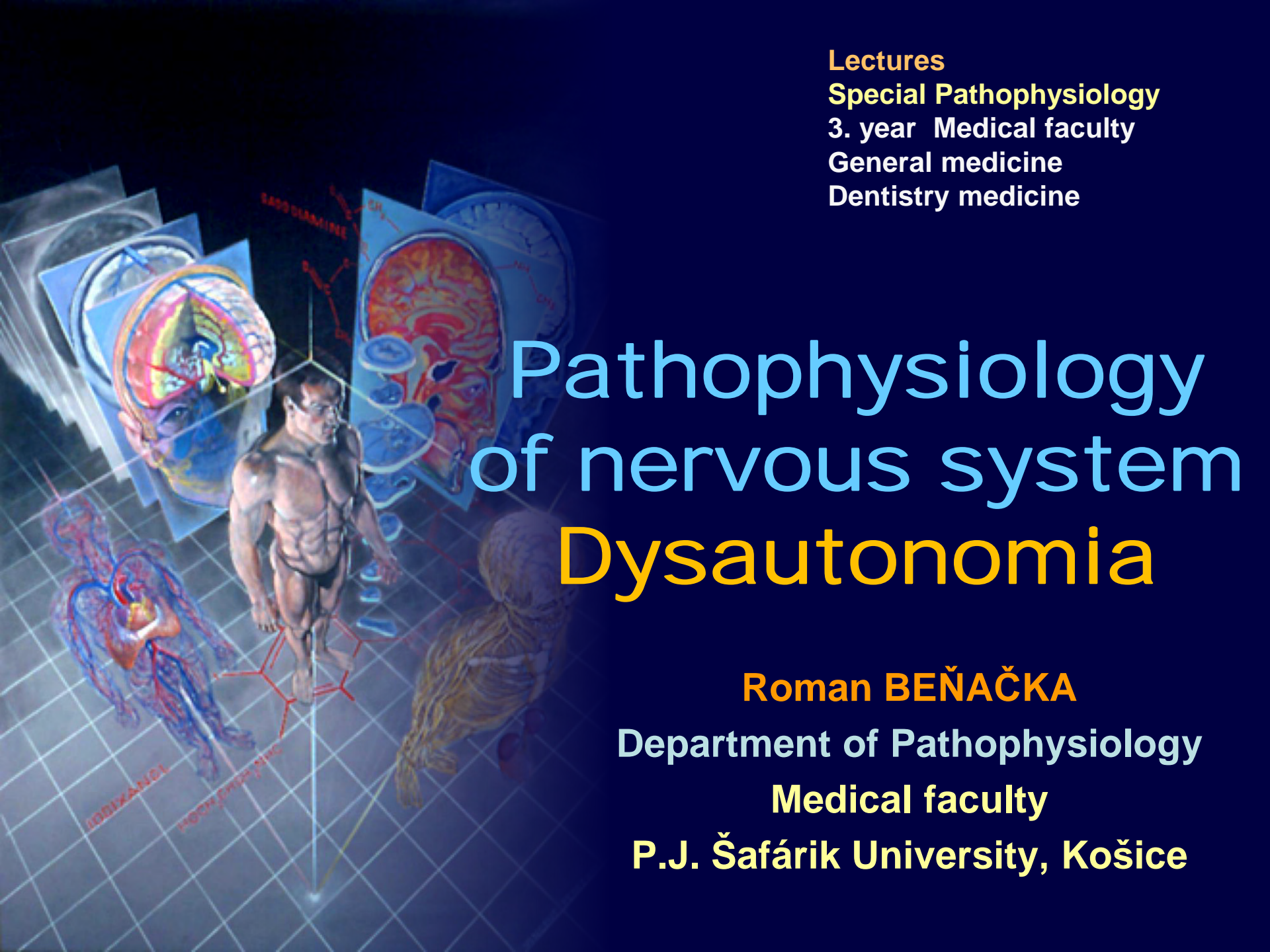


Lectures  
Special Pathophysiology  
3. year Medical faculty  
General medicine  
Dentistry medicine



# Pathophysiology of nervous system Dysautonomia

**Roman BEŇAČKA**

Department of Pathophysiology

Medical faculty

P.J. Šafárik University, Košice

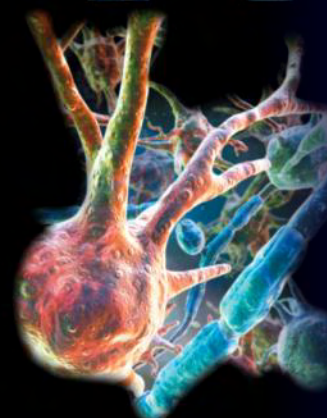
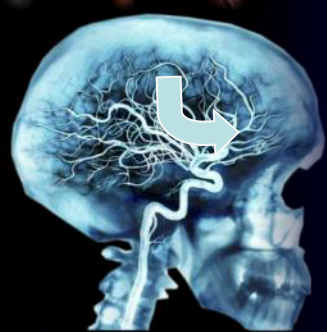
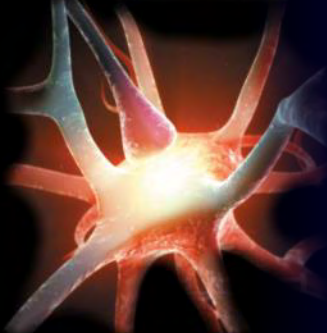
# Functions of ANS

---

- ANS possesses affects in all body processes, which are not directly related to posturation and movement
- processes can be little influenced by will and unconscious
- ANS does not command rather modulates visceral functions

## Modulation and control of

1. visceral organ functions (heart, GIT)
2. smooth muscles (vessels, airways, urogenital, piloerectores)
3. glandular secretion (napr. saliva, tears, mucus, sweat)
4. endocrine glands (nervous sy - endocrine sy. interaction)
5. immune system (nervous sy - immune sy. interaction)
6. metabolic processes (e.g. liver, muscles, fat tissue, etc.)
7. heat production (liver, muscles)
8. trophic functions (skin, connective tissue, etc.)



# Peripheral components of ANS

---

- Sympathetic system (cervical-thoracic-lumbar level)
- Parasympathetic system (cranial-sacral level) n. vagus
- ⊗ **Viscero-motor pathways** (interomotor/ glandulomotor)
- ⊗ **Viscero-sensitive pathways** (interoceptive/ glanduloceptive)
  - Preganglionic neurons  
(viscero-motor nuclei of cranial nerves, intermediolateral column of spinal cord)
  - Postganglionic neurons  
(paravertebral ganglia, isolated ganglia close to organs)  
Sympathetic: gg. cervicale, g. celiacum, g. mesenterici,  
Parasympathetic: g. ciliare, g. submandibulare, g. oticum,  
g. sphenopalatinum,

