

M U N I

M E D

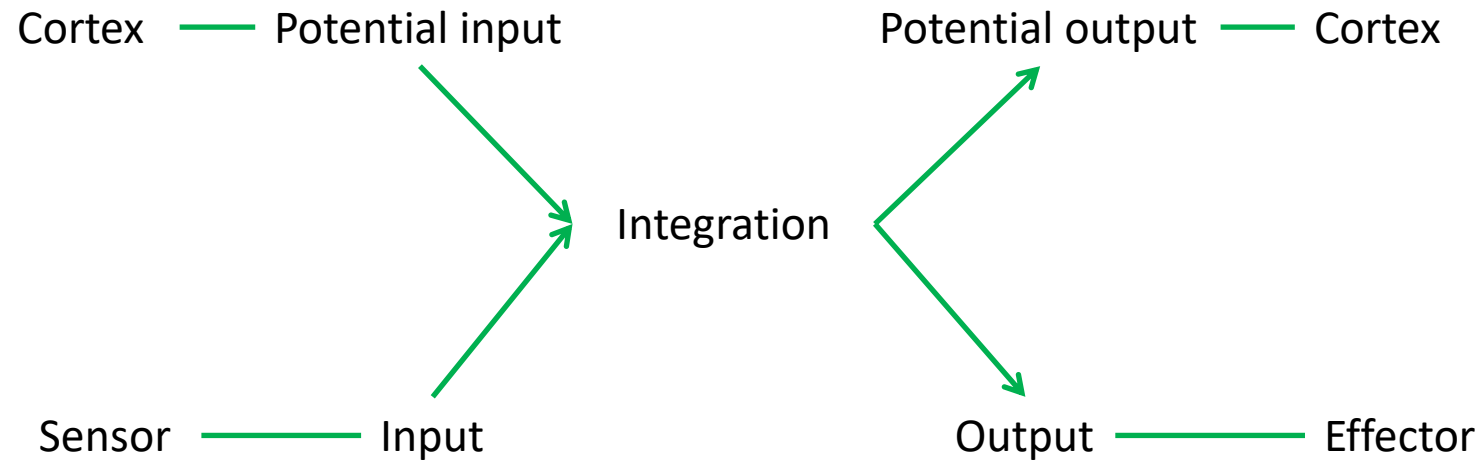
**M U N I**  
**M E D**

**5**

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

