

The Autonomic Nervous System Introduction

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Autonomic Nervous System - Overview

www.courses.vcu.edu/ptxed/m2

- 1. Tissues / Organs: - receptors present, tissue / organ response
- 2. Transmitters: - NE, Ach, synthesis, storage, release, regulation
- 3. Drugs: - receptor selectivity, mechanism of action
- 4. Can predict: - clinical application, side effects, toxicity, treatment of toxicity
- 5. Eye Anatomy: - miosis, mydriasis, cycloplegia, wide- vs narrow-angle, Horner's syn.
- 6. General: - learn by drug classes, important adverse reactions, not dosage

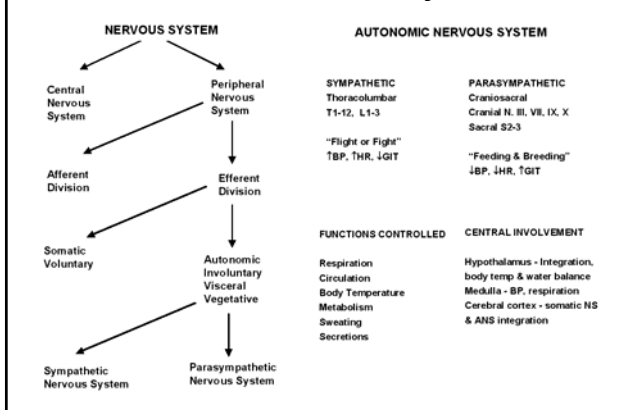
ANS – Overview Tissues/Organs

Organ	Sympathetic NS	Parasympathetic NS	Cardiovascular System
Eye: Radial m. Circular m. Ciliary m.	Mydriasis α ₁	Miosis M ₃ , M ₁	BP = CO X TPR, CO = SV X HR Reflexes oppose direct action to correct BP change (not HR change)
Heart:	↑HR, Throce β ₁	↓HR M ₂	α ₁ vasoconstriction → ↑TPR → ↑BP
Vascular muscle:	Constrict α ₁ Relax β ₂ , D ₁₂ (small)	Relax M ₃ (NO)	β ₁ ↑HR → ↑CO → ↑BP β ₂ vasodilation → ↓TPR → ↓BP
Bronchial m.	Relax β ₂	Contract M ₃	M ₃ (vagus) ↓HR → ↓CO → ↓BP
GI-tract	↓motility α ₁ , β ₁	↑motility M ₃	M ₃ (NO) relaxation → ↓TPR → ↓BP
Sphincter m.	Contract α ₁	Relax M ₃	
Genitourinary m.	Relax β ₂	Contract M ₃	Cardiovascular Drug Effects
Penis	Ejaculation α	Erection M	Nonepinephrine TTP, ↓HR (reflex)
Uterus	Relax β ₂	NO = Nitric oxide	Isoproterenol BP (α ₁), THR, TTP
Pleomotor	Contract α	2= Messengers	Epinephrine TTP, THR, TTP
Sweat glands	↑secretion M ₃	β ₁ , D ₁₂ , α ₁ , α ₂ , TAMP	Mecamylamine ↓BP, (α ₁) HR
Liver	↑glucose β ₂	α ₁ , M ₃ , D ₁₂ , α ₂ , AMP	Propranolol BP (α ₁), ↓HR
Kidney	↑renin α ₁ , M ₃ , D ₁₂	α ₁ , AMP	Atropine BP (α ₁), THR
Fat cell	Lipolysis β ₃	N ₁ , N ₂	Nar ₁ , K ₂ Phenothiazine ↓BP, ↑HR (reflex), TTP

