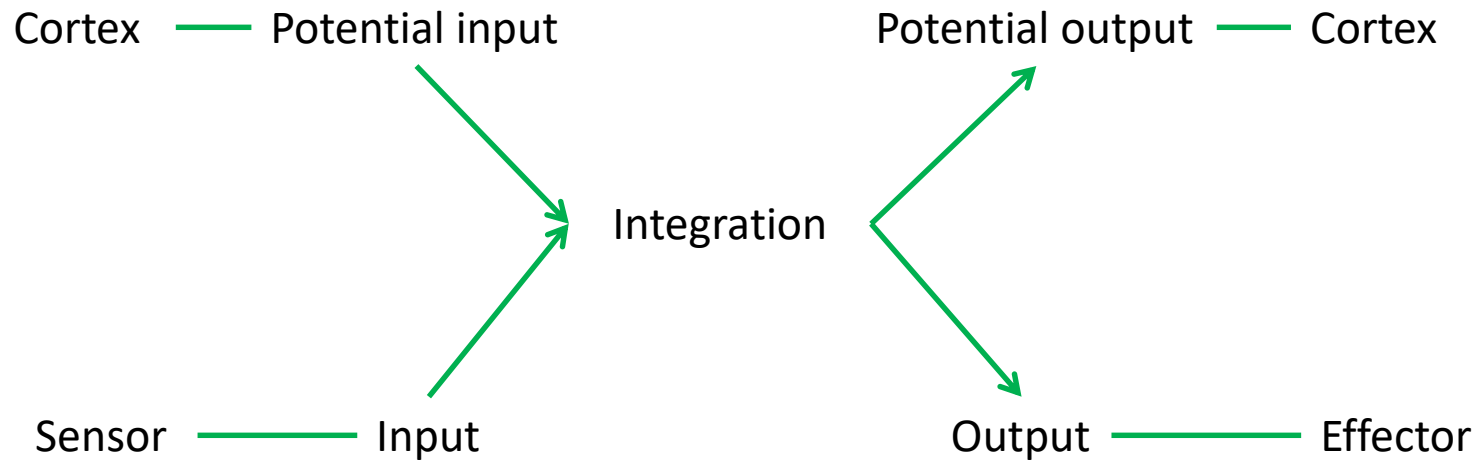


**5**

**Somatosensitivity,  
viscerosensitivity, proprioception  
and pain I**

# The role of nervous system

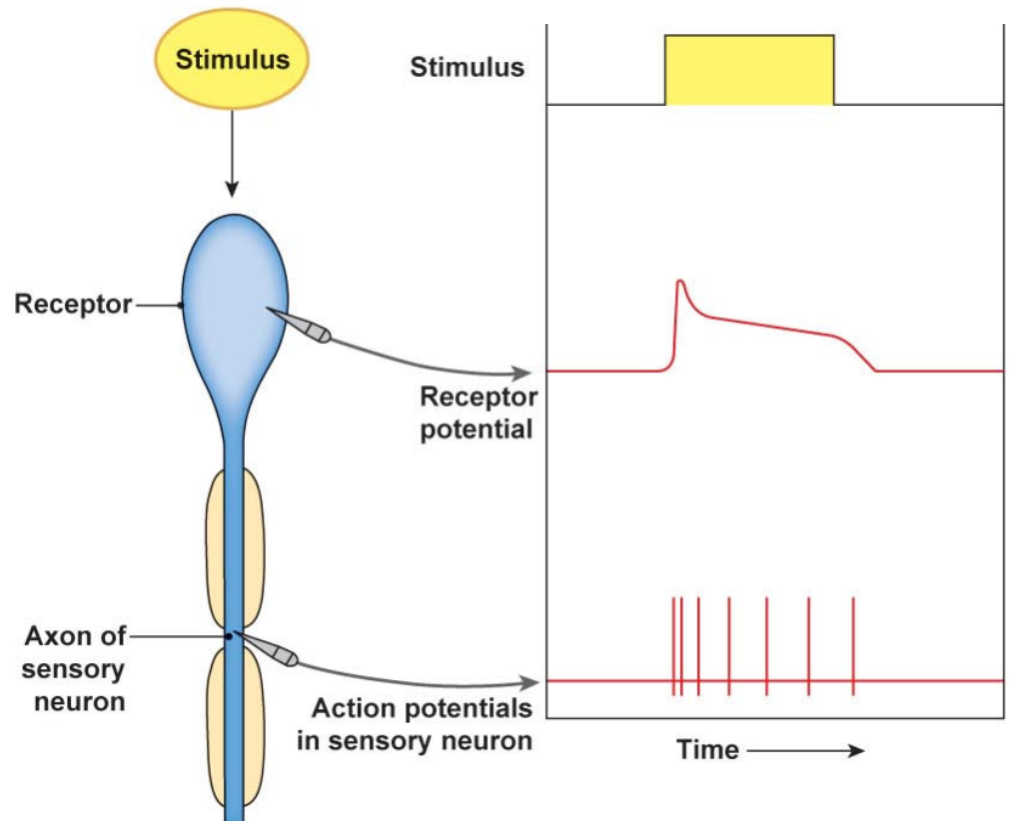
**ANTICIPATION**



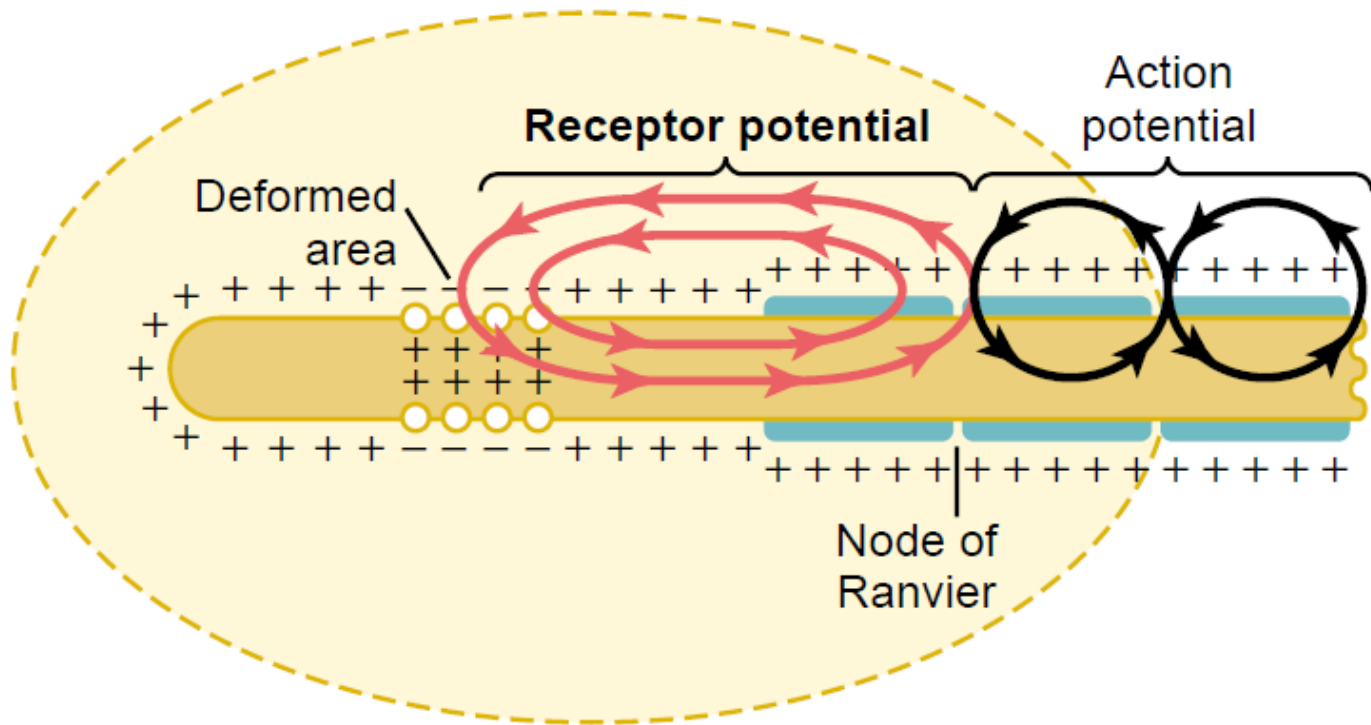
**REGULATION**

# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation
- Receptor potential
  - Generator potential
- Action potential