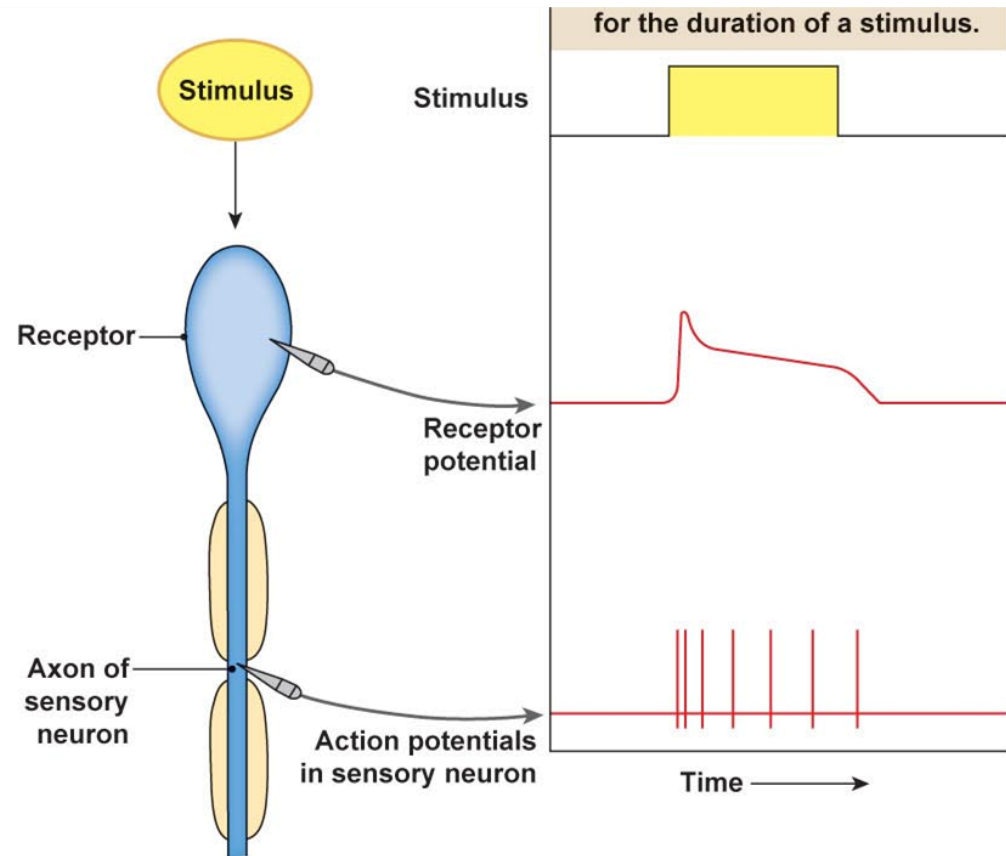
# The role of nervous system

**ANTICIPATION**



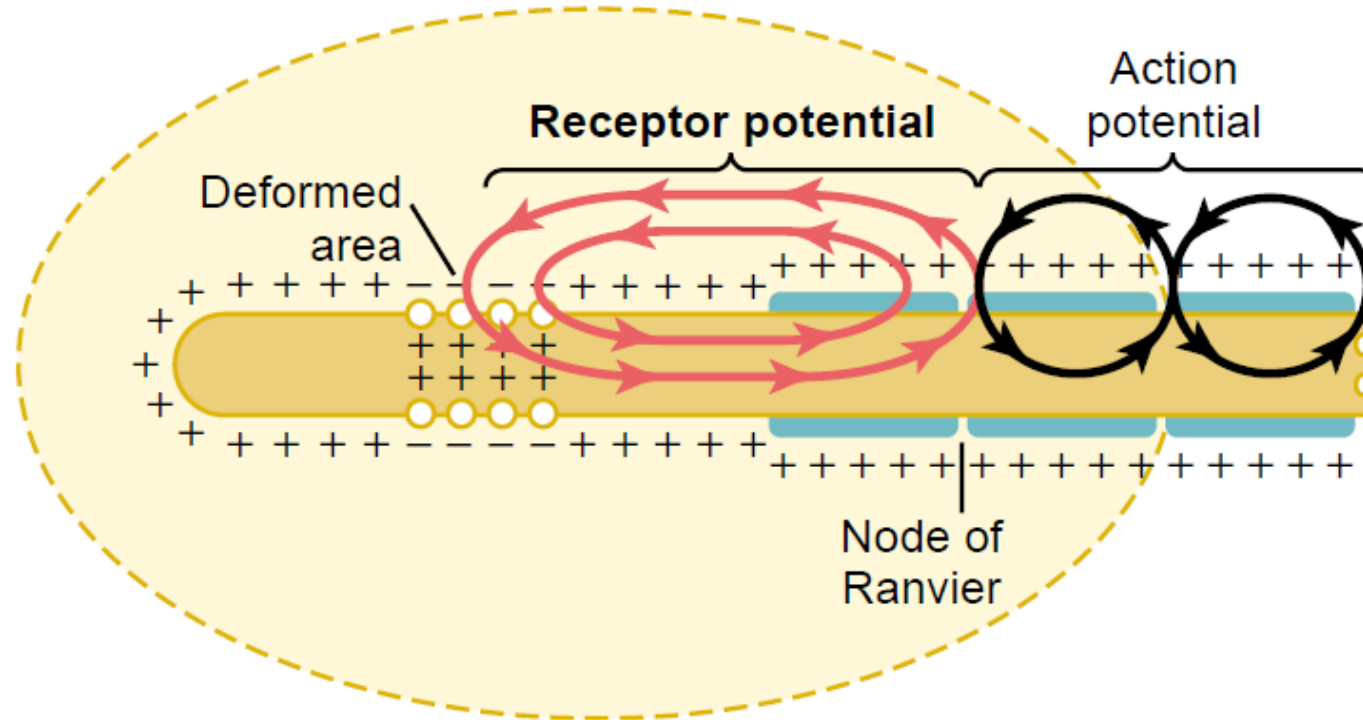
# Receptors/sensors

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



