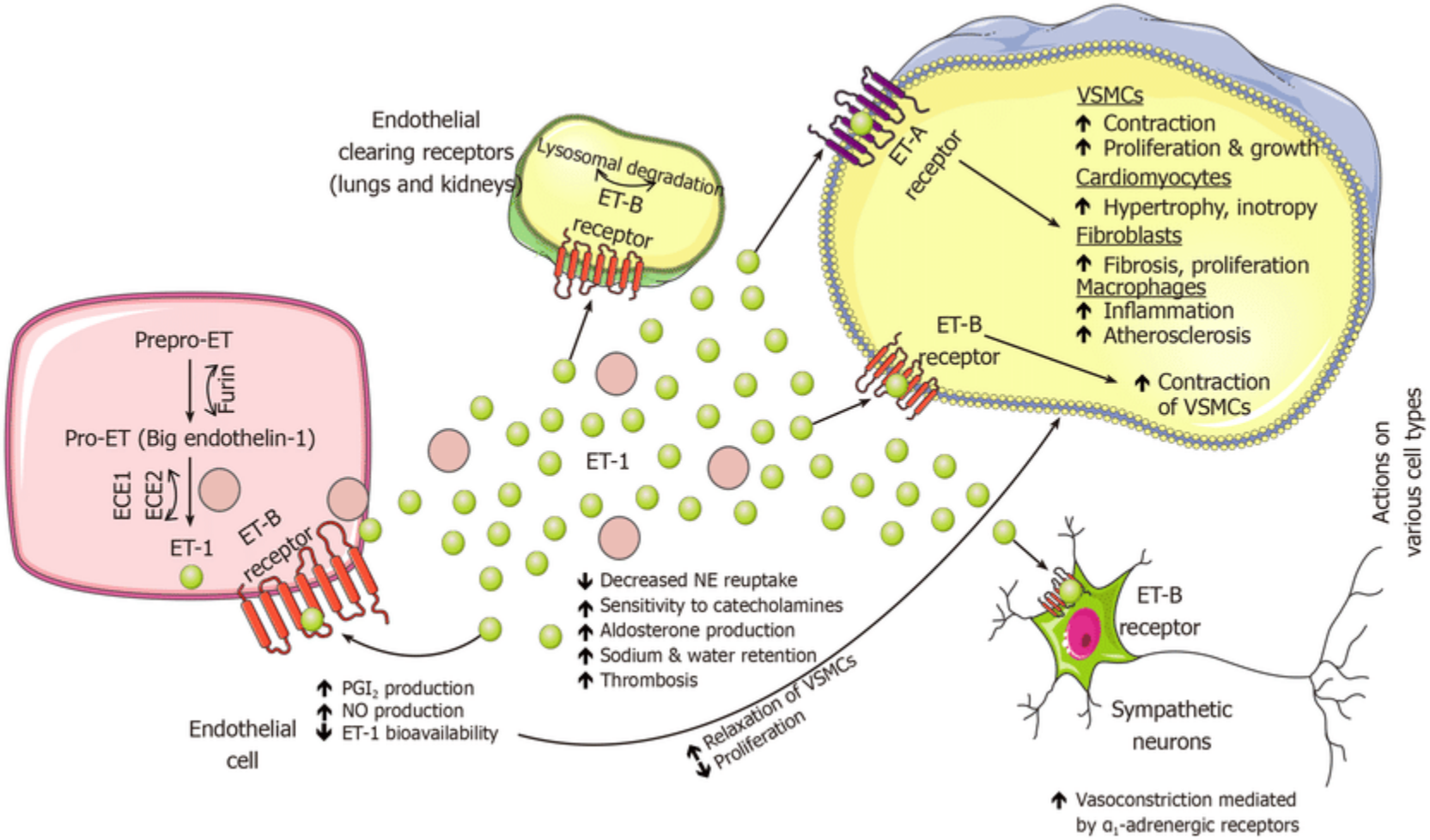
Vessels – endothelium

kidneys

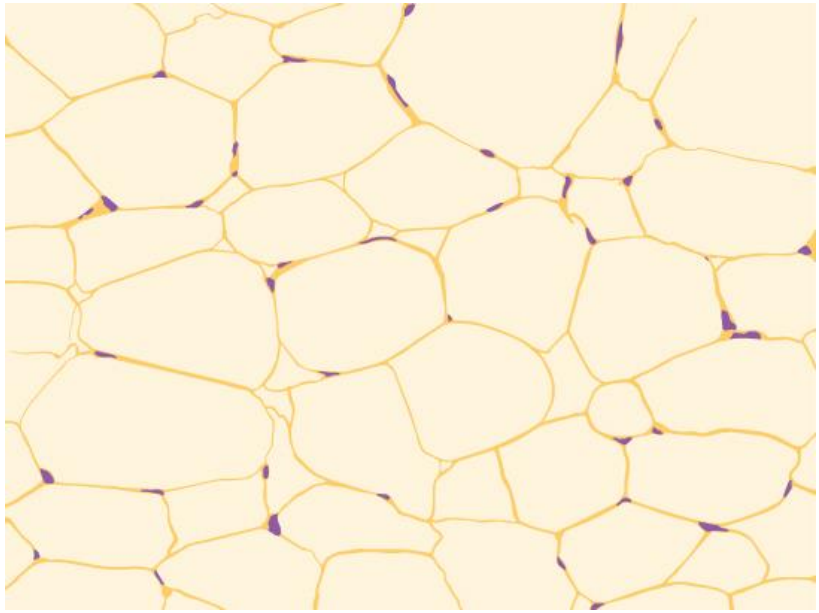
Short-term vasodilation