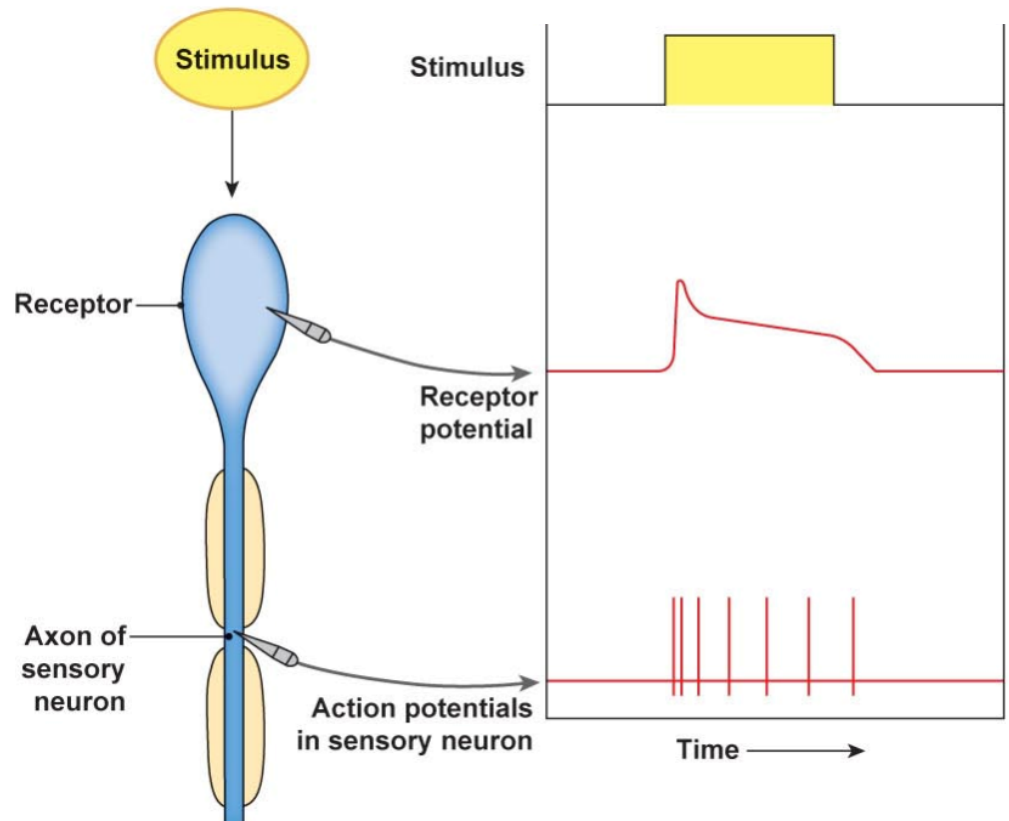


# Receptor/generator and action potential



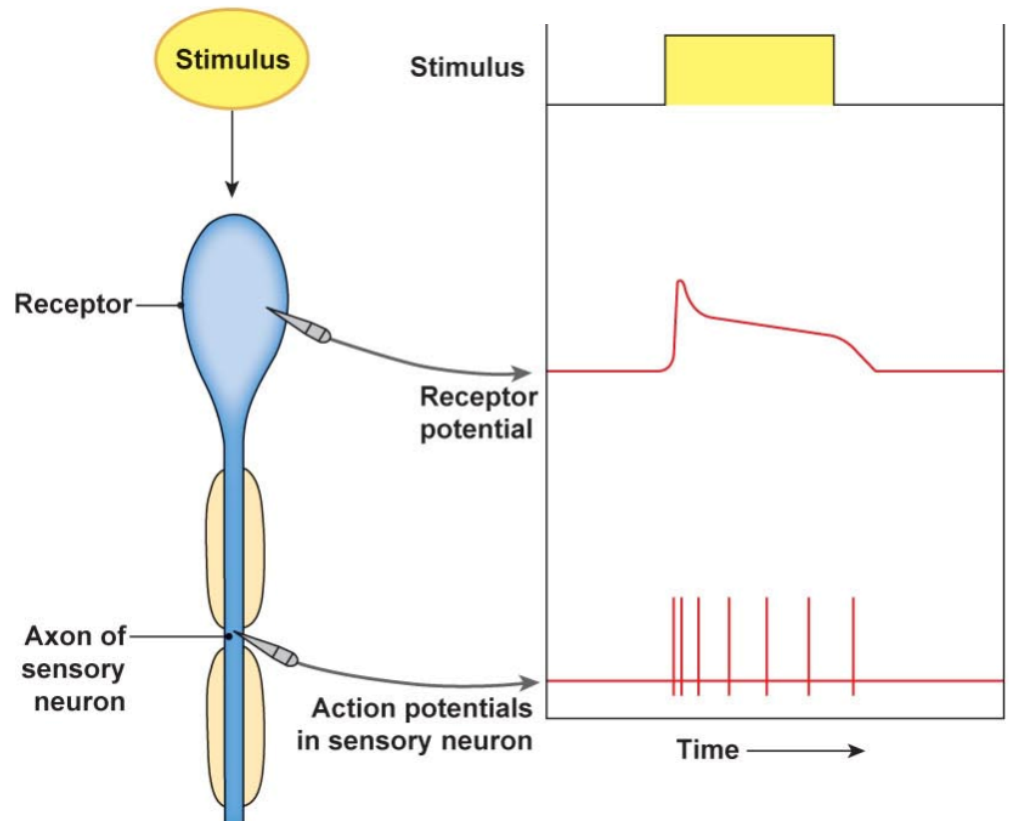
# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation
- Receptor potential
  - Generator potential
- Action potential
- Adequate stimulus
- Non adequate stimulus



# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation
- Receptor potential
  - Generator potential
- Action potential
- Adequate stimulus
- Non adequate stimulus
- Mechanoreceptors
- Thermoreceptors
- Chemoreceptors
- Fotoreceptors



# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation

- Receptor

- C

- A

- Ad

- Non

- Mecha

- Thermo

- Chemore

- Fotoreceptors

**Basic attributes of stimulus**

**Qualitative**

**Modality - What?**

**Localization - Where?**



# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation

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- Fotoreceptors

**Basic attributes of stimulus**

**Qualitative**

Modality - What?

Localization - Where?

**Quantitative**

Intensity - How much?





# Receptors/sensors

- Energy convertor
  - Signal reception
  - Signal transformation

- Receptor

- C

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- Non

- Mecha

- Thermo

- Chemore

- Fotoreceptors

**Basic attributes of stimulus**

**Qualitative**

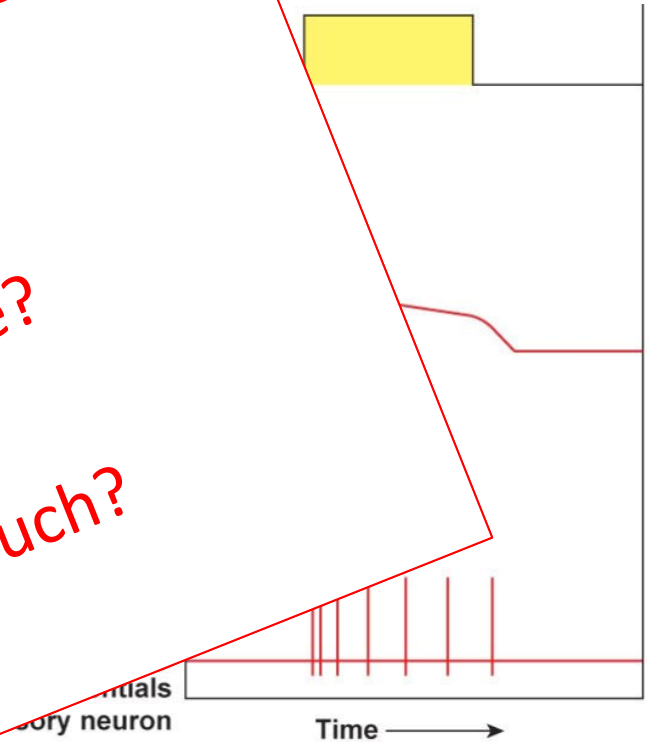
Modality - What?

Localization - Where?

**Quantitative**

Intensity - How much?

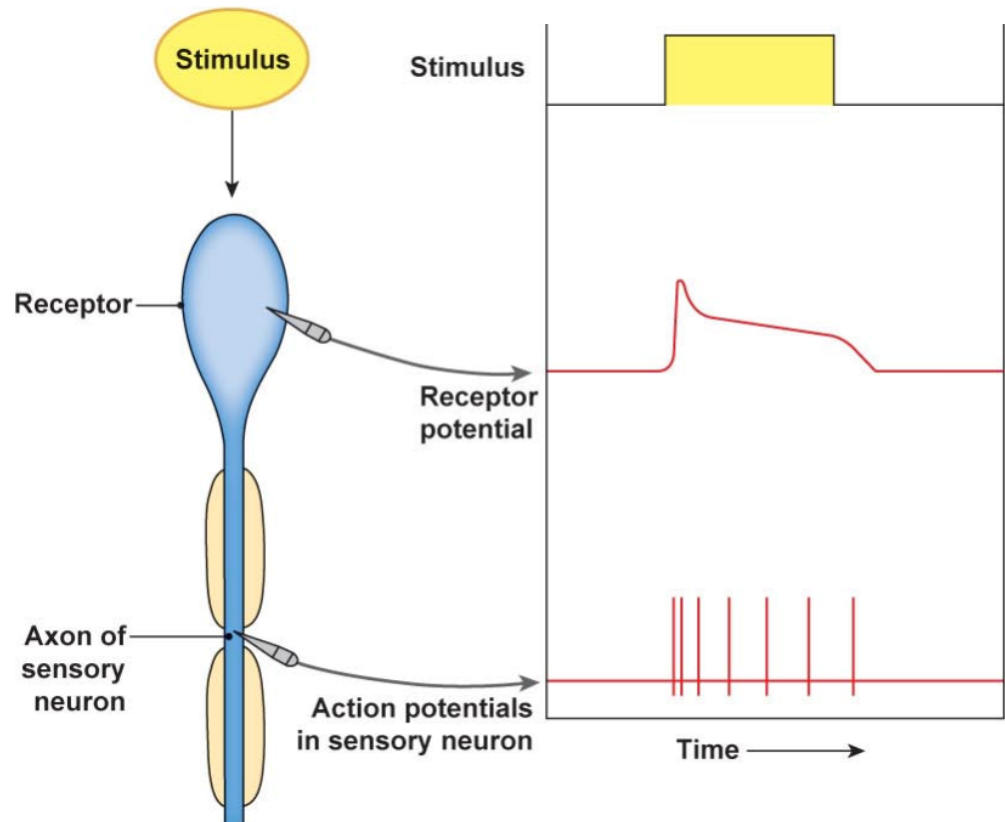
**Duration**



# Intensity coding

**How much?**

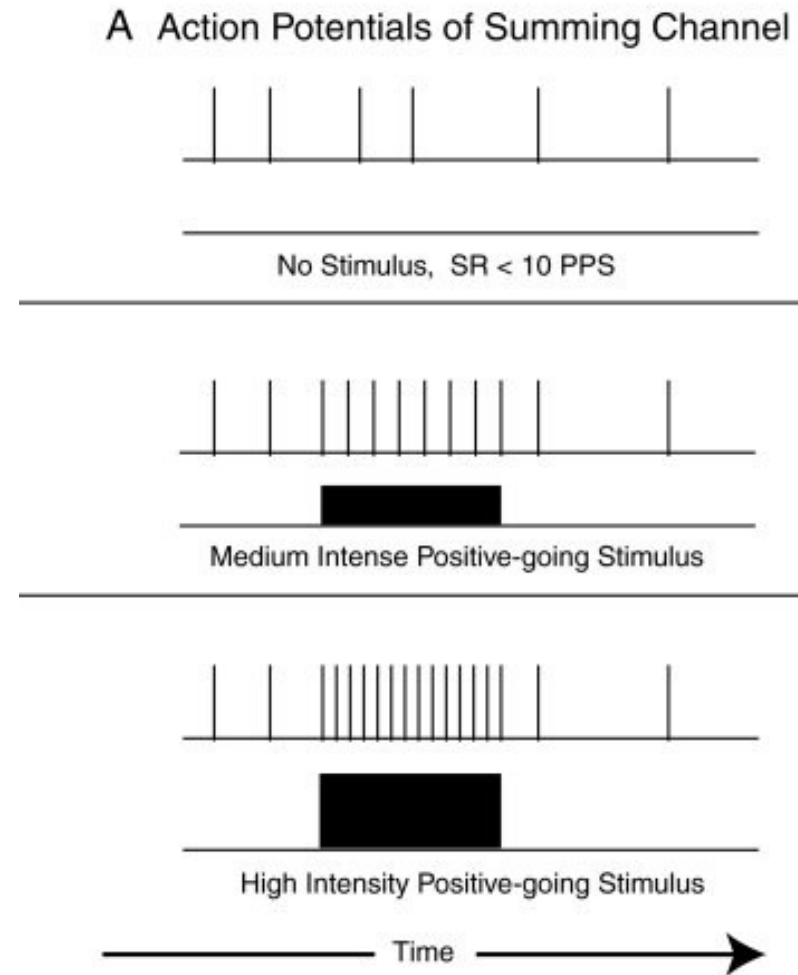
- Amplitude of receptor potential is transduced into the frequency of AP



# Intensity coding

How much?