<http://www.slideshare.net/CsillaEgri/presentations>

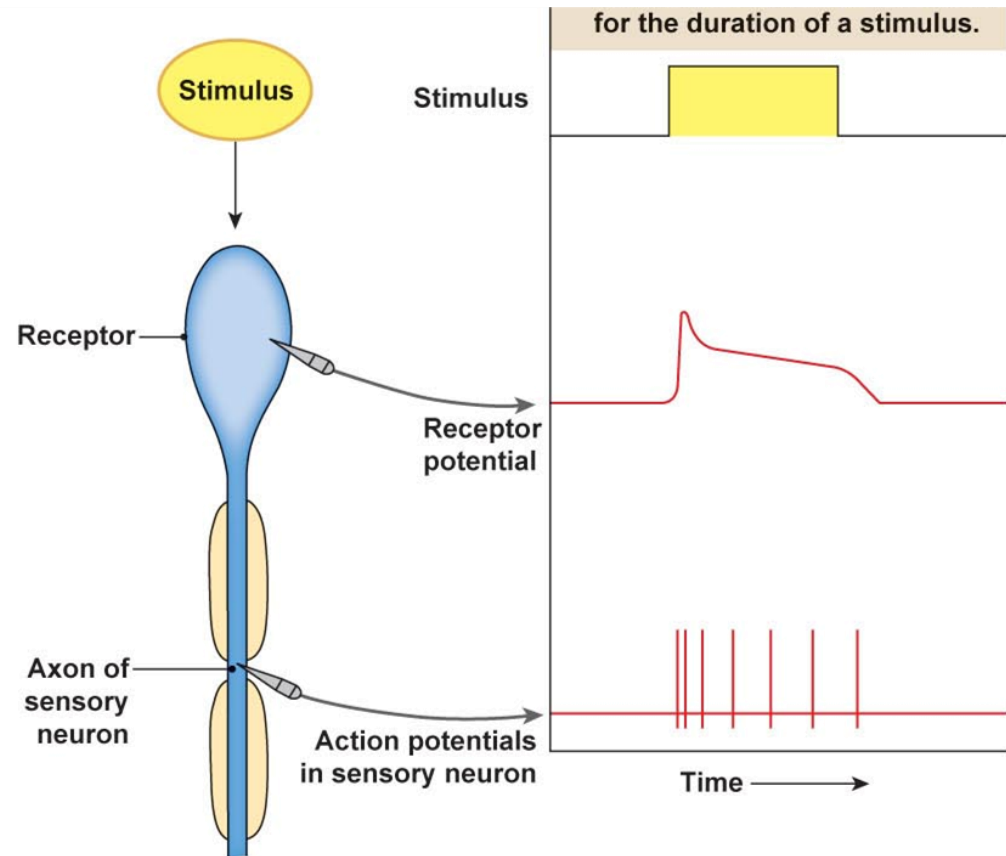
# Receptor/generator and action potential