Summary Table

Agent (trade name(s))	Therapeutic Use	Notes
MAOI = Monoamine oxidase inhibitors TCA = Tricyclic antidepressants		
Norepinephrine (Levaterenol)	Hypotension, pressor agent	α / β ₁ , β ₂ neuronal, non-circulating, I: MAOI, TCA
Epinephrine (generic)	Allergic reactions, shock, CPR	α / β ₁ , β ₂ adrenal medulla, circulating; I: MAOI, TCA
Dopamine (Intropin)	Renal vasodilatation during shock	α ₁ / β ₁ / D, precursor to NE, I: MAOI
Isoproterenol (Isuprel)	Asthma, cardiac stimulant	β ₁ synthetic, not endogenous; BP(↓), (-) HR↑
Phenylephrine (Neosynephrine)	Nasal decongestant, hypotension	Not commonly used for hypotension; S: CV, reflex bradycardia
Methoxamine (Vasoxyl)	Hypotension, pressor agent	
Metaraminol (Aramine)	Hypotension, pressor agent	α ₂ , orally active; NE or DA better choice
Clonidine (Catapres)	Hypertension	α ₂ , ↓ CNS sympathetic outflow, inhibit NE release, rebound HT; S: dry mouth, sedation, impotence; α-methyl-dopa is metabolized to α-methyl-NE (α ₂ -agonist, positive Coombs test)
Guafacine (Tenex)		
α-methyl-dopa (Aldomet)		
Dobutamine (Dobutrex)	CHF, cardiac stimulant	β ₁ , IV infusion, tolerance, desensitization
Phenylephrine		
Albuterol (Proventil, Ventolin)	Asthma - bronchodilator	β ₂ -selective. Oral 1-2 hrs onset → 4-6 hrs duration; Inhalation 5-10 min onset → 3-4 hrs duration; S: cardiovascular, less via inhalation
Ritodrine (Yutoper)	Premature labor	
Metoprolol (Alupent)	Asthma	Note: Terbutaline not FDA approved for premature labor (cheaper, longer lasting than Ritodrine)
Terbutaline (Brethaire)	Asthma, (premature labor)	

Autonomic Nervous System



Autonomic Nervous System

SYMPATHETIC
Thoracolumbar
T1-12, L1-3

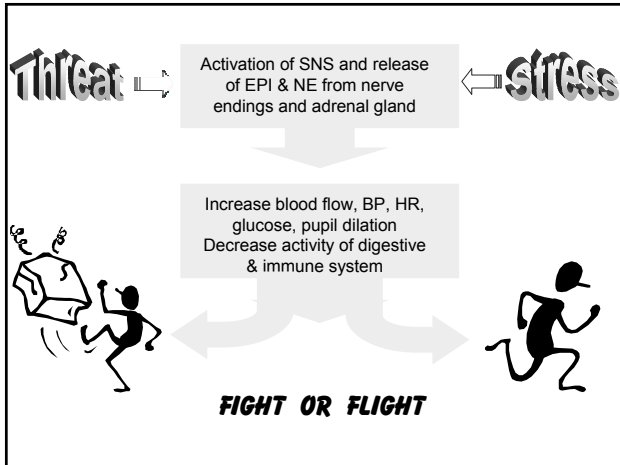
“Flight or Fight”
↑BP, ↑HR, ↓GIT

FUNCTIONS CONTROLLED
Respiration
Circulation
Body Temperature
Metabolism
Sweating
Secretions