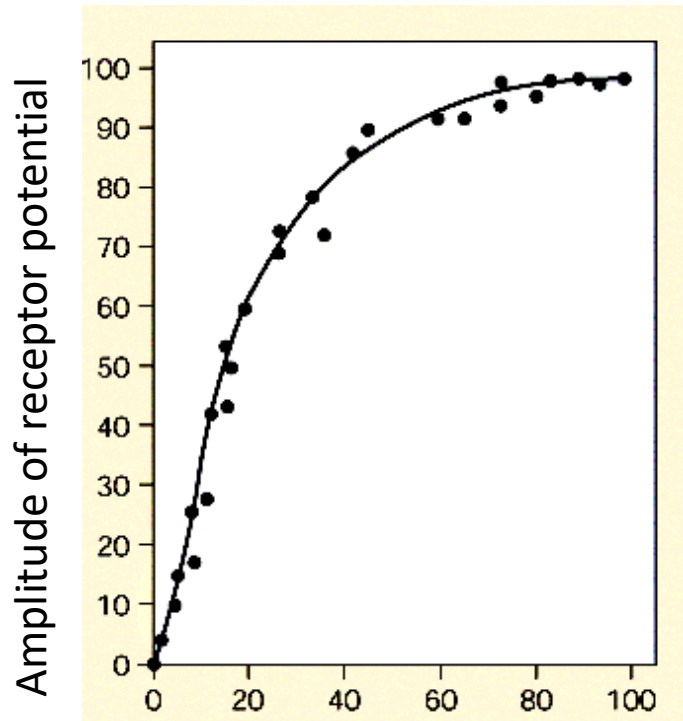
- In other words: an increased intensity is associated with increase in frequency of AP
- A high-intensity stimulus may also activate more receptors



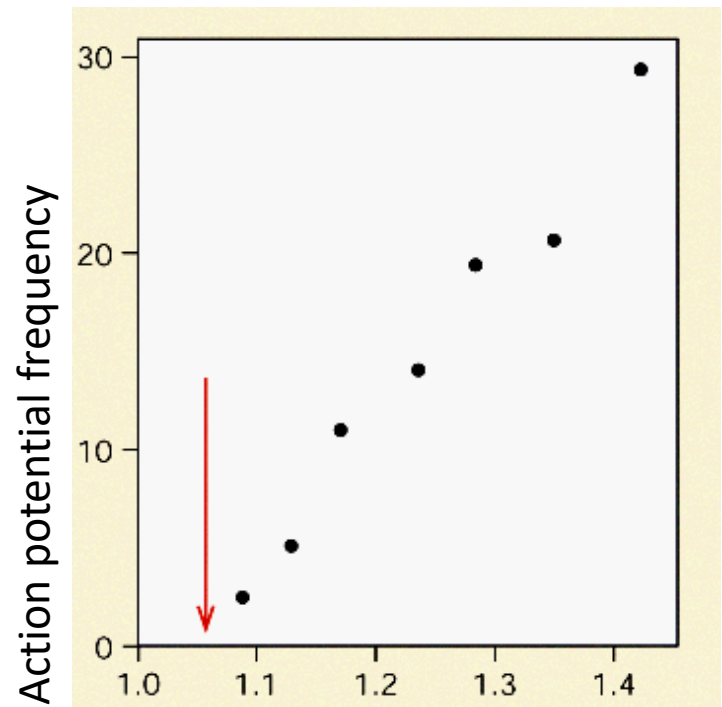
# Intensity coding

How much?

Relation between receptor and action potential is logarithmic



Stimulus intensity

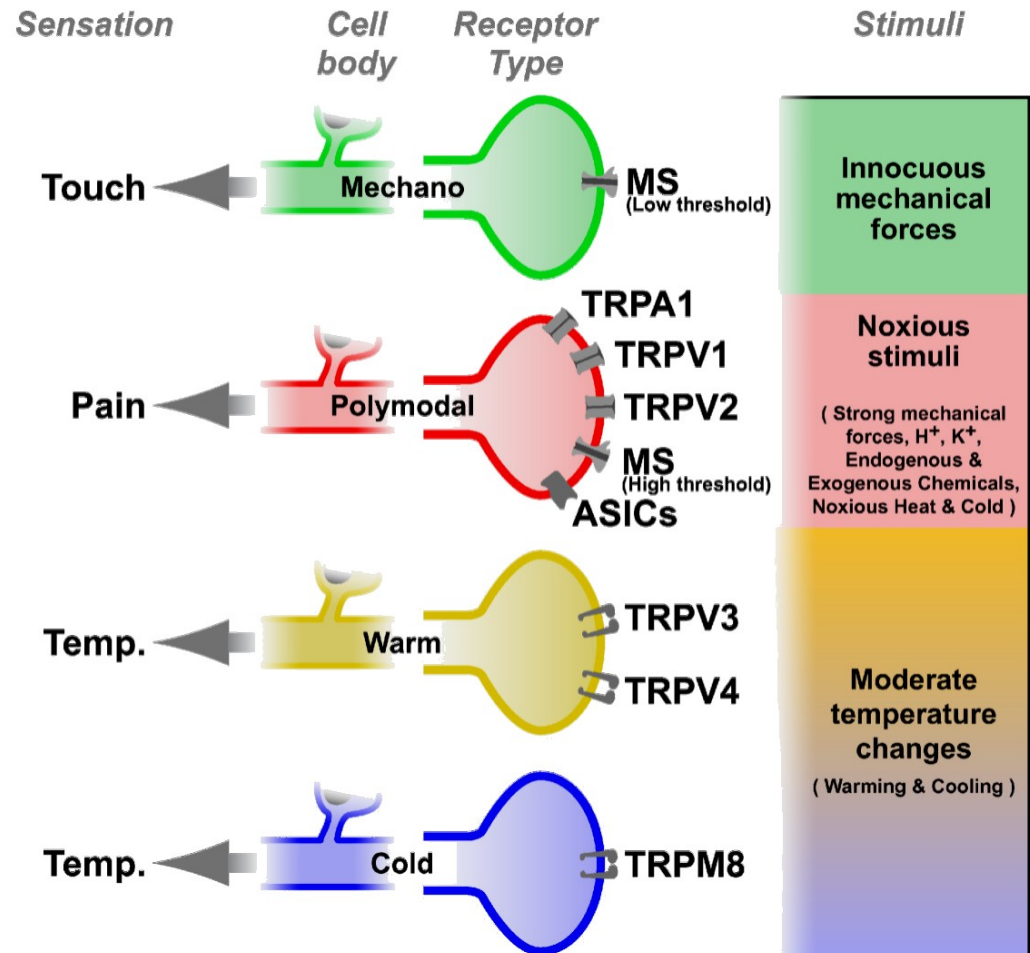


Stimulus intensity

# Qualitative information

**What?  
Where?**

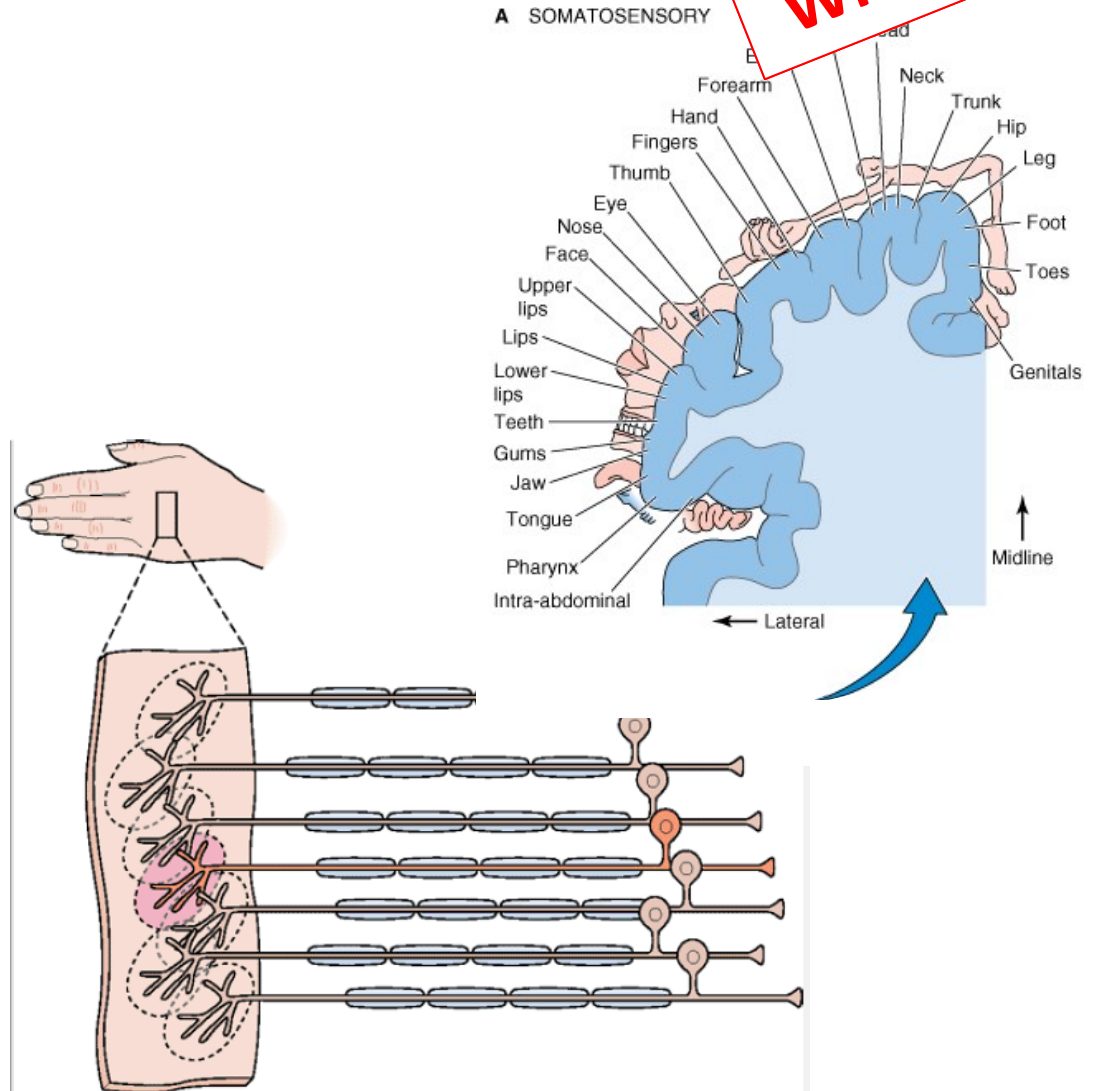
- **The law of specific nerve energies:**  
The nature of perception is defined by the pathway over which the sensory information is carried
- Labeled line coding define the information about quality