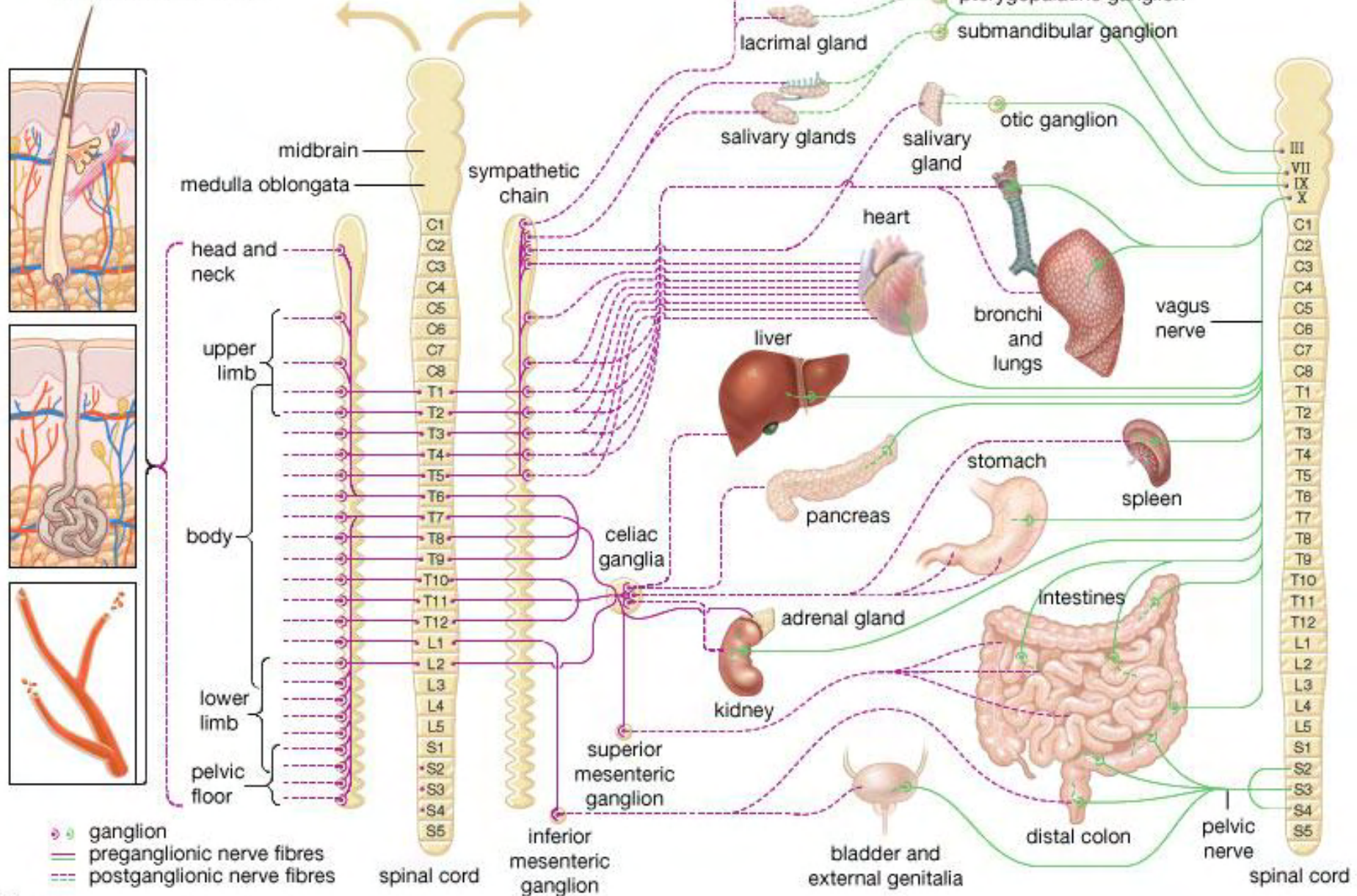


# Sympathetic nervous system

# Parasympathetic nervous system

sympathetic outflow to smooth muscle of hair follicles, sweat glands, and peripheral blood vessels

sympathetic outflow to organs of the head and trunk



# Peripheral components of ANS

---

Mediators (neurotransmission + neurocrine secretion)

Sympathetic - catecholaminergic system (noradrenalin) (exceptions - vessels, adrenal medulla, sudomotoric sweat glands); modulator: NPY

Parasympathetic - cholinergic system (acetylcholine); modulator: SP

Sympathetic + Parasympathetic systems may act:

- **Antagonistically** – opposite, blocking the effect of each other
- **Agonistically** – corroborative, identical or similar, synergic, potentiating
- **Indifferent** – independent, different actions, targets

Sympathetic – typical system involved in fright- fight or flight (s.c. sympathetic arousal)

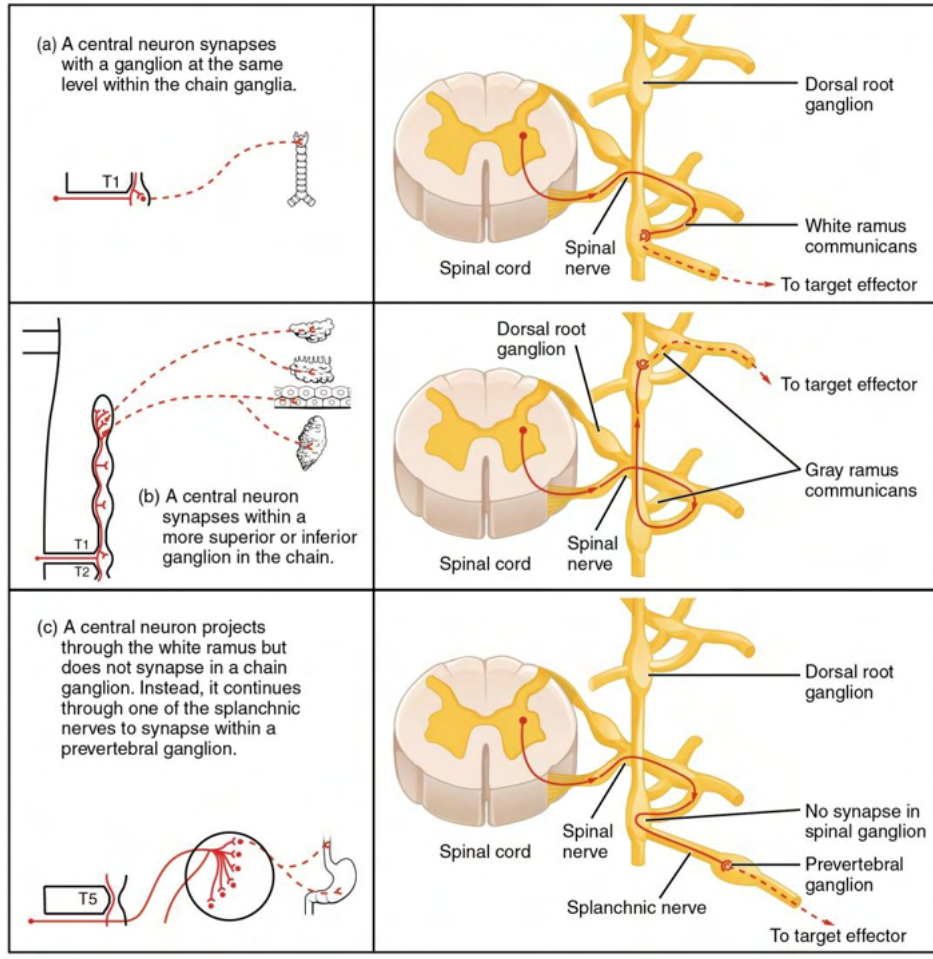
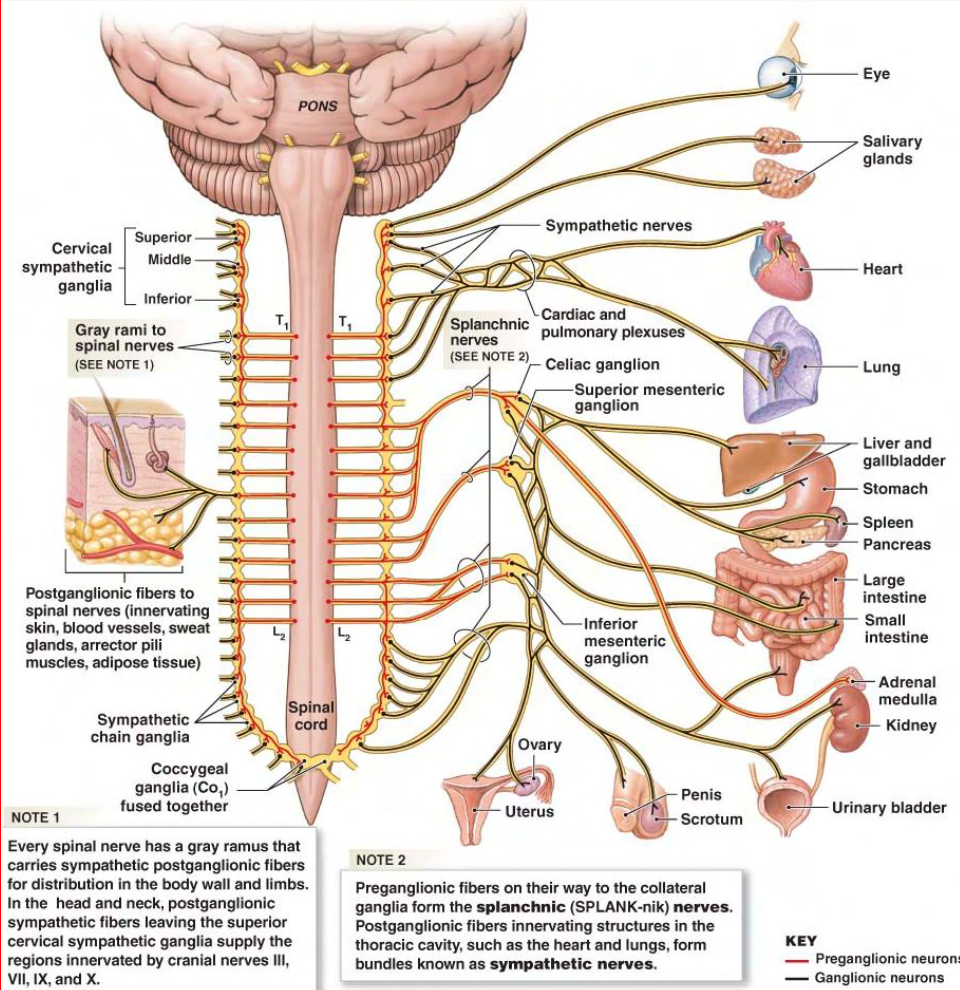
**alpha reaction:** fear, fright (e.g. piloerection, vascular constriction, sphincter constriction, pupillar dilation) = synonym of stress as danger