PARASYMPATHETIC
Craniosacral
Cranial N. III, VII, IX, X
Sacral S2-3

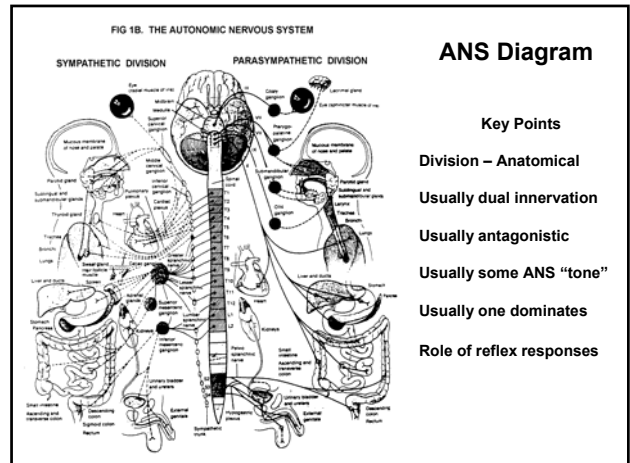
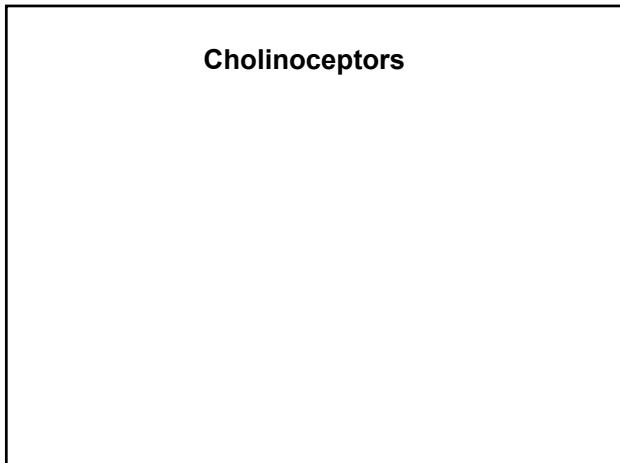
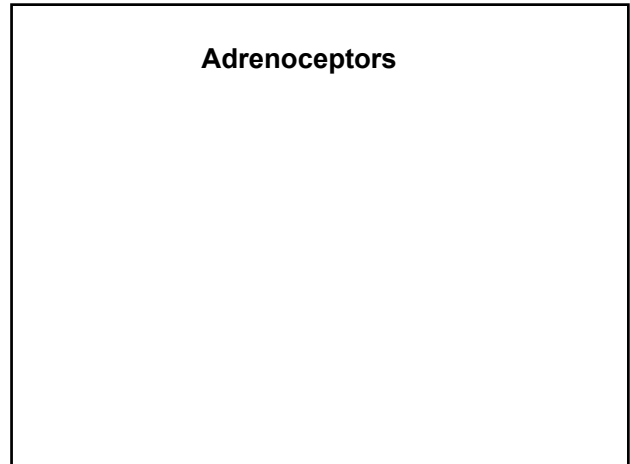
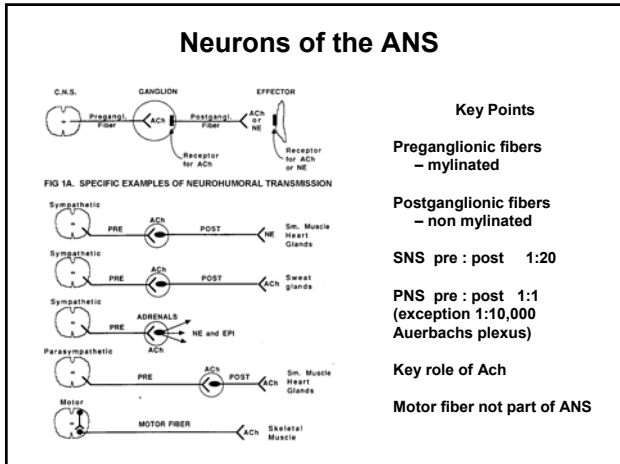
“Feeding & Breeding”
↓BP, ↓HR, ↑GIT

CENTRAL INVOLVEMENT
Hypothalamus - Integration, body temp & water balance
Medulla - BP, respiration
Cerebral cortex - somatic NS & ANS integration



Exam Stress

Normal BP: 120 / 80 mmHg	HR: 72 bpm
Before exam: 140 / 99 mmHg	HR: 97 bpm
During exam: 179 / 149 mmHg	HR: 110 bpm
End of exam: 111 / 74 mmHg	HR: 76 bpm



Raynaud's Syndrome



- Excessive sympathetic tone in nerves supplying hands and feet. Minor cold, or even thought of cold, causes pronounced vasoconstriction that can be severe enough to cause necrosis of tissues
- Discoloration of the fingers and/or toes when the patient is exposed to changes in temperature (cold or hot) or emotional events
- Abnormal spasm of blood vessels causes diminished blood supply
- Initially, the digit(s) turn white because of diminished blood supply.
- Then turn blue because of prolonged lack of oxygen
- Finally turn red, the blood vessels reopen, causing a local "flushing"
- Three-phase color sequence (white to blue to red) is typical
- Treatment: Ca⁺⁺ blockers if severe