# Qualitative information

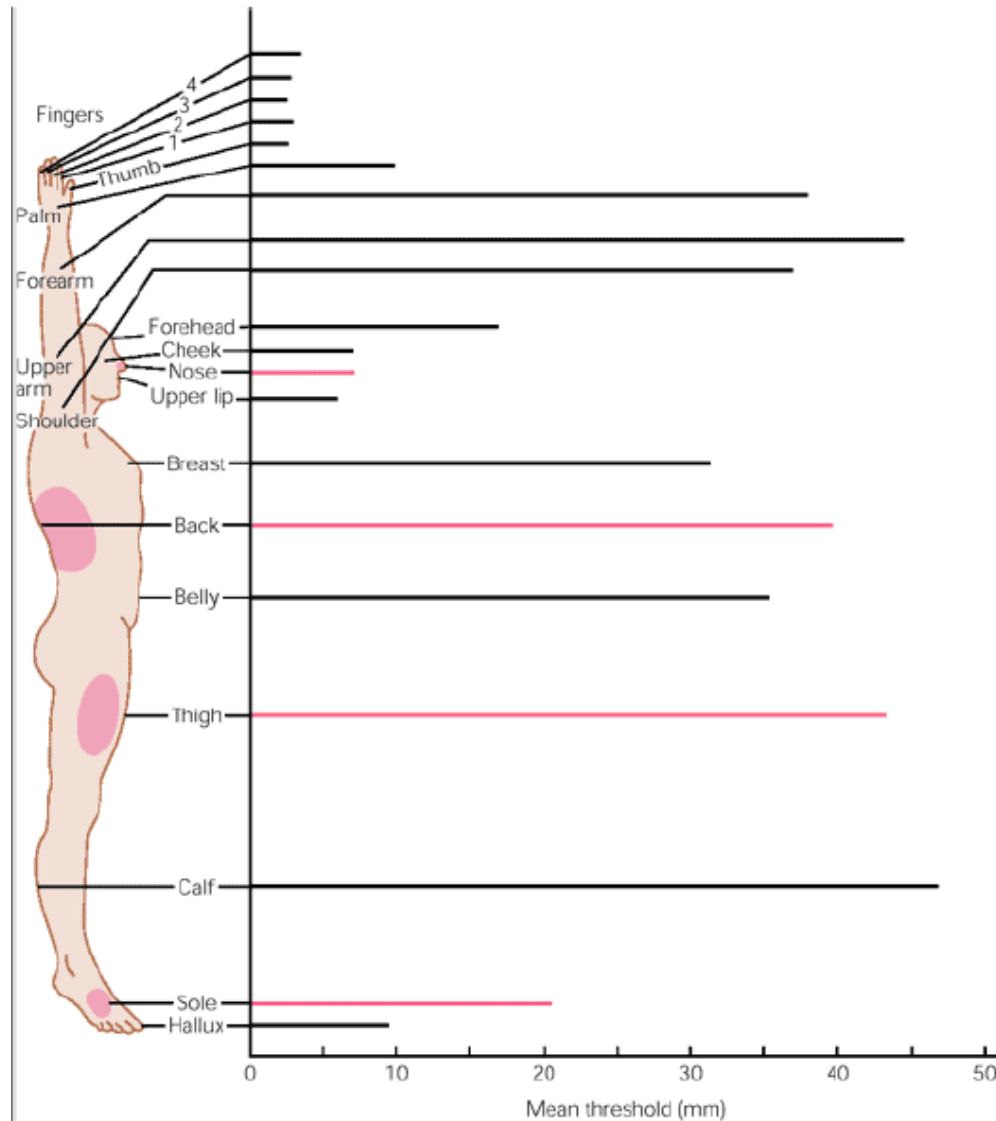
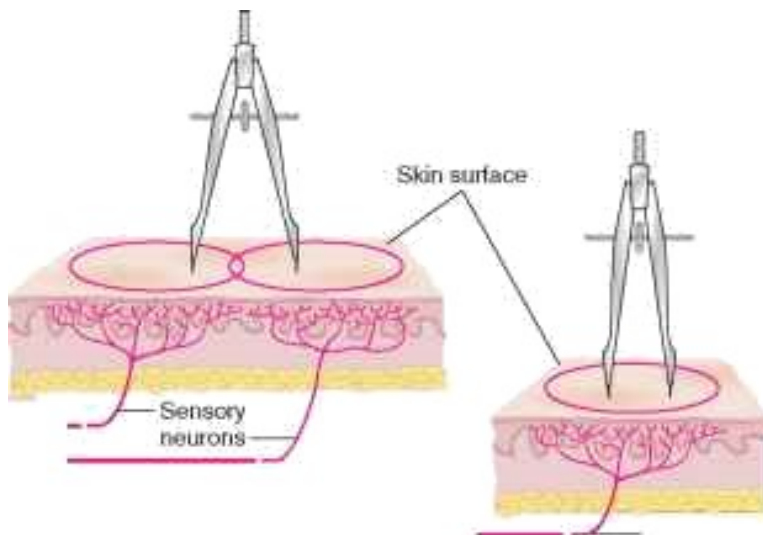
What?  
Where?

- Labeled line coding
- Receptive field
- Nerve stimulation mimics receptor stimulation

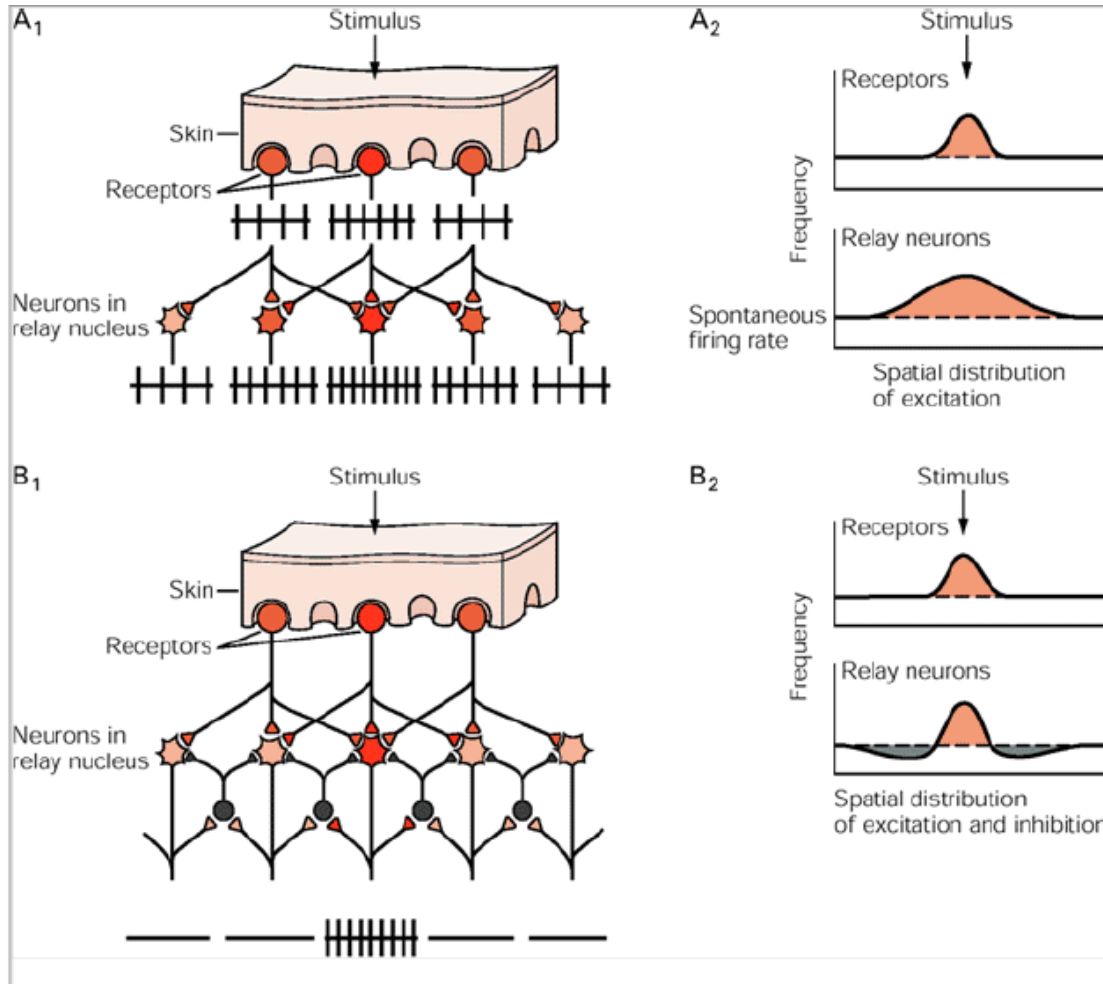


# Receptive fields

- Various size and overlay
- Small receptive field – high resolution
- Spatial resolving power increased by lateral inhibition



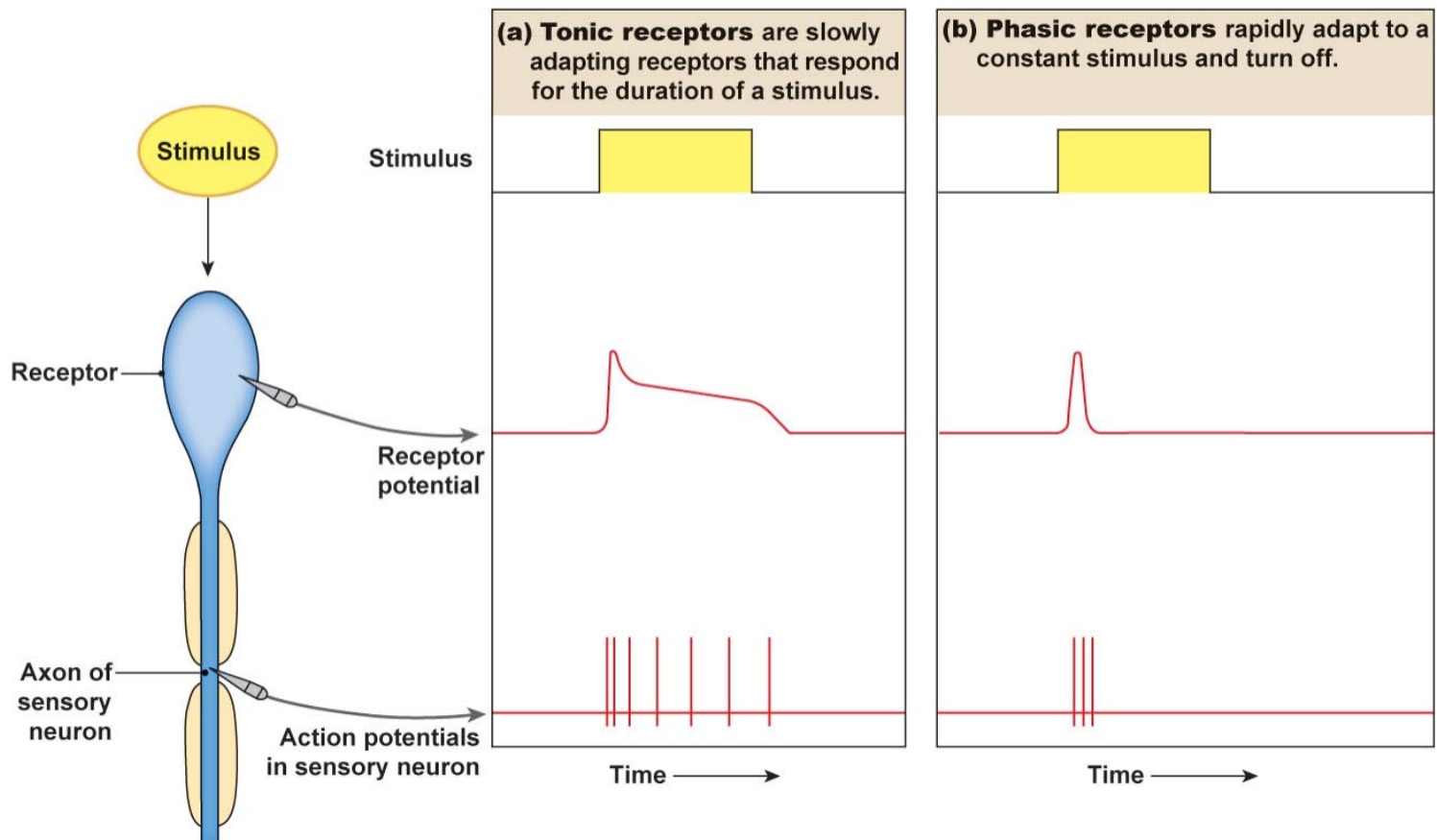
# Lateral inhibition





# Receptor adaptation

- The decline of receptor responses in spite of stimulus presence
- Tonic receptors – slow adaptation – presence of stimulus, position
- Phasic receptors – rapid adaptation – change of stimulus