**beta reaction:** action, activity (e.g. cardiac stimulation, muscle vasodilatation, bronchodilatation) = synonym of stress as a challenge

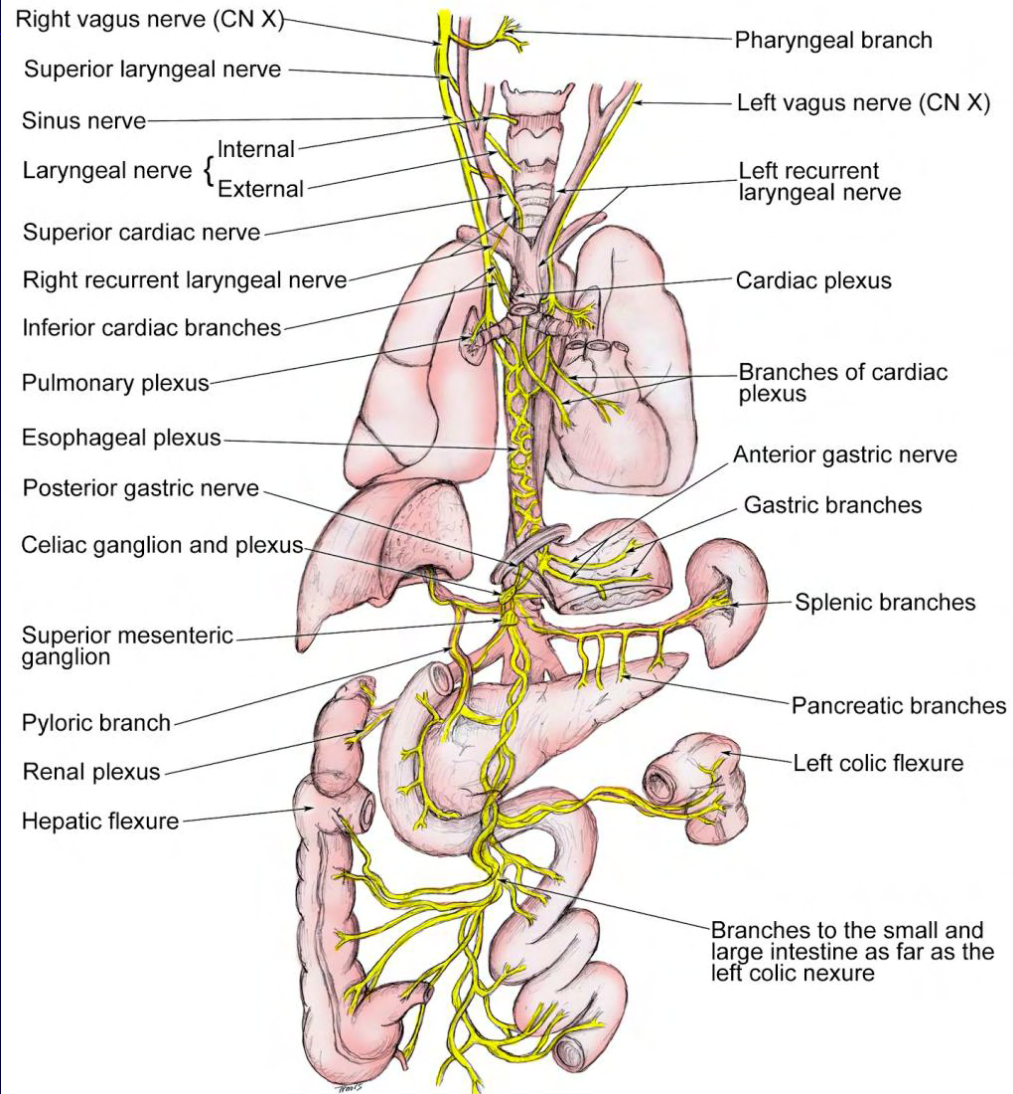
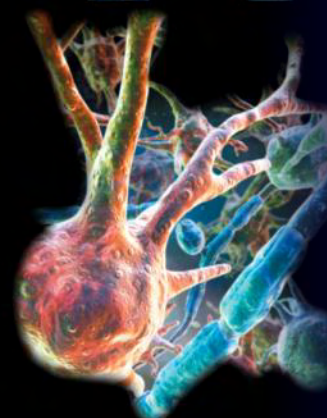
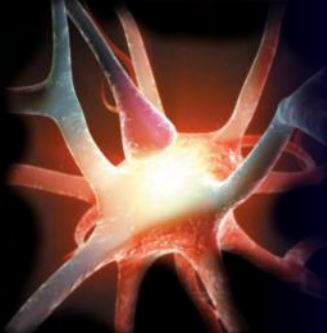
Parasympathetic - relaxation (blood supply, increased peristalsis in GUT, salivation, muscle relaxation )