<http://www.slideshare.net/drpsdeb/presentations>

# Receptors/sensors

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

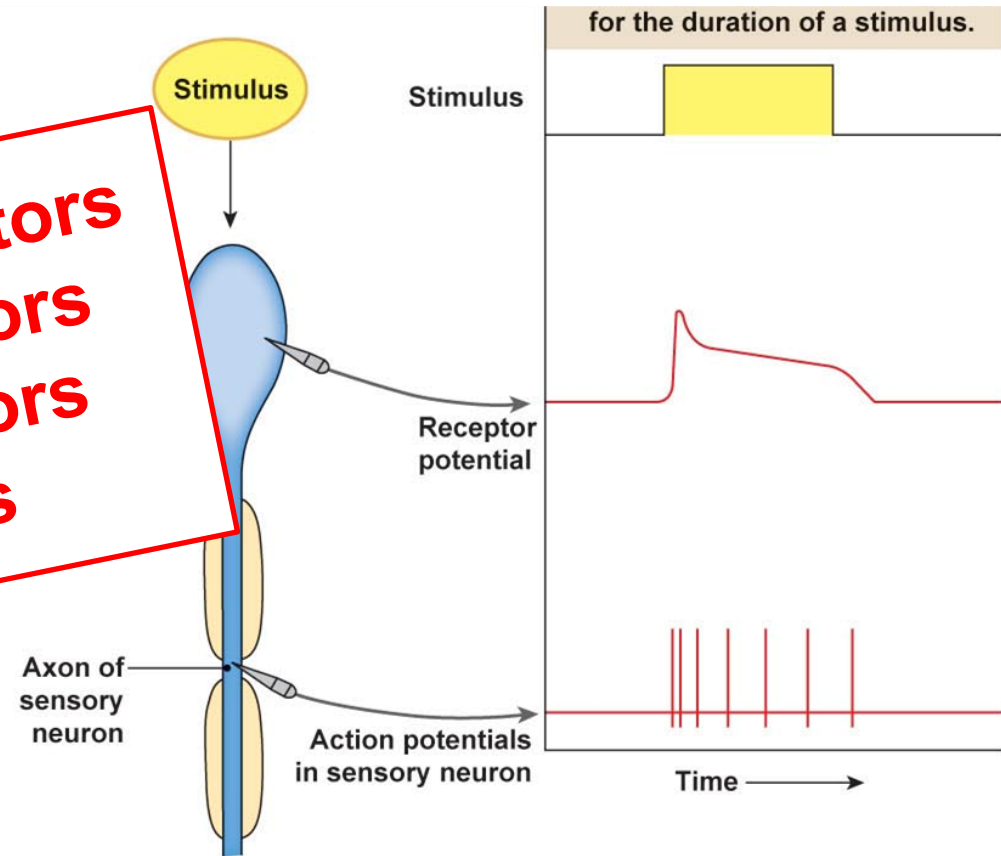


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# Receptors/sensors

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✓ **Mechanoreceptors**  
✓ **Thermoreceptors**  
✓ **Chemoreceptors**  
✓ **Fotoreceptors**

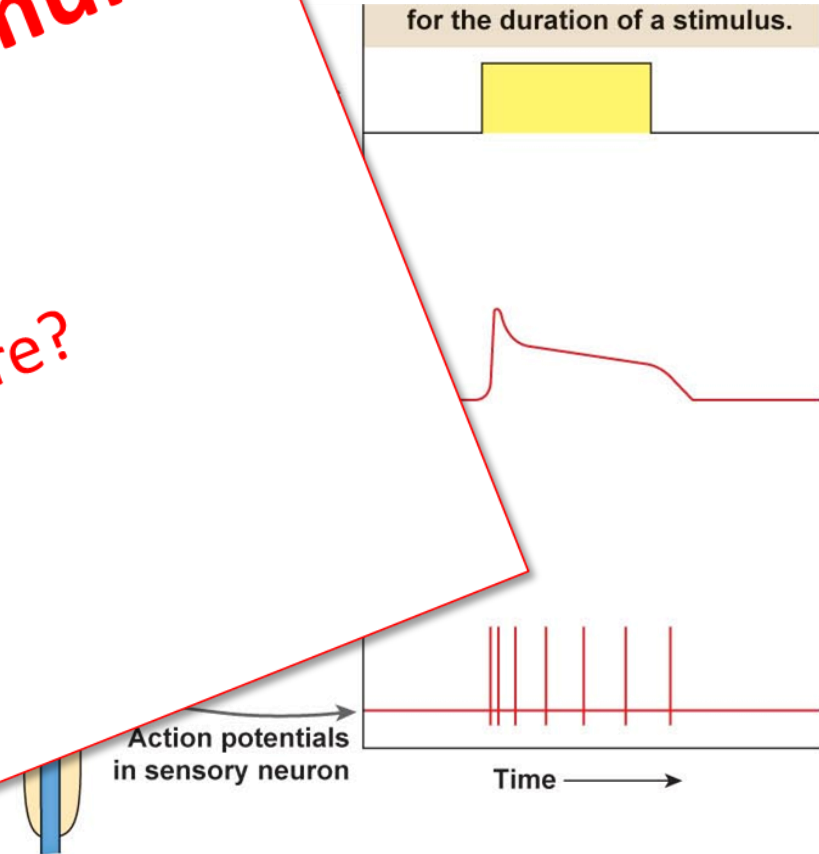


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# Receptors/sensors

- Energy convertor
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**Basic attributes of stimulus**  
**Qualitative**  
**Modality - What?**  
**Localization - Where?**