# Receptors

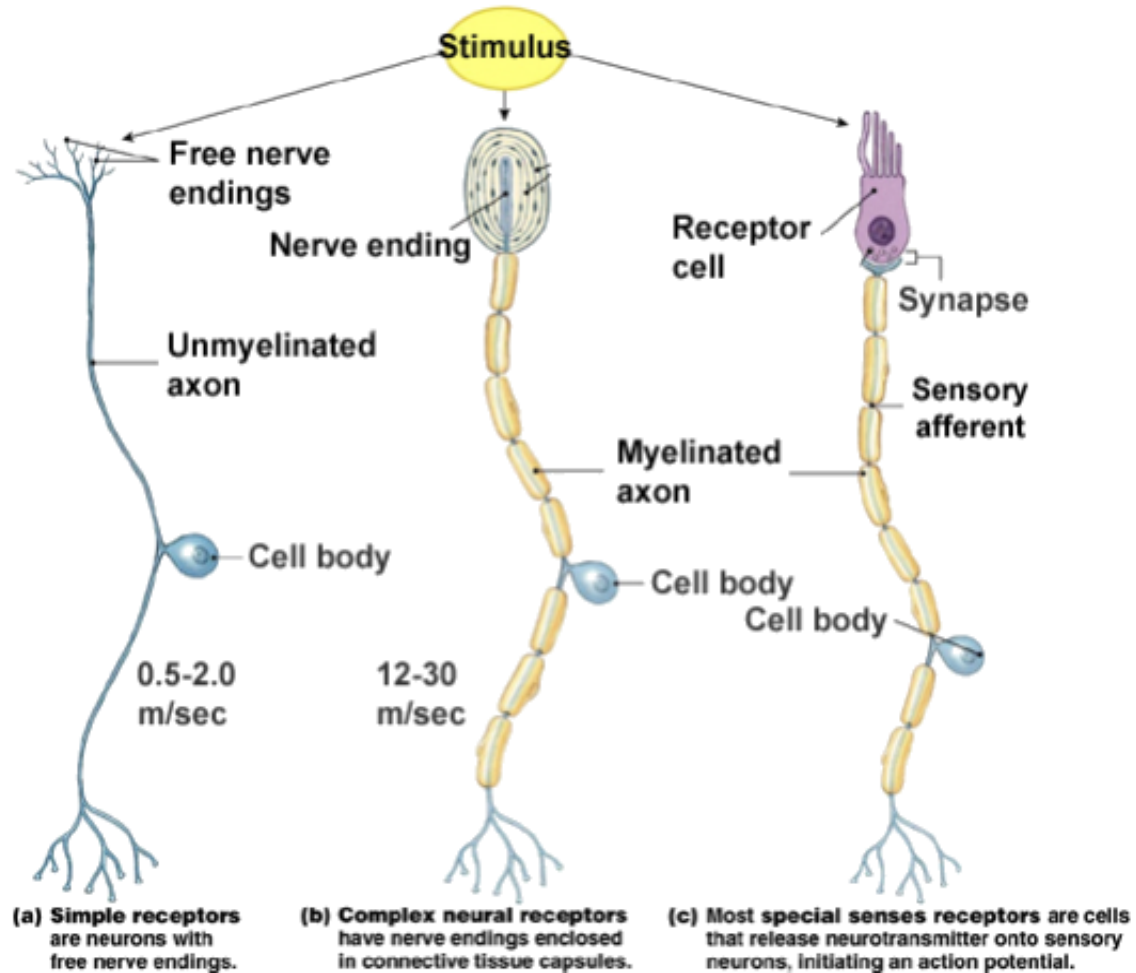
- General
  - Superficial – somatosensors
  - Deep – viscerosensors
  - Muscles, tendons, joints – proprioceptors
- Special
  - Part of sensory organs

# Receptors

- General
  - Superficial – somatosensors
  - Deep – viscerosensors
  - Muscles, tendons, joints – proprioceptors
- Special
  - Part of sensory organs
- Mechanoreceptors
- Thermoreceptors
- Chemoreceptors
- Photoreceptors

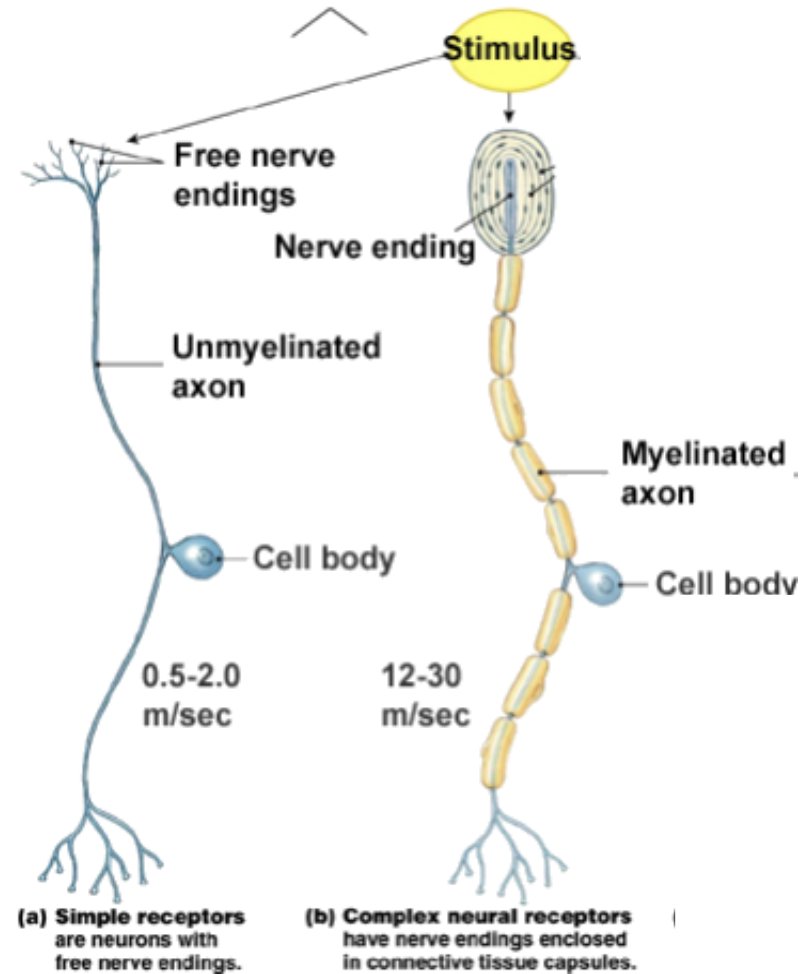
# Receptors

- Simple
- Complex
- General
  - Superficial – somatosensor
  - Deep – viscerosensors
  - Muscles, tendons, joints – proprioceptors
- Special
  - Part of sensory organs
- Mechanoreceptors
- Thermoreceptors
- Chemoreceptors
- Photoreceptors



# Somato/viscero/ proprio sensitivity

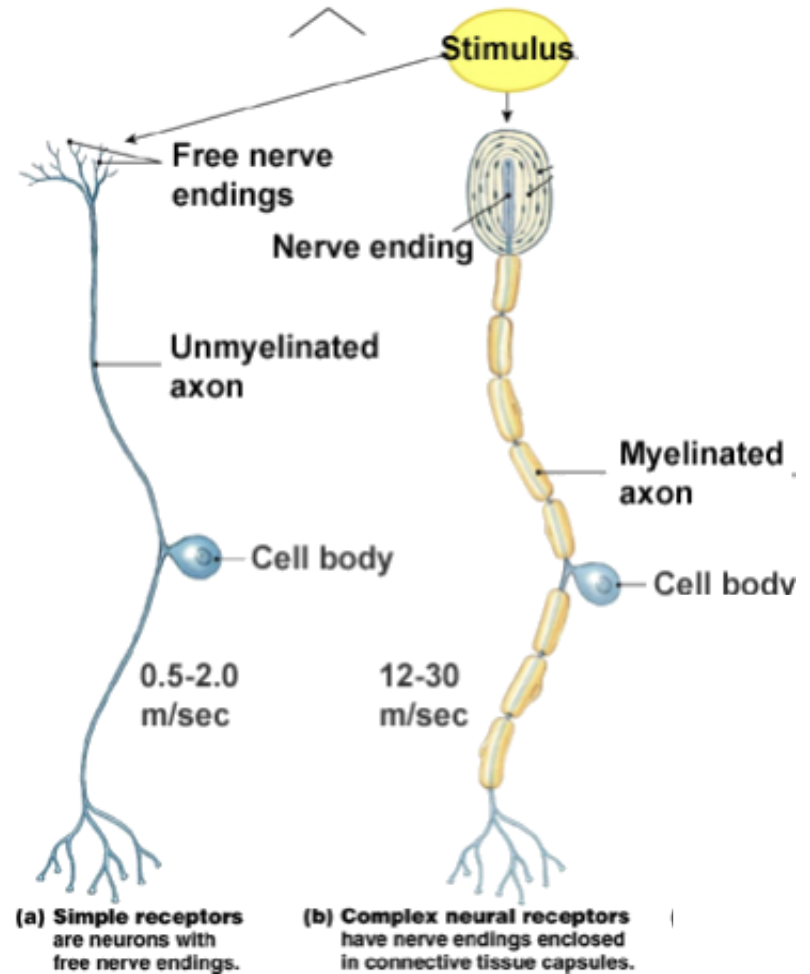
- Somatosemsitivity
  - Pain
  - Temperature
  - Touch
- Viscerosensitivity
  - Pain
- Proprioception
  - Position
  - Movement



# Somato/viscero/ proprio sensitivity

- Somatosemsitivity
  - Pain
  - Temperature
  - Touch
- Viscerosensitivity
  - Pain
- Proprioception
  - Position
  - Movement