followed by vasoconstriction



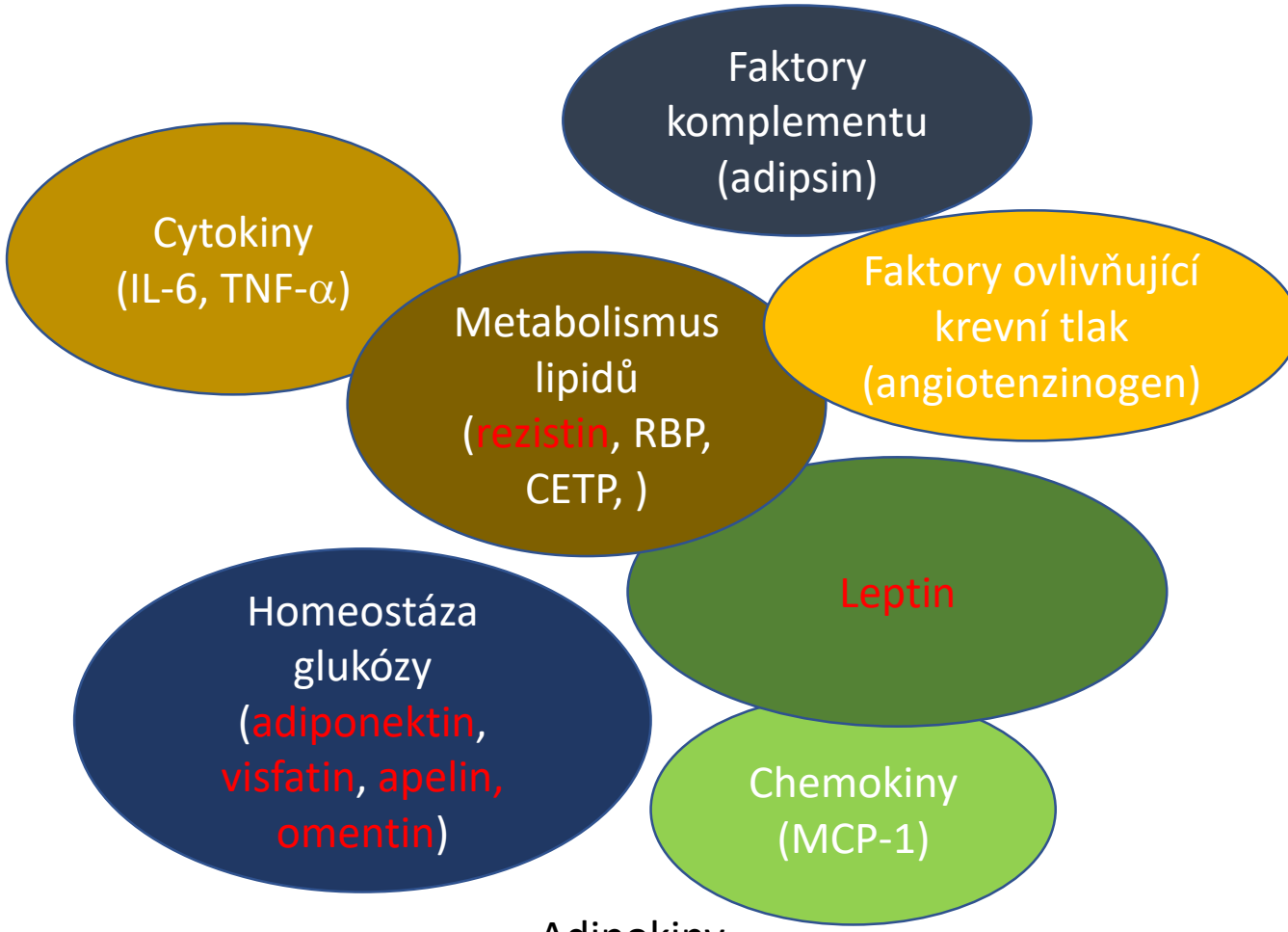
Endothelins and implication in physiology and patophysiology