# Sympathetic nerve supply

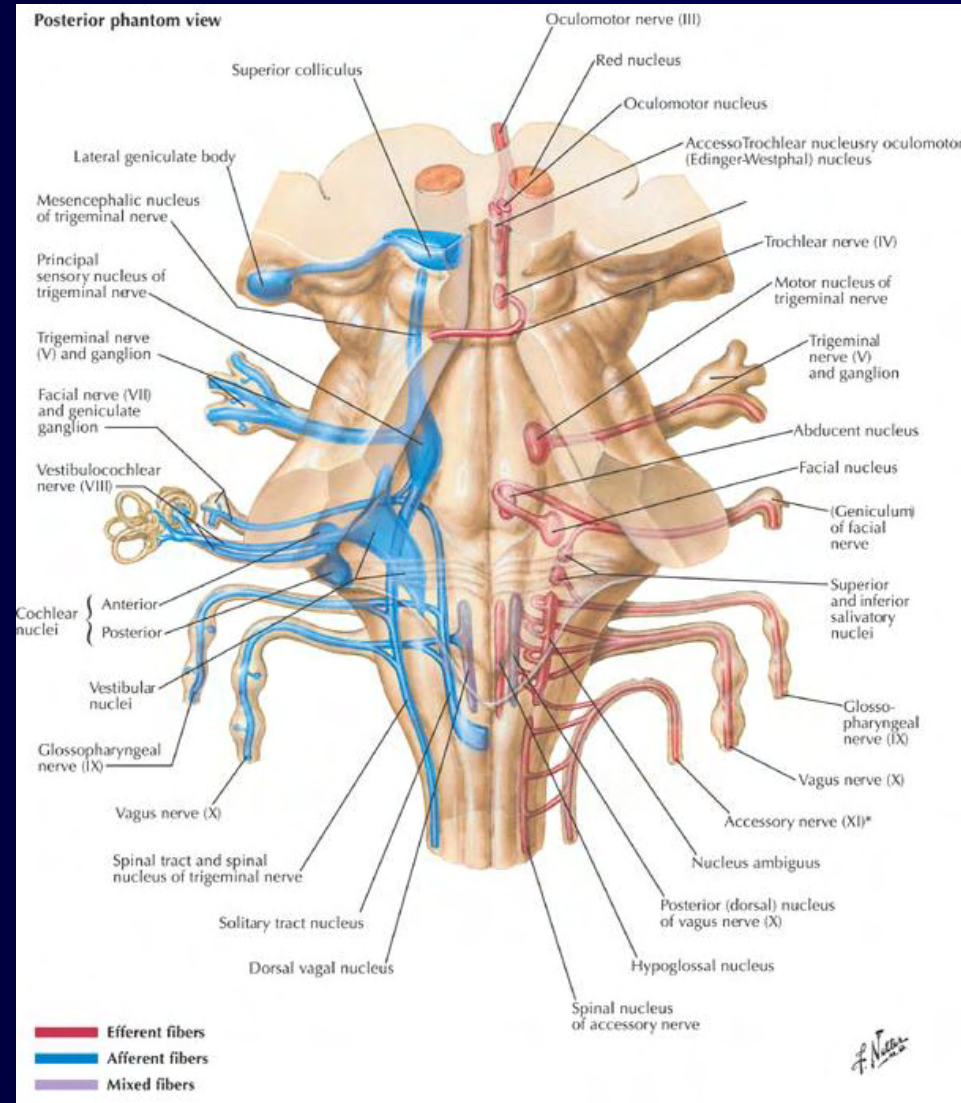


# Vagus nerve



# Central components of ANS

- Spinal level : intermediolateral column (intermotoneurons, interosensoric neurons, inhibitory interneurons, etc.)
- Brainstem :
  - bulbar visceral-sensory relay - nucl. of tractus solitarii,
  - pontile visceral-sensory relay - nucll. parabrachiales, nucl. Kölliker-Fuse,
  - viscerosensoric nuclei & visceromoric nuclei of cranial nerves (III, VII, IX, X)
  - serotonergic (B-group), katecholaminergic (A, C - groups)
  - vasopressor, vasodepressor, kardiostimulatory, cardioinhibitory reflex circuits (rostral medulla)



# Central parts of ANS 1

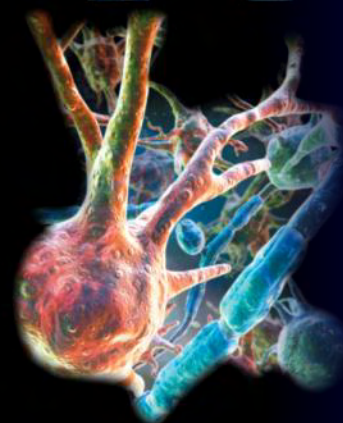
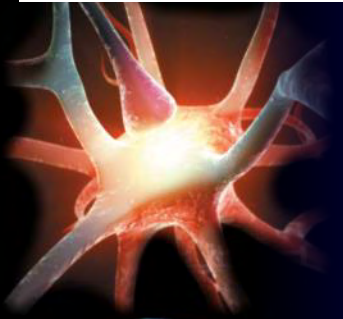
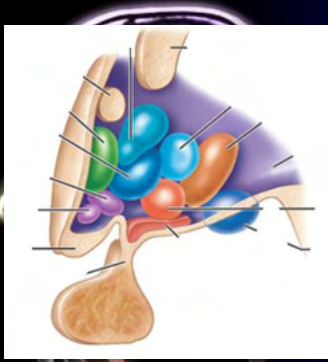
---

## ● Subcortical level :

**Hypothalamic-hypophyseal system** - somatotopic representation of various qualities of visceral afferentation and efferentation for different body segments of smooth muscles, glands and inner organs

## Laesions:

- ventromedial hyp. (center of satiety) - polyphagia, bulimia, obesity, lethargia
- ventrolateralis (center of hunger) - cachectia, anorexica,
- rostromedial hyp. (thirst center) - polydipsia, polyuria,
- rostromedial hyp. - oligodipsia, hyperglycaemia, glykosuria, hypoinsulinaemia
- laterocaudal/dorsal hyp. (heat production/ conservation center) paroxysmal hypothermia, poikilothermia,
- rostromedial hyp. (heat dissipation center) - central neurogenic hyperthermia, hyperhidrosis
- Other responses elicited from hypothalamus : progressive lipodystrophy, hypoalbuminaemia, hemorrhagic erosions or ulcers in GIT



# Central parts of ANS 2

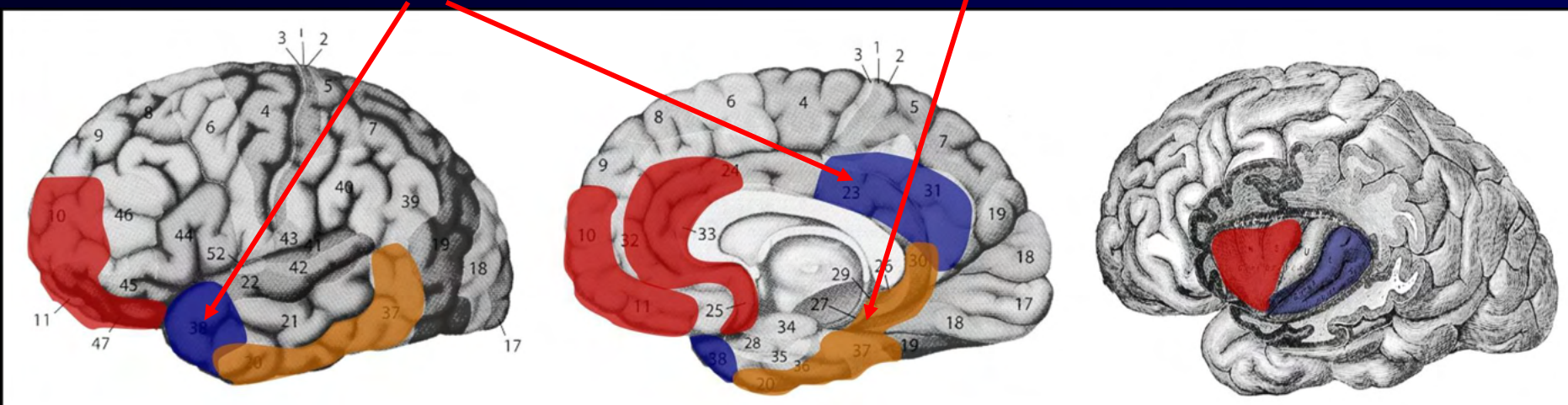
## Cortical level:

**Viscerosensory** : medial area of temporal-parietal cortex

**Parasympathetic representation** - insula (area 13), temporoparietal cortex (area 38), subparietal region of g. cinguli (area 23, 31);

**laesion** → **overactivity of sympathetic sy.** ( e.g. mydriasis, tachycardia, bronchodilatation, piloerection, decreased peristalsis in GUT, etc.)