**The majority of  
information does not reach  
consciousnes**

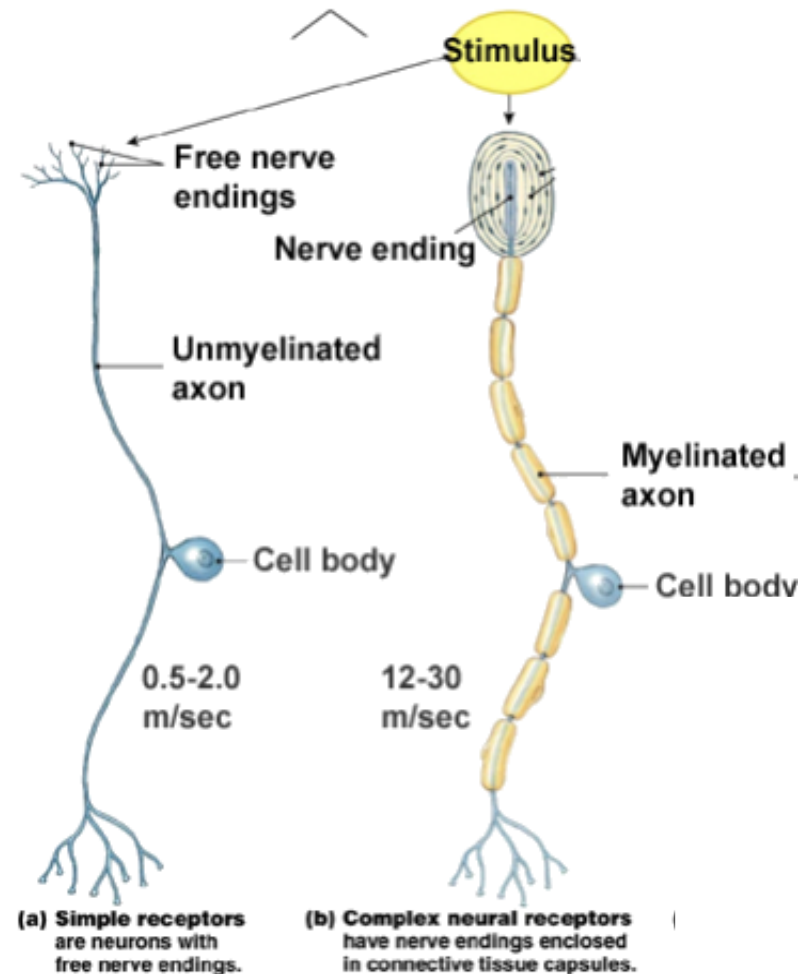


# Somato/viscero/ proprio sensitivity

- Somatosemsitivity
  - Pain
  - Tempera
  - Touch
- Viscerosensitivity
  - Pain
- Proprioception
  - Position
  - Movement

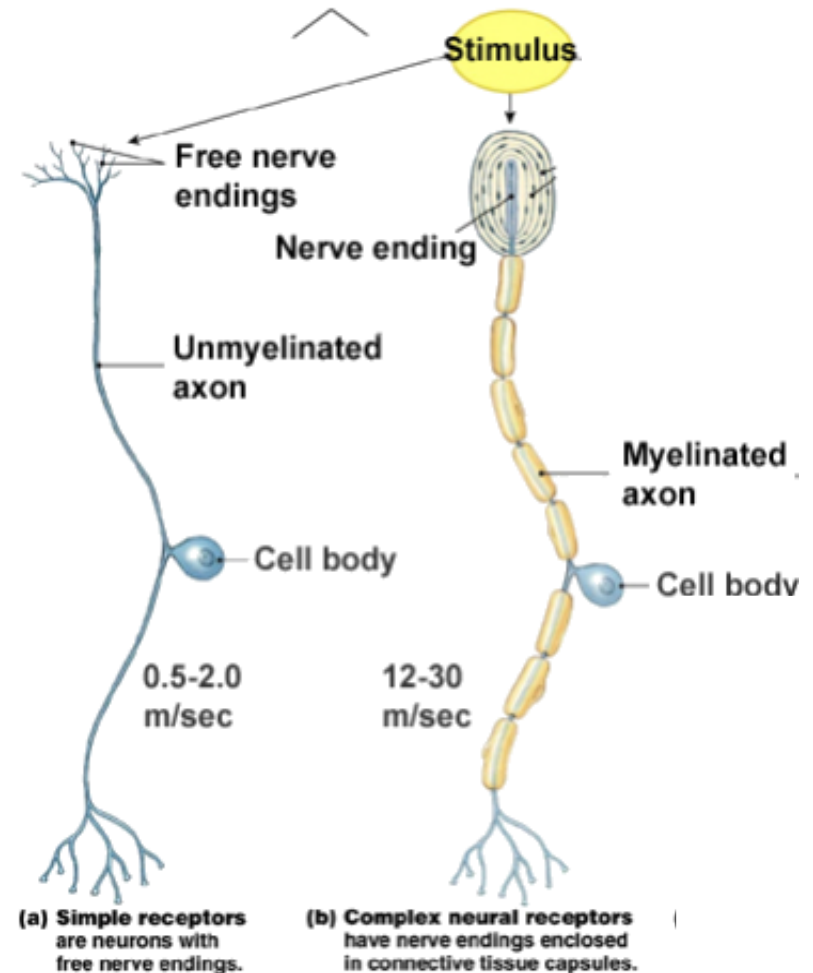
**Evolutionary  
point of view**

**The majority of  
information does not reach  
consciousnes**



# Evolutionary point of view

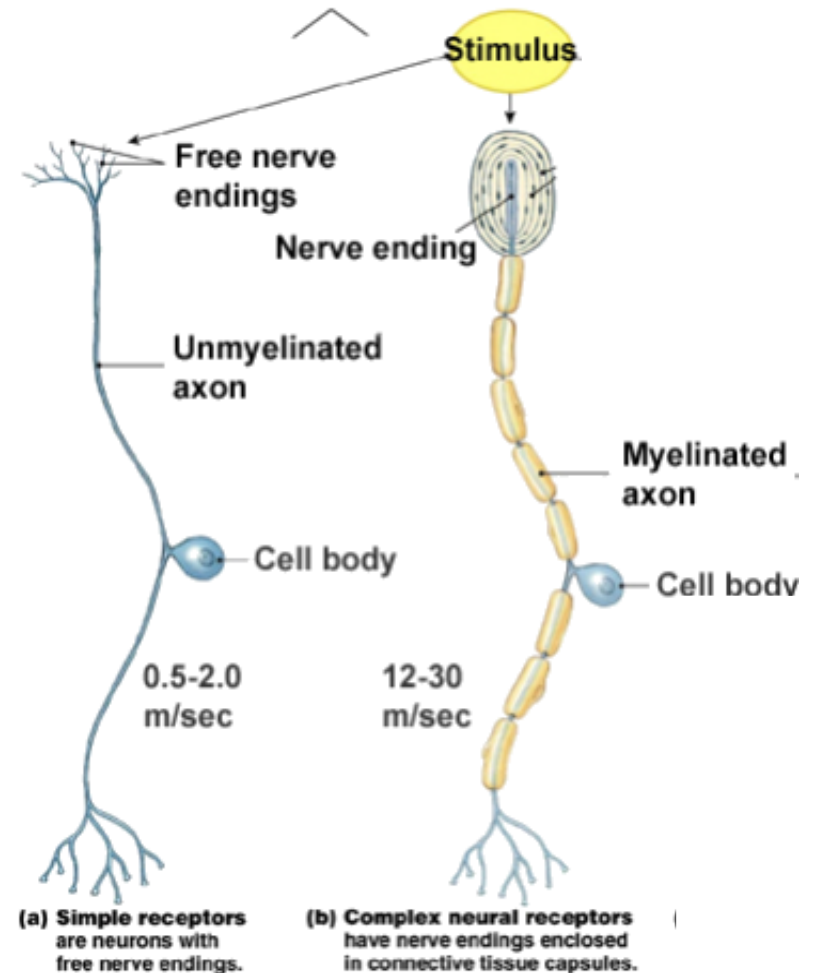
- The signals indicating potential damage are the most important and the corresponding systems evolved early
  - Pain
  - Temperature





# Evolutionary point of view

- The signals indicating potential damage are the most important and the corresponding systems evolved early
  - Pain
  - Temperature
- The touch signals have adaptive value and evolved later



# Evolutionary point of view

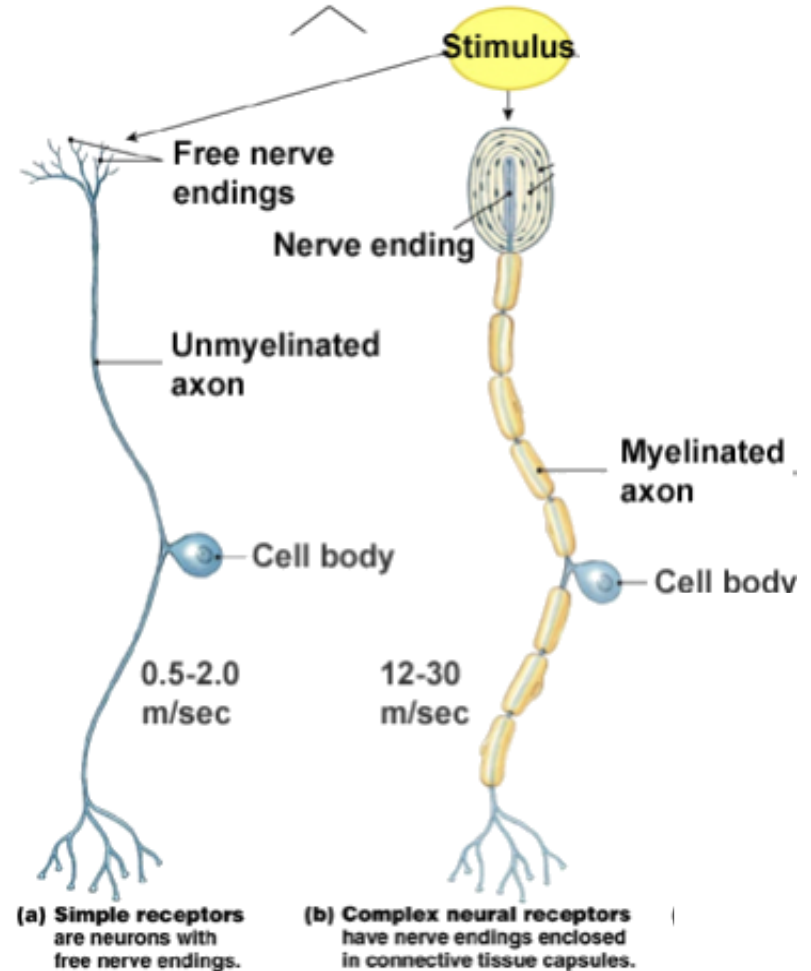
- The signals indicating potential damage are the most important and the correct response evolved

**Immediate survival**

- Temperature

- The signals have adaptive value

**Long-term survival**



# Evolutionary point of view

- The signals indicating potential damage are the most primitive and the corresponding receptors evolved