Endocrine function of adipose tissue

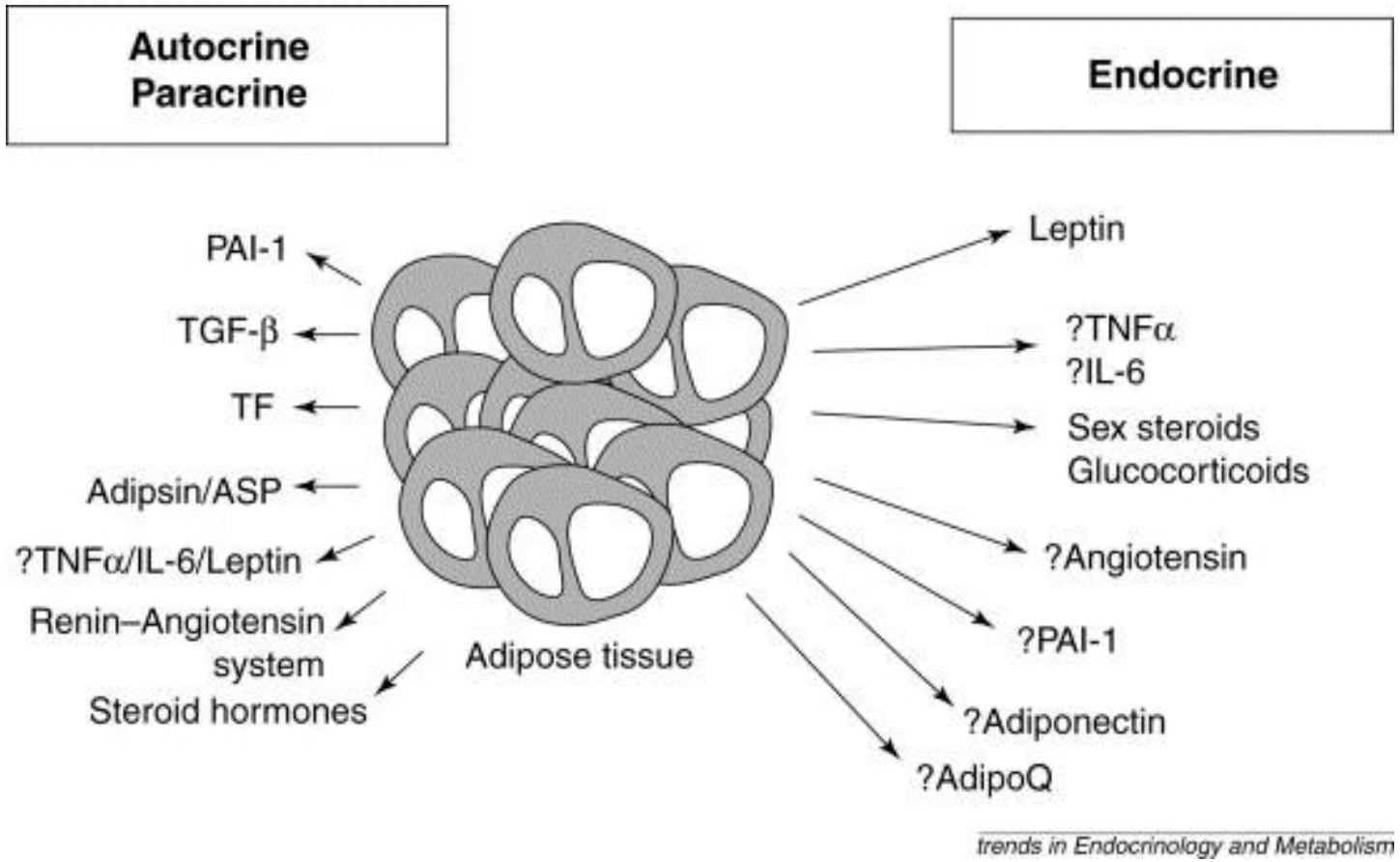


Tuková tkáň

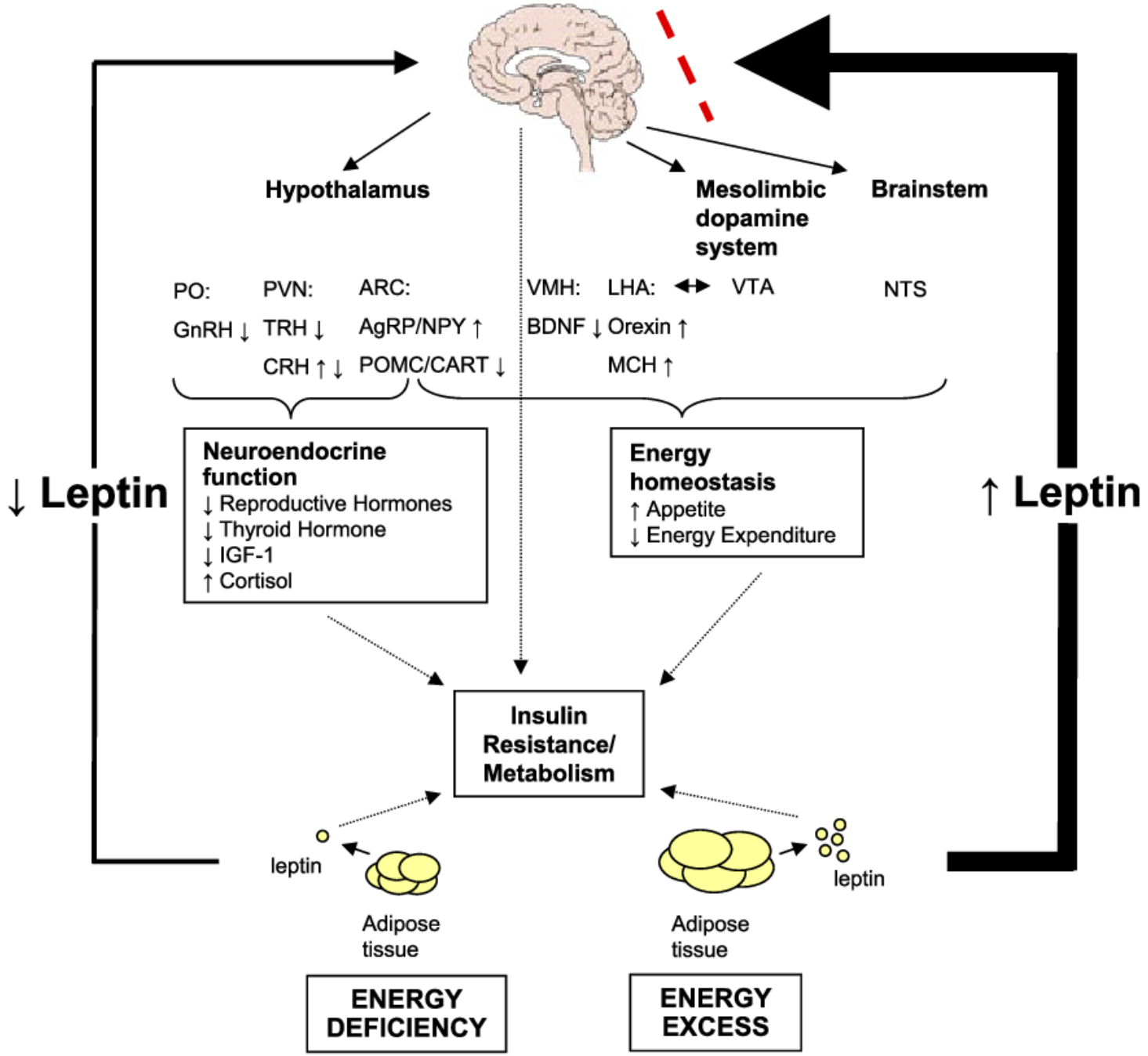


Adipokiny

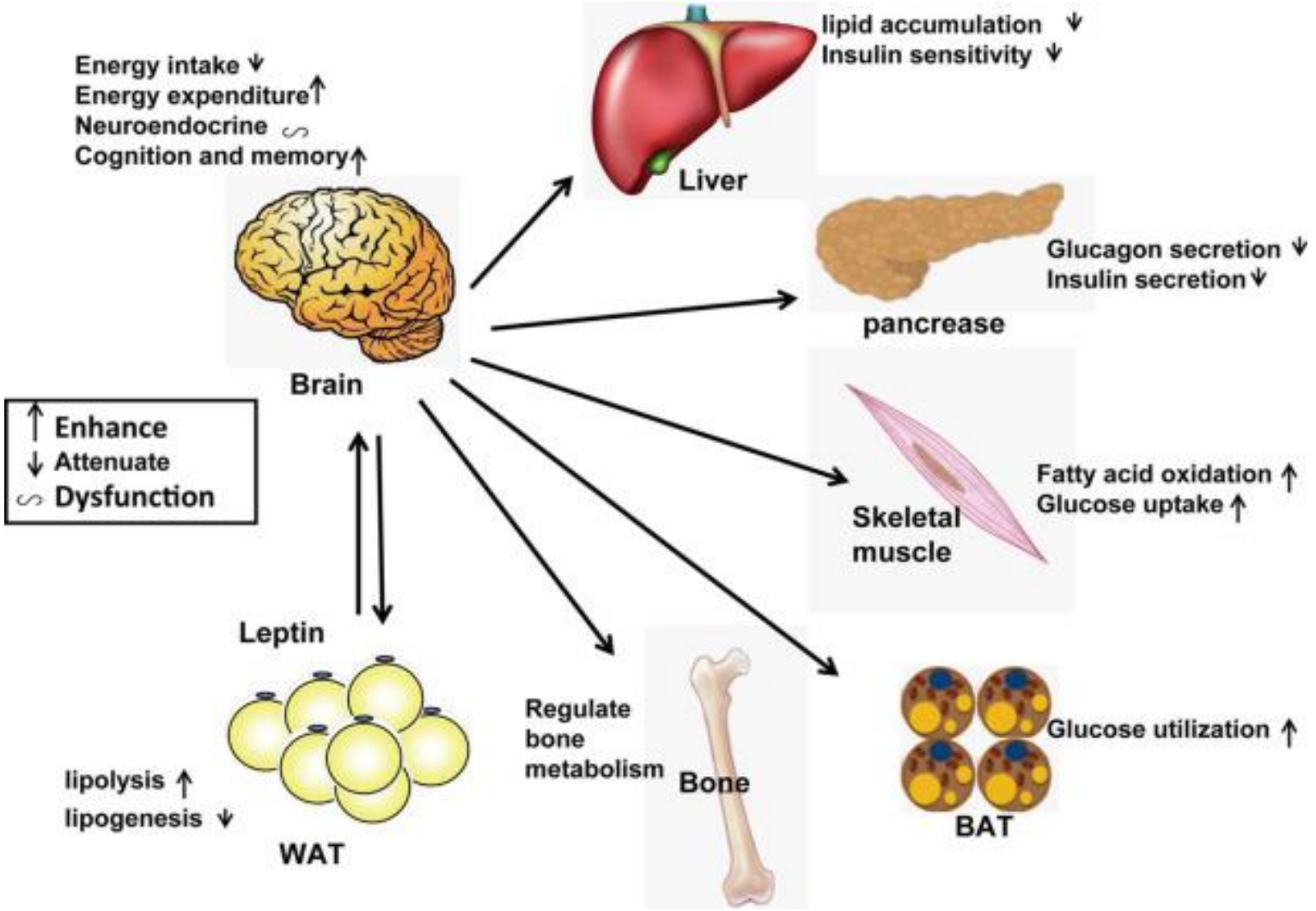
