Somatic Nervous System:
• Coordinate:
  ∗ Effector:
    ⇒ Neurons:
    ∗ Neurotransmitter:
  • Denervation: Stimulates:
    ⇒ Skeletal muscle activity completely controlled by:

Autonomic Nervous System:
• Coordinate:
  ∗ Effector:
    ⇒ Viscera: Organs w/in body cavities
  ∗ Neurotransmitters:
• Denervation: Tissue maintains a:
  ∗ Autonomic Nervous System moderates:

Target Tissue Innervation:
1. Somatic Nervous System:
   • Efferent (Motor) Pathway:
     ⇒ Exit: CNS & directly innervate:
   • Effect: Motor neuron ALWAYS:
     ✓ Produce:
     ✓ Receptor & Neurotransmitter:
       ∗ Nicotinic Receptor:

2. Autonomic Nervous System
   • Efferent (Motor) Pathway:
     ⇒ Exit: CNS & indirectly innervate:
   a. Pre-ganglionic Motor Neuron
      ∗ Soma w/in:
      ∗ Synapses onto:
b. **Post-ganglionic Motor Neuron**
   - Soma w/in:
   - Synapses onto:

   - **Effect:**
     - Produce:
     - Receptors & Neurotransmitters:
       a. Alpha and Beta receptors:
       b. Muscarinic receptors:

   *(Ganglion: Collection of neuron soma outside the CNS)*

**Autonomic Nervous System:**

2 Functional Divisions:

1. **Sympathetic Nervous System (SNS):**
   - **Function:** Tissue preparation for *real or perceived*:
     "*Fight or Flight*"
   - **Effects mediated by Sympathetic NS:**
     a. Heart Rate:
     b. Breathing Rate:
     c. Gut motility:

2. **Spinal Nerves:**

   ![Diagram of Spinal Nerves]

   - **Ganglia location:** Most are:
     - Ganglia Arrangement:
b. **Parasympathetic NS**:

- **Function**: Antagonize (oppose):
  - *Rest & Digest*
- **Effects mediated by Parasympathetic NS**
  a. Heart Rate:
  b. Breathing Rate:
  c. Gut motility:
- **Spinal Nerves**:
  - **Ganglia location**: Most are *close* to:
    - Ganglia arrangement:

**Neurotransmitters of ANS**:

1. **Acetylcholine (ACh)**
   a. Released from: **ALL**:
   - *
   - **Effect Produced**:
     - ⇒ Target Cell:
     - ⇒ Target Receptor:
   b. Released from: **ALL**
   - **Effect Produced**:
     - ⇒ Target Cells:
     - ⇒ Target Receptor:
   - **ALL** issue effects mediated by ACh are termed:

2. **Norepinephrine (NE)** *(noradrenaline)*
   a. Released from:
   - **Effects Produced**:
     - ⇒ Target Cells:
     - ⇒ Target Receptors:
   - **ALL** issue effects mediated by NE are termed:

**Neurotransmitter Receptors**

1. **Nicotinic Receptors** : (N)
   - **Location**: **ALL**:
   - ⇒ Present on **ALL**:
2. **Muscarinic Receptors**: (M)

<table>
<thead>
<tr>
<th>Location</th>
<th>Mechanism</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>IPSP (K⁺ Efflux)</td>
<td>✓</td>
</tr>
<tr>
<td>GI Smooth Muscle</td>
<td>EPSP (Ca²⁺ or Na⁺ Influx)</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Significance**: Parasympathetic Nervous System uses exclusively:

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**Adrenergic (NE) Receptors**:

<table>
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<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>EPSP (Na⁺ influx)</td>
<td>✓</td>
</tr>
<tr>
<td>GI Smooth Muscle</td>
<td>IPSP (K⁺ Efflux)</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Significance**: Sympathetic Nervous System uses both:

**Clinical Applications**:

1. **Beta Blockers**: Block effects of:
   - Heart: Increases heart rate & force
   - Bronchioles: Relaxes (Dilation)
   - Skeletal muscle blood vessels: Relaxes

   - **Propanolol**;
     - **Mechanism**: Blocks
     - **Effects**:
       - Desired:
Treatment: Hypertension

- Blocks β receptor in Heart

b. Complication:

- β. Bronchioles: Constriction

→ New drugs (atenolol): More specific for β.

2. Beta Agonist: Stimulate β & β receptors

- Epinephrine Nasal Spray:
  → Mechanism: Stimulates
  → Effects:
    a. Desired:
      - Treatment: Asthma
      - Binds β receptor in Bronchiole
    b. Complication: Increased Heart rate
      - β. Heart: Increased rate

→ New drugs (Terbutaline): More specific for β.

Dual Innervation:

- Organ Innervation: Most organs are innervated by:
  * Mechanism: Effects are predominately
  * Tissue Activity: Controlled by a Complex balance between:

- Exceptions:
  * Some organs receive ONLY:
    - Most Blood Vessels
    - Arrector Pili Muscles
    - Sweat Glands of the skin
    - Adrenal Medulla

→ Mechanism of Control: Alterations in:

  → ie: Blood vessels:

  Constriction: Increased sympathetic activity
  Dilation: Decreased sympathetic activity

Study Questions:
1. What tissue type do the somatic motor neurons control? What tissue types do autonomic motor neurons control?
2. What will happen when a somatic motor neuron is cut or damaged to the effector tissue activity? What will happen to the activity of the autonomic tissue when the autonomic motor neuron is cut or damaged? What does this tell you about what the nervous systems role is in both somatic and autonomic tissue control?
3. How many motor neurons are required to control a somatic motor unit? What neurotransmitter is released from the somatic motor neuron? Is the response by target tissue always excitatory, inhibitory or a combination of both?
4. How many motor neurons are involved in coordinating autonomic tissue control? What terms are used to label these neurons? What neurotransmitters are utilized by the autonomic nervous system? Are the responses by the target tissue always excitatory, inhibitory or a combination of both?
5. With respect to pre & post ganglionic neurons of the sympathetic and parasympathetic fibers; describe which neurotransmitters are released and from these neurons. What neurotransmitter is ALWAYS released from the preganglionic neuron? What neurotransmitter is always released from the parasympathetic postganglionic neuron? What neurotransmitter is released from the postganglionic
sympathetic neuron?
Therefore: what is the “neurotransmitter of choice” for the parasympathetic nervous system? What are the effects mediated by this neurotransmitter called?
What is the “neurotransmitter of choice” for the sympathetic nervous system? What are the effects mediated by this neurotransmitter called?
6. Where are the sympathetic and parasympathetic ganglia located relative to their target tissue (ie close to target tissue or distant from target tissue)?
7. Describe how acetylcholine can mediate both excitatory and inhibitory effects. Describe how the nicotinic receptors function. What is always the response when a nicotinic receptor is used?
8. Describe how the muscarinic receptors function. What types of responses can be mediated by the muscarinic receptors?
Which of the channels is a direct ion channels and which is a G-protein moderated? Do you think there is an advantage to each type of channel?
9. What are the Norepinephrine (Adrenergic) receptors called? What neurotransmitter always stimulates the release of NE from the postganglionic neuron? What type of receptor are the alpha and beta receptors (direct or G-protein moderated)?
10. What is meant by the terms cholinergic and adrenergic? Provide some examples of each.
11. Describe what is meant by dual innervation.
12. Some tissues are only innervated by sympathetic nervous system. Describe how tissue activity is moderated if only sympathetic innervation is utilized.
13. What hormone does the adrenal gland release? What neurotransmitter does it mimic? What effect does the adrenal gland likely have in the body?