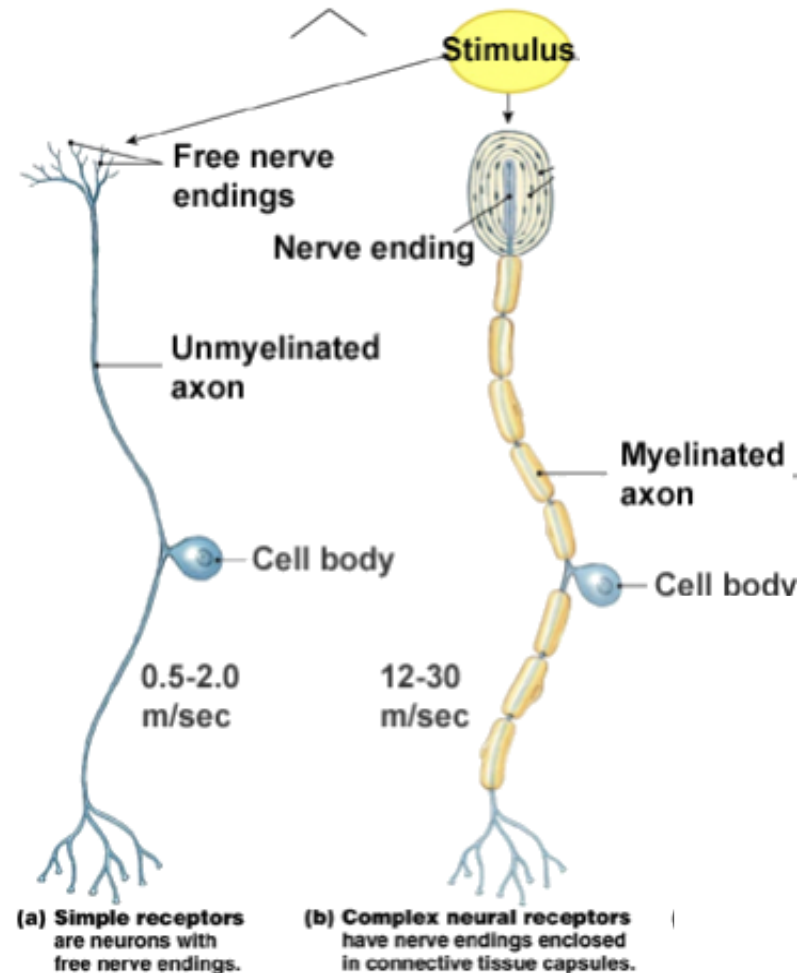
**Immediate survival**

- Temperature

**Long-term survival**

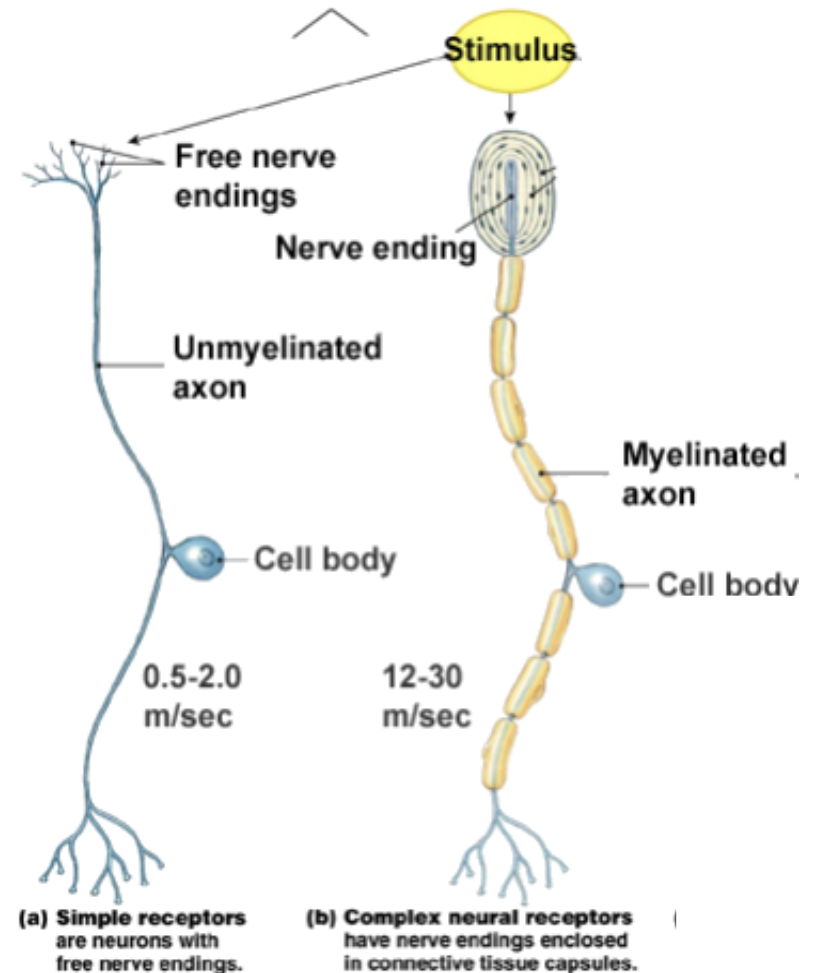
- The receptors have adaptive value

- The structure of the receptor, nerve fibers and pathways reflects the evolution

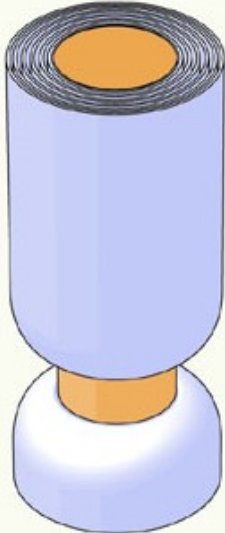





# Free nerve endings

- Non-specialized nerve endings
- Polymodal
  - Nociception
  - Thermoreception
  - Mechanoreception
- A delta fibres
- C fibres



# Nerve fibres

Axons from skin	A $\alpha$	A $\beta$	A $\delta$	C
Axons from muscles	Group I	II	III	IV
				
Diameter ( $\mu\text{m}$ )	13–20	6–12	1–5	0.2–1.5
Speed (m/sec)	80–120	35–75	5–30	0.5–2
Sensory receptors	Proprioceptors of skeletal muscle	Mechanoreceptors of skin	Pain, temperature	Temperature, pain, itch

# Nociceptors

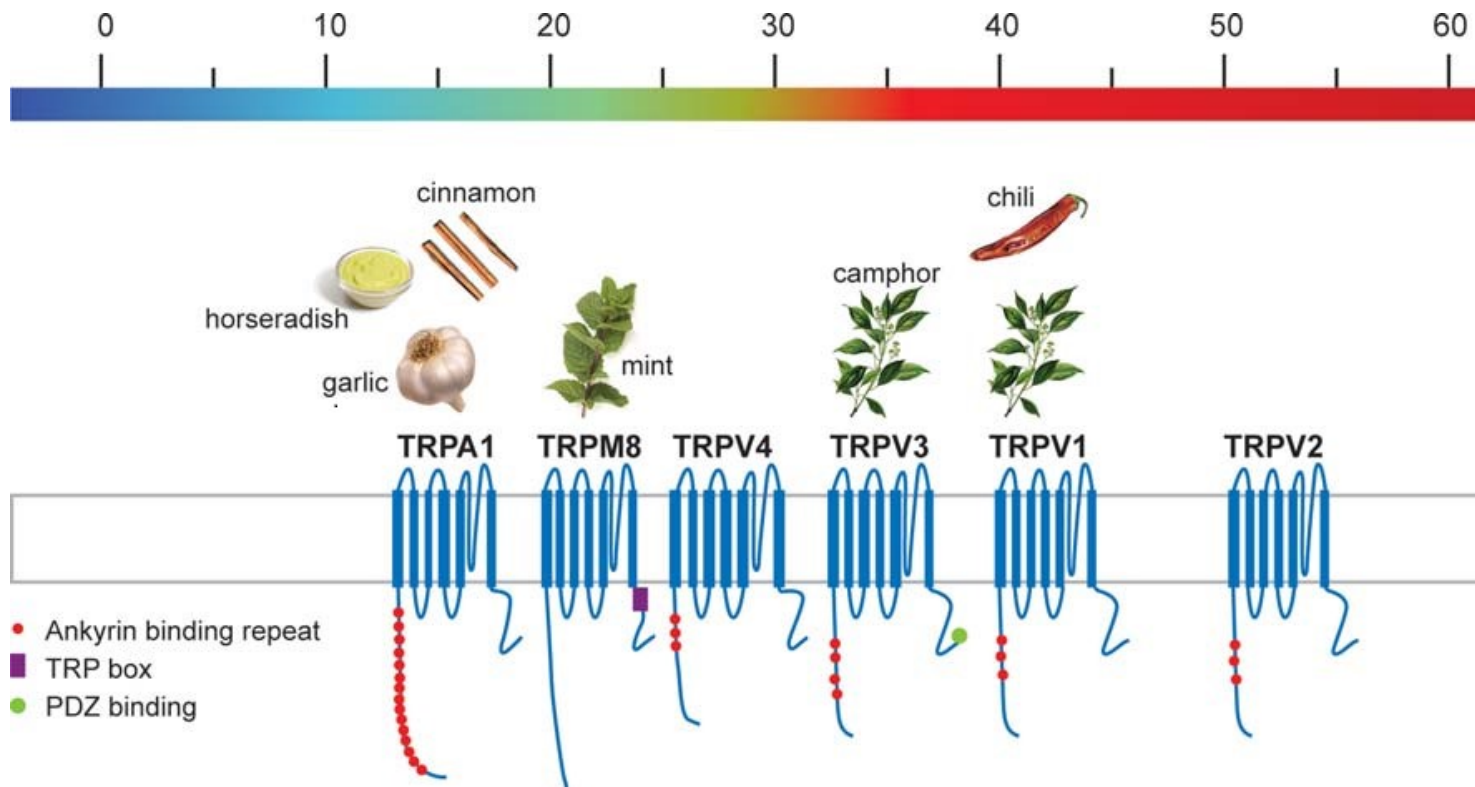
- Free nerve endings responding to high-intensity stimuli
- Stimulus
  - Mechanical
    - ✓ High pressure
    - ✓ Sharp object
  - Thermal
    - ✓ Above approx. 45°C
    - ✓ Low threshold – variable
  - Chemical
    - ✓ pH
    - ✓ Mediators of inflammation and so on