**Sympathetic representation** - temporal-basal cortex (area 20, 36, 37, 38), perisplenic area (area 26, 29, 30); **laesion** → **overactivity of parasympathetic** (e.g. miosis, vasodilatation, bradycardia, hypotension, bronchial constriction, hyperperistalsis of bowels, hypersecretion of saliva, sweat, mucus, etc.)

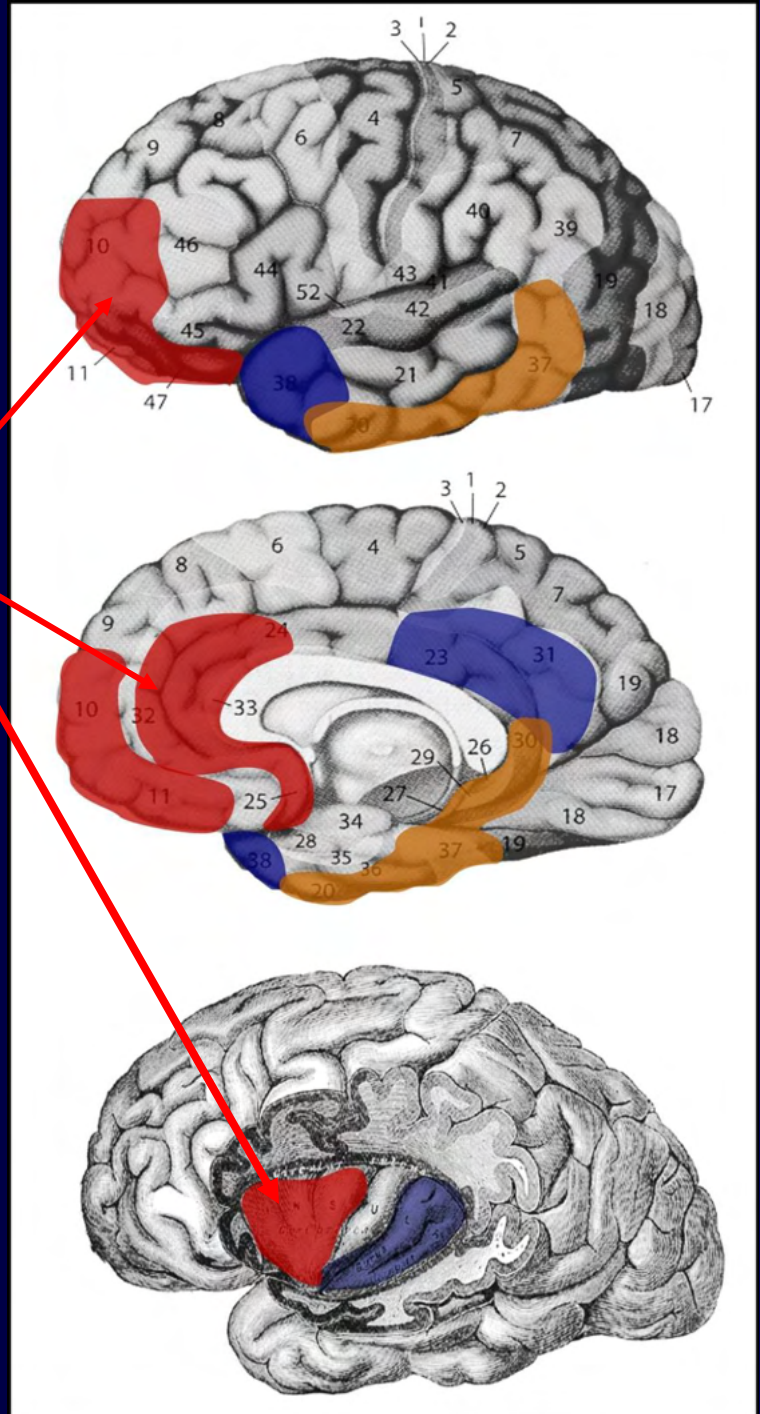


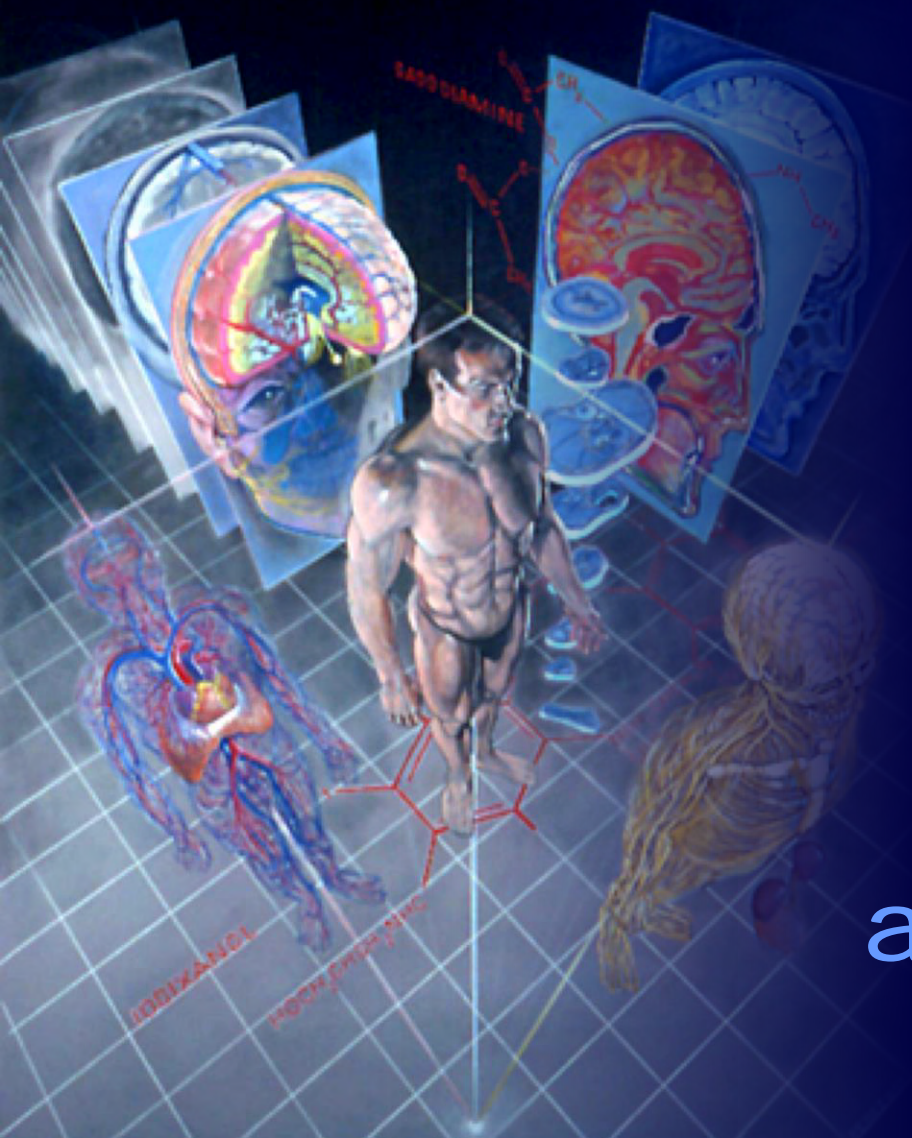
# Central parts of ANS

## Cortical level

**Visceromotor:** anterior and basal frontal cortex (area 10, 11, 12, 47), anterior part of insulae (area 14, 15, 16) resp. subfrontal part of g.cinguli (area 24, 25, 32, 33).