Table 1. Direct Effects of Autonomic Nerve Activity on some Organ Systems

Organ	Effect of			
	Sympathetic		Parasympathetic	
	Action	Receptor ¹	Action	Receptor ²
Eye				
Iris (radial muscle)	Contracts	α ₁	Contracts	M
Iris (circular muscle)	Relaxes	β ₂	Contracts	M
Ciliary muscle	Contracts	β ₂	Contracts	M
Heart				
Sinoatrial node	Accelerates	β ₁	Decelerates	M
Atrioventricular node	Accelerates	β ₁	Decelerates	M
Contractility	Increases	β ₁	Decreases (partial)	M
Vascular smooth muscle				
Small, splanchnic vessels	Contracts	α ₁	Relaxes	M
Skeletal muscle vessels	Relaxes	β ₂	Contracts	M
(Contracts)	Relaxes	β ₂	Contracts	M
Respiratory smooth muscle	Relaxes	β ₂	Contracts	M
Gastrointestinal tract				
Smooth muscle	Relaxes	α ₁ , β ₂	Contracts	M
Salivary gland	Contracts	α ₁	Relaxes	M
Secretion	Inhibits	α ₁	Increases	M
Metabolic (liver)				
Glucagon release	Increases	β ₂	Contracts	M
GI-tract				
Smooth muscle	Contracts	α ₁	Relaxes	M
Uterus, pregnant	Contracts	α ₁	Relaxes	M
Uterus, nonpregnant	Contracts	α ₁	Relaxes	M
Penis, seminal vesicles	Ejaculation	α ₁	Erection	M
Bladder				
Detrusor smooth muscle	Contracts	α ₁	Relaxes	M
Smooth muscle (ureter)	Contracts	α ₁	Relaxes	M
Sweat glands				
Thermoregulatory	Increases	M	Decreases	M
Apocrine (scent)	Increases	M	Decreases	M
Liver	Glucagon release	α ₁ , β ₂	Contracts	M
Intestine	Contracts	α ₁	Relaxes	M
Fat cells	Lipolysis	β ₁ , β ₂	Contracts	M
Kidney	Renin release	β ₁	Contracts	M

Direct Actions

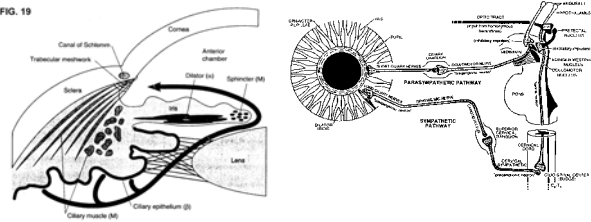
- Sympathetic
- Cardiovascular system
- Metabolic actions
- Sweat glands (M-receptors)
- Parasympathetic
- GI-Tract
- Urinary Tract
- Eye

Eye – Miosis, Mydriasis & Cycloplegia

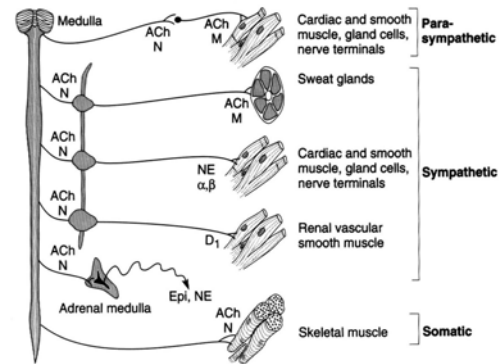
Miosis:
Mydriasis:
Cycloplegia:

pin point pupils
dilated pupils (bella-donna agents)
loss of accommodation (focus)

FIG. 19



Neurons of the ANS



Transmitter synthesis and release