**A delta fibers**  
– sharp, localised pain

**C fibers**  
– dull, diffuse pain

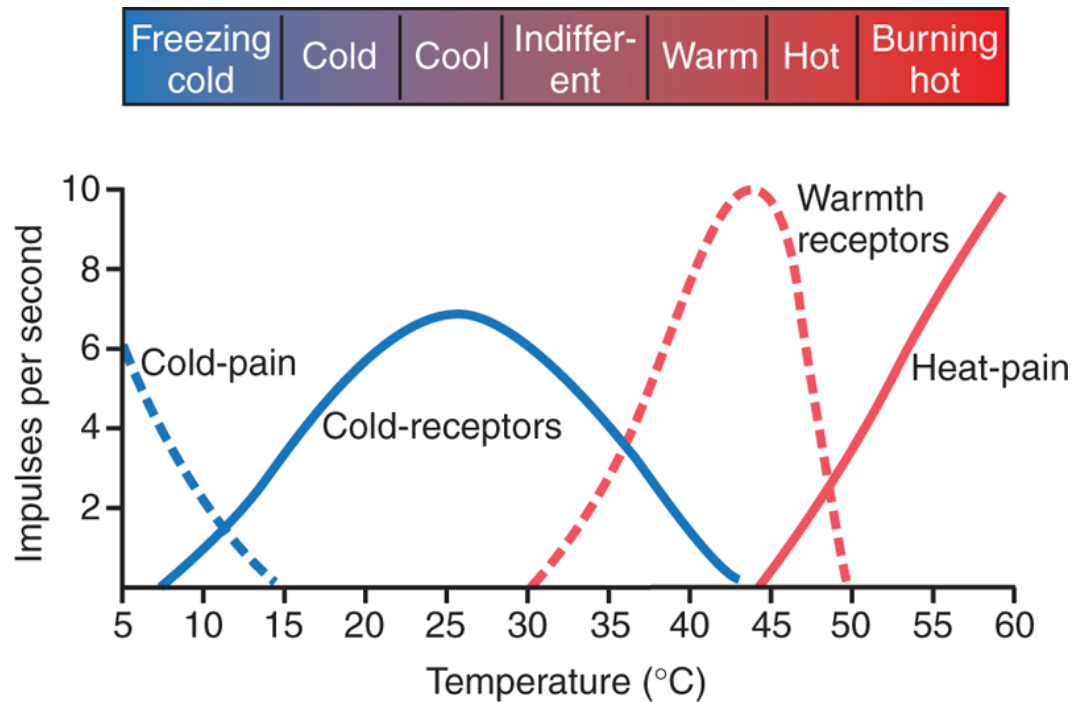
# Thermoreceptors

- Free nerve endings receptive to thermal stimuli
- TRP (transient receptor potential) channels
- Each subtype of TRP channel receptive to sensitive to a certain temperature and chemical substance



# Thermoreceptors

- Perceived temperature is determined by relative activity of cold and warm receptors



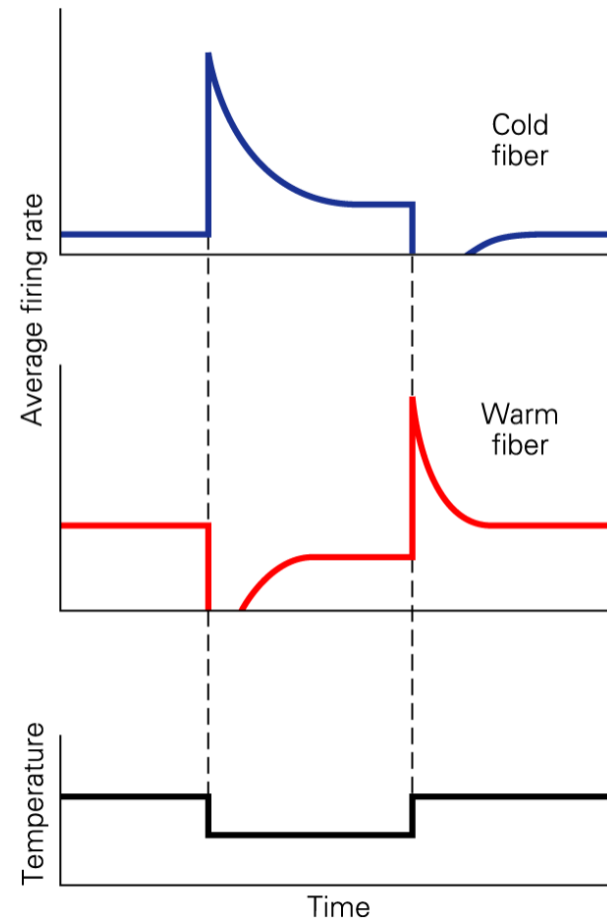
Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition  
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# Thermoreceptors

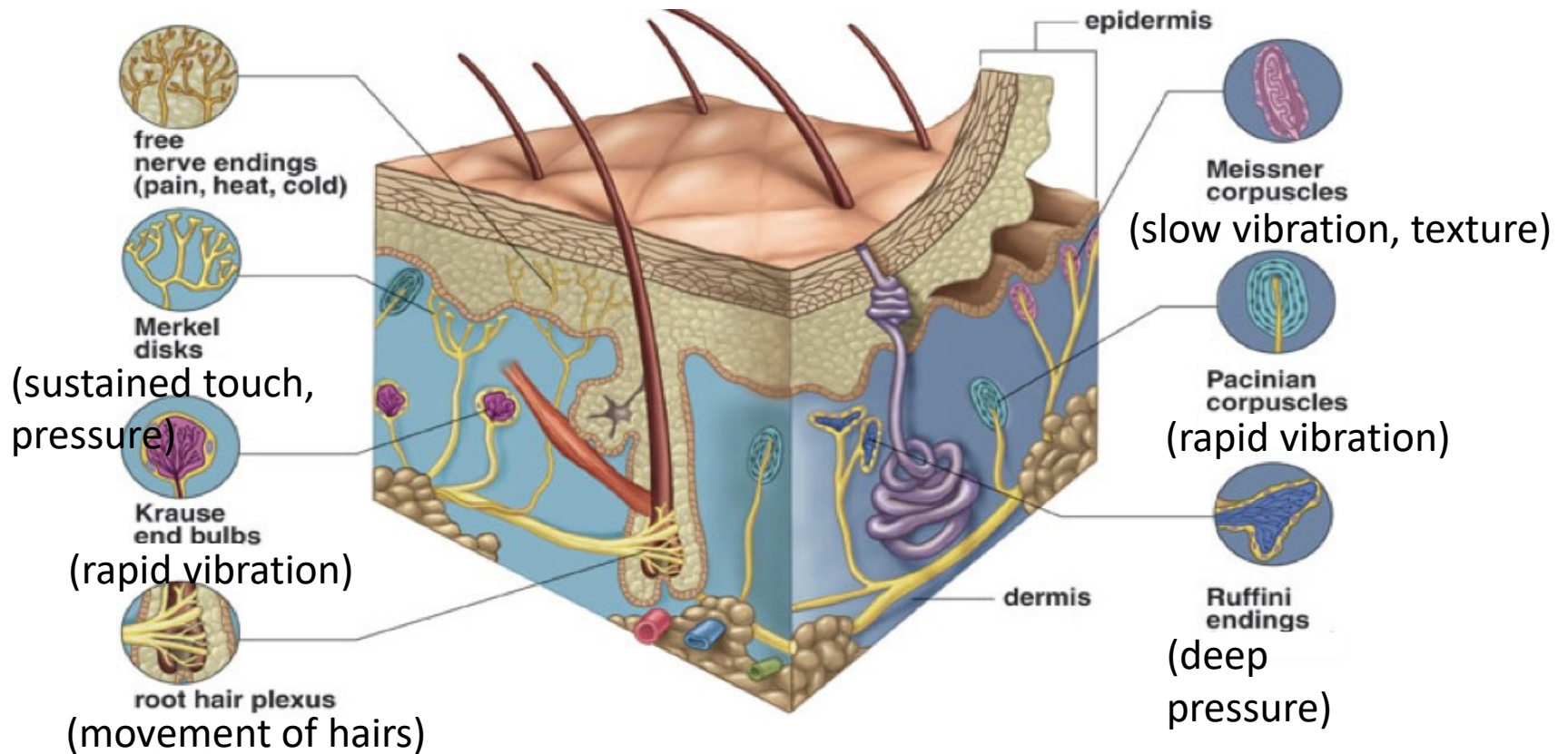
- Mostly phasic response

B Dynamic temperature

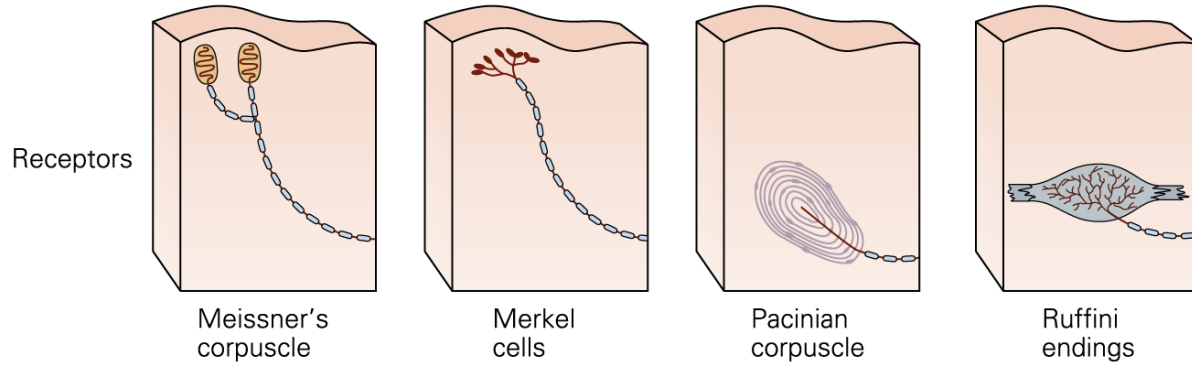


# The receptors of the skin

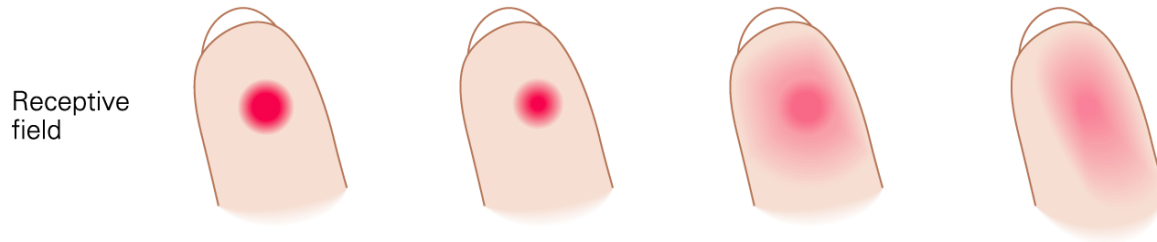
## Simple versus complex



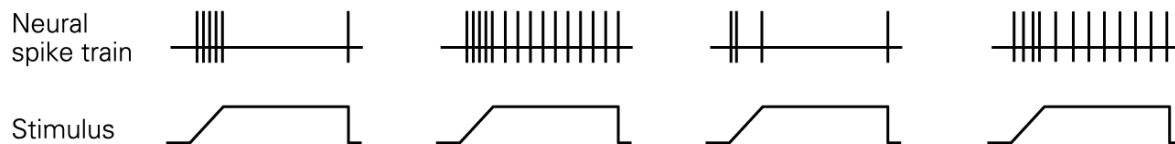
# The receptors of the skin



## B Location



## C Intensity and time course



# The receptors of the skin

Receptor	Type	Sensation	Signals	Adaptation
<b>Meissner corpuscle</b>	Encapsulated & layered	Touch: Flutter & Movement	Frequency/Velocity & Direction	Rapid
<b>Pacinian corpuscle</b>	Encapsulated & layered	Touch: Vibration	Frequency: 100-300 Hz	Rapid
<b>Ruffini corpuscle</b>	Encapsulated collagen	Touch: Skin Stretch	Direction & Force	Slow
<b>Hair follicle</b>	Unencapsulated	Touch: Movement	Direction & Velocity	Rapid
<b>Merkel complex</b>	Specialized epithelial cell	Touch, Pressure, Form	Location & Magnitude	Slow
<b>Free Nerve Ending</b>	Unencapsulated	Pain, Touch, or Temperature	Tissue damage, Contact, or Temperature change	Depends on information carried