**laesion** → smooth muscle disorders  
somatotopic





## Symptoms of autonomic nervous system

# Types of dysautonomias

- According to etiopathogenesis:

- a) **Primary vegetative disorders** - without proven organic damage (e.g. primary autonomic failure)

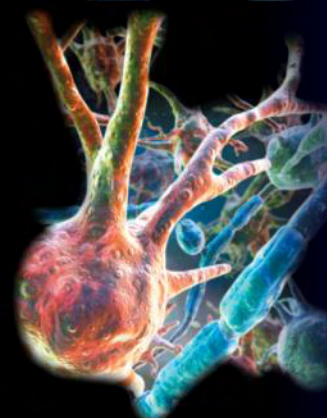
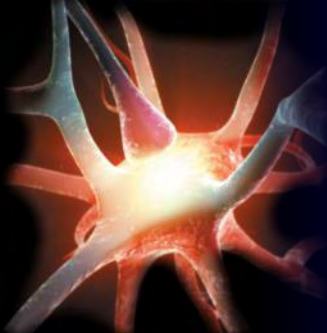
- b) **Secondary vegetative disorders** - consequence of acute and chronic diseases ( e.g. diabetic and uremic neuropathy)

- According to location and/or mechanisms:

- a) **Topic syndromes** - on particular levels of central and peripheral autonomic regulation,

- b) **Reflex syndromes** - involvement of vegetative endings from various peripheral organic laesions,

- c) **Global syndromes** - systemic disorders involving either sympathetic or parasympathetic system or both



# Signs of dysautonomia / 1

---

## 1. Psychical disorders

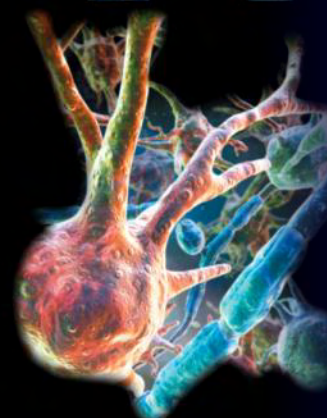
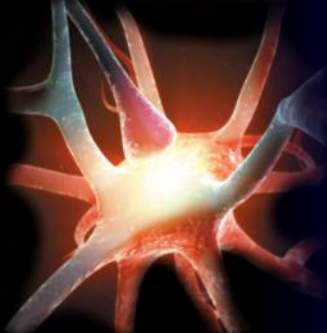
phobias, anxiety, aggression, tiredness, decrease of intellectual output, sleep disorders, and others

## 2. Circulatory disorders

- **Microcirculation:** sudden redness or paleness of skin (flush), cyanosis or edematous manifestation without organic reasons, dermographism, etc.

- **Systemic circulation:** orthostatic hypotension, collapse, hypertension, paroxysmal cardiac dysrhythmia (tachycardias, bradycardias, extrasystoles), angina pain, neurocirculatory asthenia,

- **Cerebral circulation:** vasomotor headache, vertigo, fainting, syncope, meteosensitivity, migraine



# Signs of dysautonomia / 2

---

## 3. Respiratory disturbances

respiratory dysrhythmias, secondary hyperpnoea, tachypnoea, laryngeal stridor, dysphonia, **bronchospasms**, neurogenic asthma

## 4. Gastrointestinal disorders

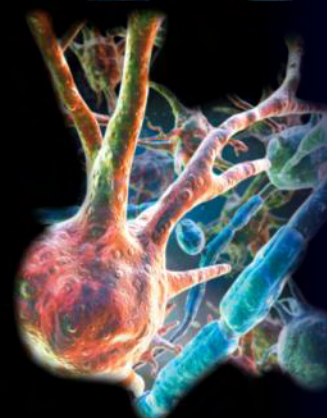
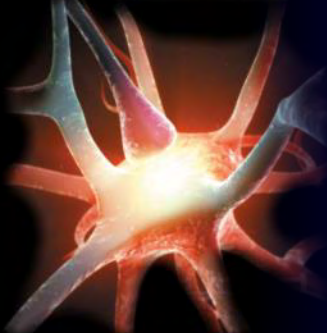
**dysphagia**, **delayed stomach emptying**, **hypomotility or hypermotility of bowels**, spasms in stomach, neurogenic (psychogenic) diarrhoea, constipation, meteorism, insufficiency or spasms of sphincters (cardia, pylorus, rectum), **abdominal cramps** w/o organic reasons

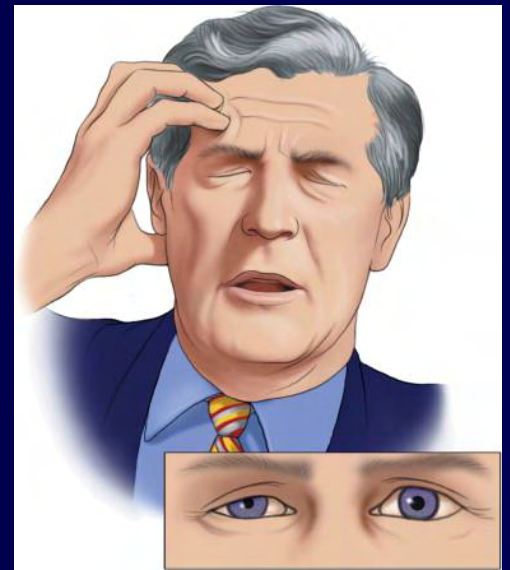
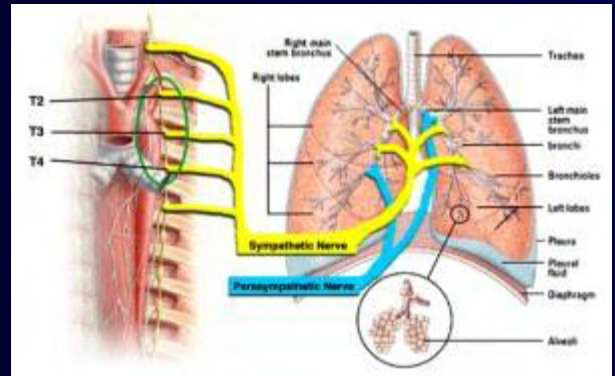
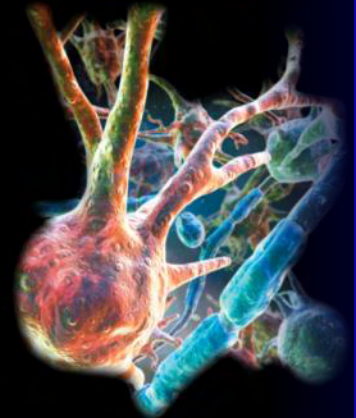
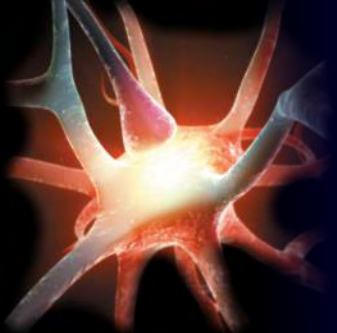
## 5. Urinary disorders

polyuria, anuria, nycturia, **urinary urgency**, **incontinency**, painfull spasms of urinary sphincters

