The Autonomic Nervous System

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Autonomic Nervous System - Overview

www2.courses.vcu.edu/ptxed/ptx/

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

Reference Material

Basic and Clinical Pharmacology by Katzung, 11th ed., 2009, paperback
(required text, new: $65, used: $49)

Paperback manual ($58, based on 11th ed.)

Summary Table

<table>
<thead>
<tr>
<th>Agent</th>
<th>Therapeutic Use</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dopamine</td>
<td>(trade name®)</td>
<td>-</td>
</tr>
</tbody>
</table>

Autonomic Nervous System - Overview Tissues/Organs

<table>
<thead>
<tr>
<th>Organ / Action</th>
<th>Receptor</th>
<th>Action / Receptor</th>
<th>Cardiovascular System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sympathetic NS</td>
<td>NE, Epi</td>
<td>β1, β2, β3</td>
<td>CO = SV X HR</td>
</tr>
<tr>
<td>Parasympathetic NS</td>
<td>Ch, Ach</td>
<td>M1, M2, M3</td>
<td>HR, TPR</td>
</tr>
</tbody>
</table>

Flashcards - Dopamine

<table>
<thead>
<tr>
<th>Drug</th>
<th>Action / Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dopamine</td>
<td>(Intropin)</td>
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Autonomic Nervous System

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**Autonomic Nervous System**

**SYMPATHETIC**
- Thoracolumbar: T1-L3
- “Flight or Fight”
  - ↑ BP, ↑ HR, ↓ GIT

**PARASYMPATHETIC**
- Craniosacral: Cranial N. III, VII, IX, X
  - Sacral S2-3
- “Feeding & Breeding”
  - ↓ BP, ↓ HR, ↑ GIT

**FUNCTIONS CONTROLLED**
- Respiration
- Circulation
- Body Temperature
- Metabolism
- Sweating
- Secretions

**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

**Neurons of the ANS**

**Key Points**
- Preganglionic fibers – myelinated
- Postganglionic fibers – non myelinated
- SNS pre : post 1:20
- PNS pre : post 1:1 (exception 1:10,000 Auerbachs plexus)
- Key role of Ach
- Motor fiber not part of ANS
Adrenoreceptors

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha $\alpha_1$</td>
<td>Vascular smooth muscle</td>
</tr>
<tr>
<td>$\alpha_2$</td>
<td>Nerve terminals</td>
</tr>
<tr>
<td>Beta $\beta_1$</td>
<td>Cardiac muscle</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>Bronchial smooth muscle</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>Fat cells</td>
</tr>
<tr>
<td>Dopamine $D_1,5$</td>
<td>Renal, vascular smooth muscle ($D_1$)</td>
</tr>
</tbody>
</table>

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.

Cholinoreceptors

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Function</th>
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</thead>
<tbody>
<tr>
<td>Muscarinic $M_1$</td>
<td>Ganglia cells</td>
</tr>
<tr>
<td>$M_2$</td>
<td>Cardiac muscle</td>
</tr>
<tr>
<td>$M_3$</td>
<td>Sweat glands</td>
</tr>
<tr>
<td>$M_4/M_5$</td>
<td></td>
</tr>
<tr>
<td>Nicotinic $N_a$</td>
<td>Ganglia cells</td>
</tr>
<tr>
<td>$N_m$</td>
<td>Neuromuscular junction</td>
</tr>
</tbody>
</table>

Eye – Miosis, Mydriasis & Cycloplegia

- Miosis: pin point pupils
- Mydriasis: dilated pupils (bella-donna agents)
- Cycloplegia: loss of accommodation (focus)

ANS Diagram

Key Points
- Division – Anatomical
- Usually dual innervation
- Usually antagonistic
- Usually some ANS “tone”
- Usually one dominates
- Role of reflex responses

Transmitter synthesis and release