Endocrine function of adipose tissue



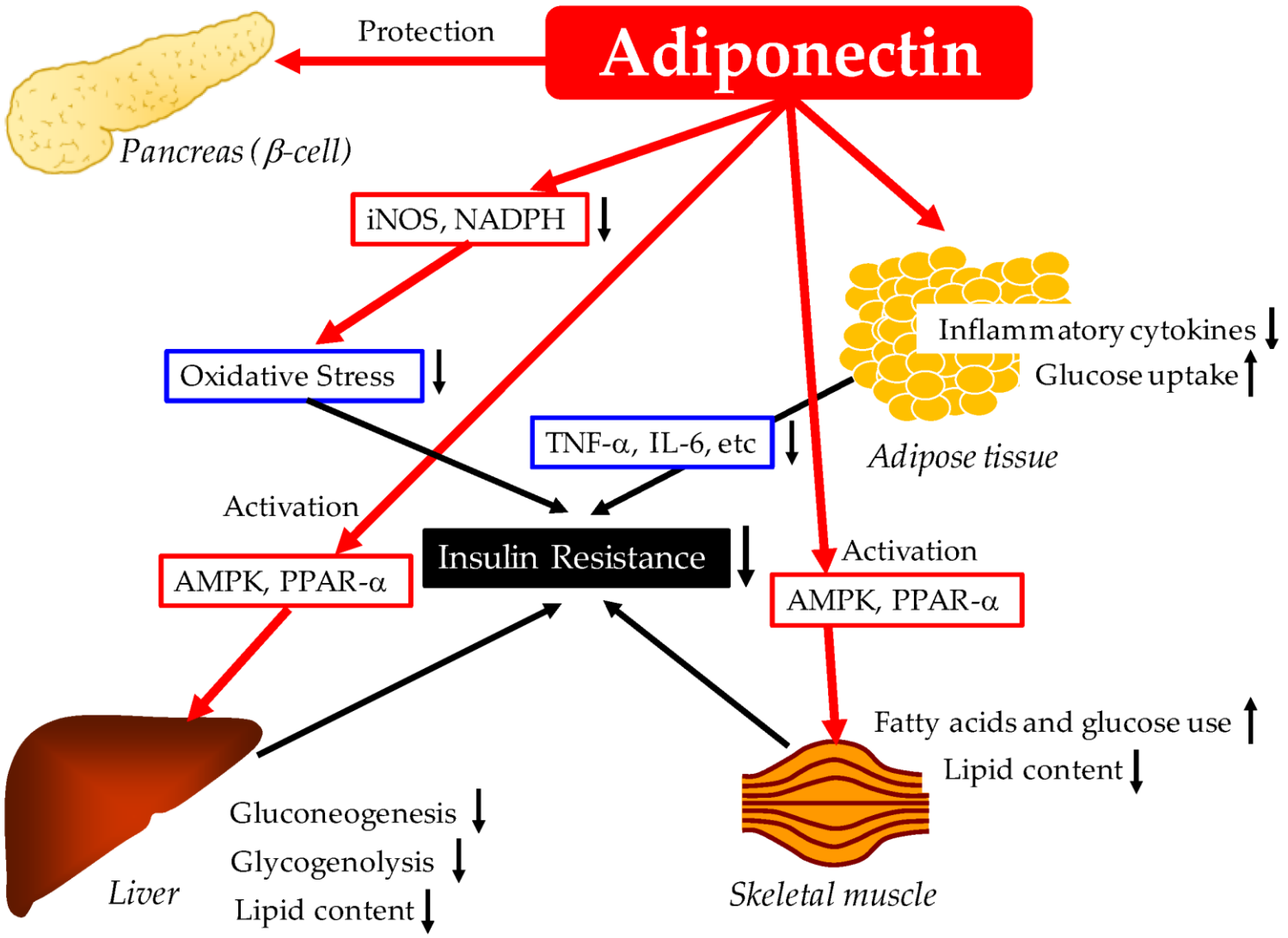
Leptin and energy metabolism



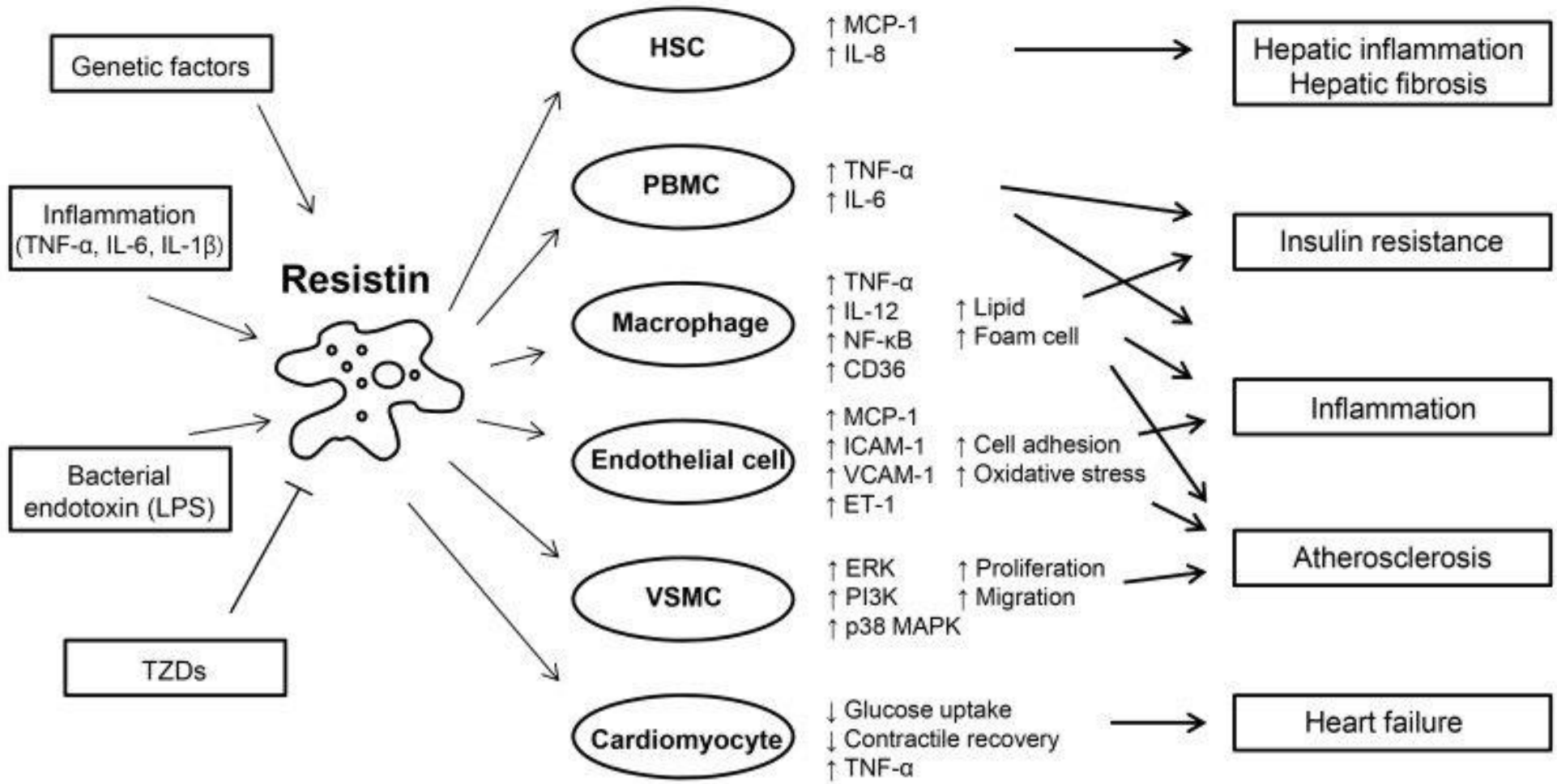
Leptin - functions



Adiponectin



Resistin


Genetic factors
Inflammation (TNF-α, IL-6, IL-1β)
Bacterial endotoxin (LPS)
TZDs
Resistin
HSC
↑ MCP-1
↑ IL-8
PBMC
↑ TNF-α
↑ IL-6
Macrophage
↑ TNF-α
↑ IL-12
↑ NF-κB
↑ CD36
↑ Lipid
↑ Foam cell
Endothelial cell
↑ MCP-1
↑ ICAM-1
↑ VCAM-1
↑ ET-1
↑ Cell adhesion
↑ Oxidative stress
VSMC
↑ ERK
↑ PI3K
↑ p38 MAPK
↑ Proliferation
↑ Migration
Cardiomyocyte
↓ Glucose uptake
↓ Contractile recovery
↑ TNF-α
Hepatic inflammation
Hepatic fibrosis
Insulin resistance
Inflammation
Atherosclerosis
Heart failure