## 6. Genital disorders

**sy. of erectile dysfunction**, penile intumescence, dyspareunia, menstruation disorders





# Signs of dysautonomia / 3

---

## 7. Secretory disorders

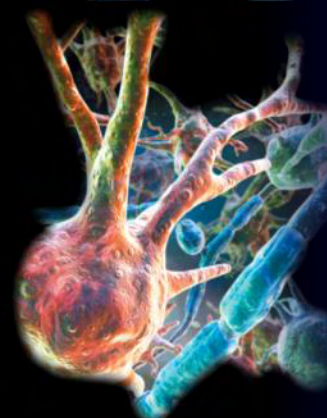
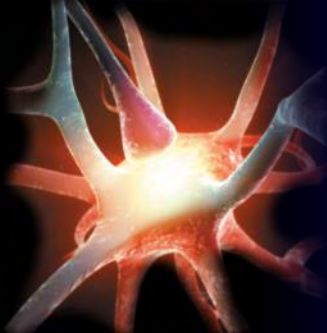
**hyperhidrosis or anhidrosis**, hyposalivation or hypersalivation, **hypolacrimation or hyperlacrimation**, lactation disorders, change in composition of sweat, saliva or mucus in respiratory airways, etc.

## 8. Disorders of regulation of body temperature

hyperthermia, feeling of cold, subfebrility, poikilothermia etc.,

## 9. Metabolic disorders

**cachexia, anorexia nervosa**, adiposity independent of food intake, disorders of metabolism of fat, acute hyperglycemic or hypoglycemic attacks, etc.



# Signs of dysautonomia / 4

## 10. Endocrine disorders

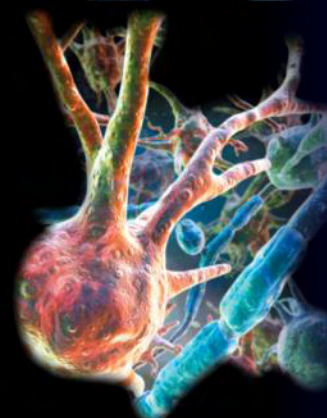
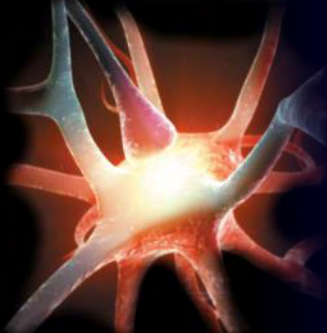
sexual hormonal dysfunction, thyreoidal & parathyreoidal disorders, **dysbalance in adrenal functions, pheochromocytoma**, etc.

## 11. Trophic disorders

atrophy and keratosis of skin, skin pigmentation disorders, loss of hairness, demineralisation of skeleton, muscle, ligamental and fascial calcinosis, bone necrosis, **neurogenic allergy** (urticaria, Quincke oedema), atrophy of testes, etc.

## 12. Disorders of blood and immune cells

disorders of trombocytic aggregation, reactive anaemias, T-lymphocyte dysfunctions, macrophage dysfunctions, etc.

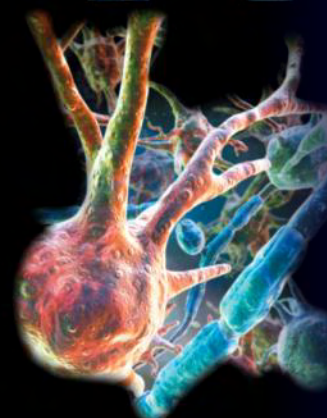
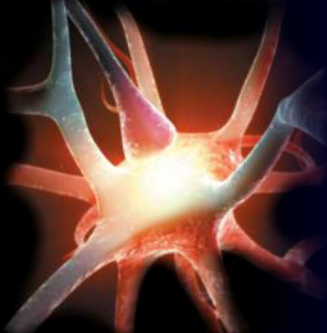




# Autonomic disorders

# Sy. of ortostatic intolerance/ Sy. of postural tachycardia (POTS)

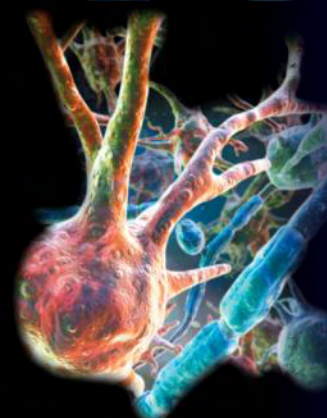
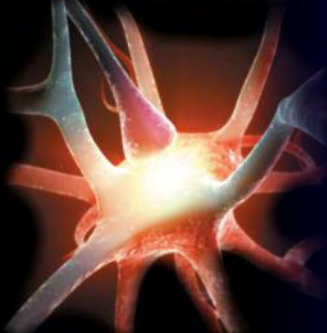
Hyperadrenergic orthostatic hypotension	Partial dysautonomia
Orthostatic tachycardia syndrome	Sympathotonic orthostatic hypotension
Postural orthostatic tachycardia syndrome (POTS)	Mitral valve prolapse syndrome
Postural tachycardia syndrome	Soldier's heart
Hyperadrenergic postural hypotension	Vasoregulatory asthenia
Sympathotonic orthostatic hypotension	Neurocirculatory asthenia
Hyperdynamic beta-adrenergic state	Irritable heart
Idiopathic hypovolemia	Orthostatic anemia



# Sy. of orthostatic hypotension

---

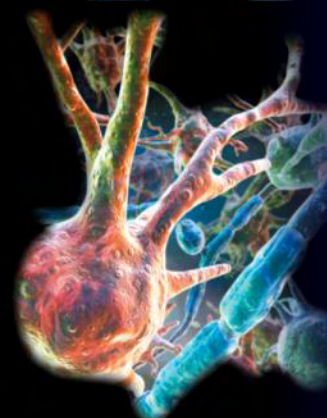
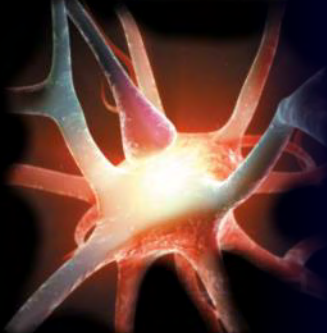
- Characteristics: fall of BP  $> 20/10$  mmHg during sudden change of body position from sitting or lying position to standing position, lack transient rise of HR  $> 30$ /min
- Occurrence: both in women and men 20 - 50 y.
- Mechanism: failure of sympatheticotonic postural baroreflex
- Etiology: hereditary- congenital;
  - metabolic defects in catecholamine synthesis,
  - vascular alpha-adrenergic receptor hyposensitivity
- Signs: sudden fainting or fall, paleness in face, vertigo and titubations - loss of balance, headache, tiredness




# Sy. of ortostatic intolerance/ Sy. of postural tachycardia (POTS)

---

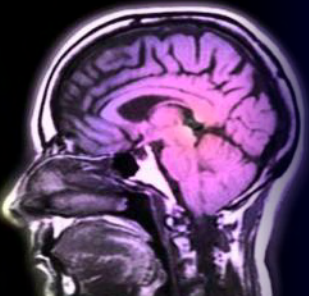
- **Characteristics:** change of BP  $< 20/10$  mmHg during posturation, rise of HR  $> 30$ /min and plasmatic level of NE 600 pg/ml during longer standing
- **Occurrence:** young women  $< 35$  r. (F: M = 4:1)
- **Mechanism:** permanently increased basal sympaticotonia
- **Signs:** palpitations, weakness, fainting, redness and swelling of lower extremities, scotomas, tremor, headache, tiredness during long duration standing
- **Etiology:** unknown;
  - (a) preceding viral infection?,
  - (b) cardiac beta-adrenergic receptor hypersensitivity,
  - loss of cardiac baroreflex sensitivity;
  - autoimmune: Ab against alfa-3 nicotine receptor in ganglia





# Multiple systemic atrophy (MSA)/ Shy-Drager sy. (familial ortostatic hypotension)

- Characteristics: fall of BP  $> 20/10$  mmHg during sudden change of body position from sitting or lying position to standing position , transient rise of HR  $> 30$ /min
- Mechanism: progressive disappearance of autonomic functions
- Signs:
  - attacks of severe postural hypotension - syncopas,
  - parkinsonism, cerebellar ataxia, central sleep apnoea
  - other autonomic dysfunction (anhidrosis, erectile dysfunction, dysuria, disorders of peristalsis)
- Etiology: progressive degeneration and atrophy of cortex and other regions in CNS

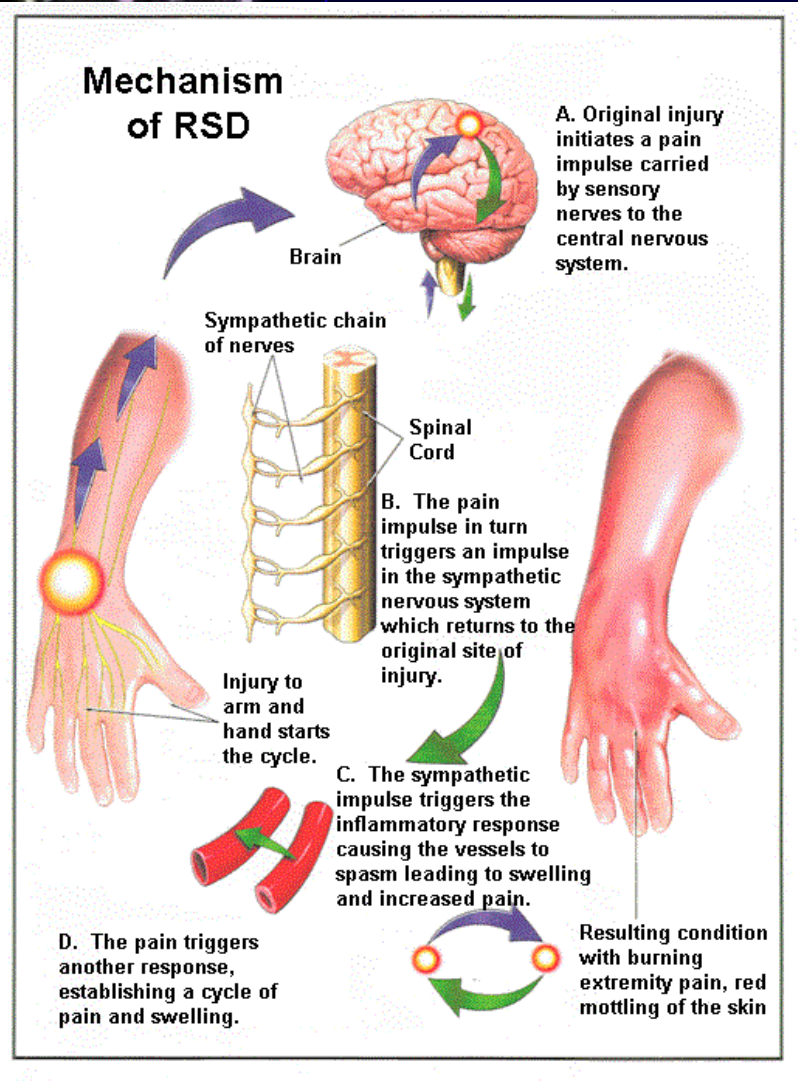


# Localized disorders

## Reflex sympathetic dystrophy (RSD)

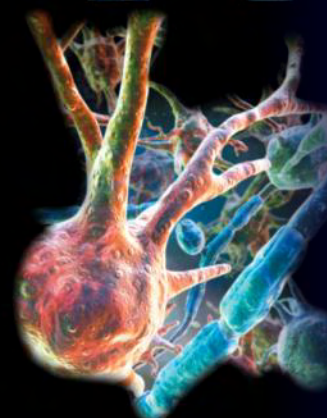
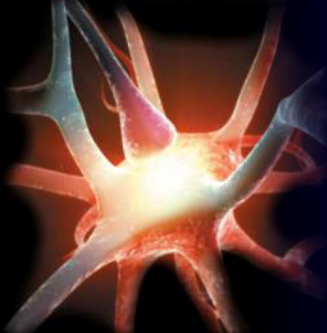
### Complex regional pain sy. (CRPS)

- 1875, Mitchell, Moorehouse a Keen
- strong burning pain,, hyperpathia (tenderness)
- pathological skin changes (ulceration, atrophy, browning, reticulation), possible also changes in bones (atrophy, Sudeck necrosis), excessive regional sweating, swelling
- muscle atrophy, movement disorders, spreading from extremities into trunk
- CRPS type I (RSD) – without apparent nerve and tissue damage (e.g. fracture, contusion)
- CRPS type II (causalgia) – history of previous inflammation, surgery, damage to nerves



# Reflex sympathetic dystrophy

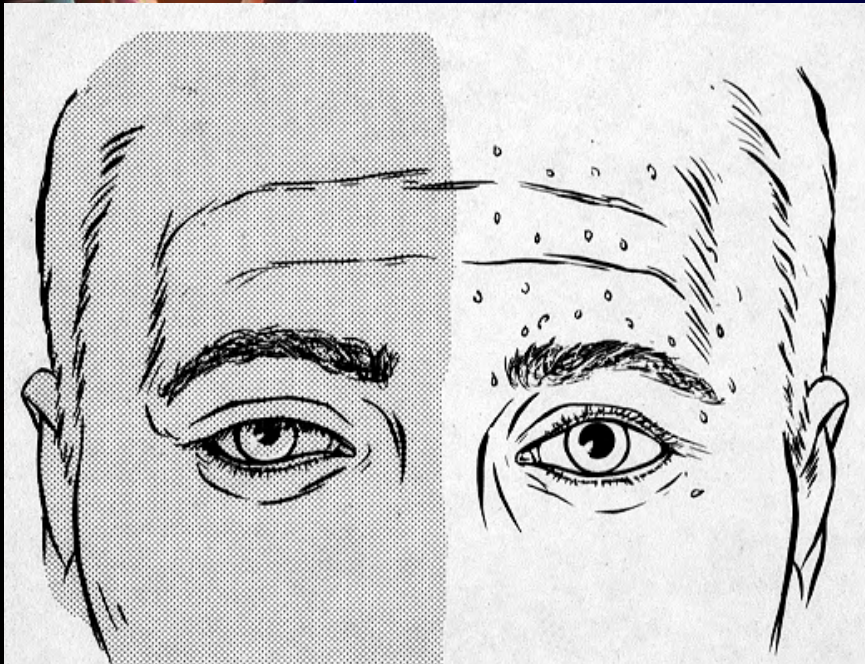
---



- Dystrophic alterations in the skin, subcutaneous tissues
- Swellings, reticulation, pigmentation



# Localized disorders



## Horner's syndrome

Eti: ipsilateral cervical ganglion damage, congenital defects, syringomyelia, carotic trombosis

### Sy:

1. **Miosis** - pupillary constriction (parasympaptikotonia)
2. **Ptosis** – drop of the eyelid (paresis in m. levator palpebrae)
3. **Enophthalmus** – retraction of eye bulbus (ocular muscle paresis)
4. **Anhidrosis** in the homolateral site of the face and neck
5. **Hyperhidrosis** on contralateral site