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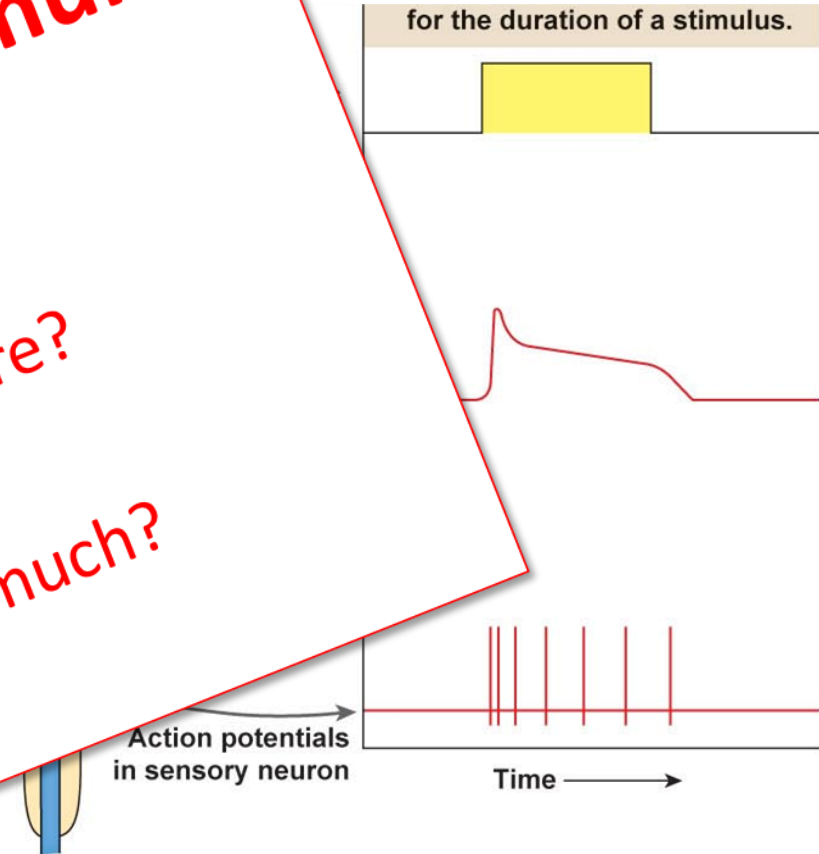
# Receptors/sensors

- Energy convertor
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- Non adequate stimulus

**Basic attributes of stimulus**

**Qualitative**  
Modality - What?  
Localization - Where?

**Quantitative**  
Intensity - How much?



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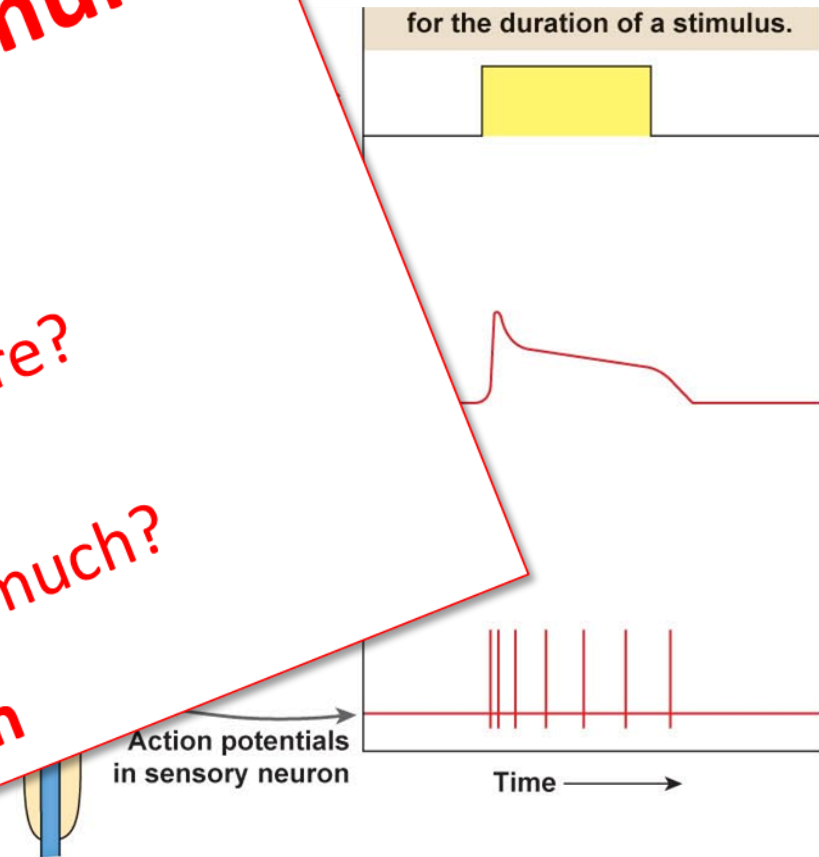
# Receptors/sensors

- Energy convertor
  - Signal reception
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- Receptor potential
  - Generator potential
- Action potentials
- Adequate stimulus
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**Basic attributes of stimulus**

**Qualitative**  
Modality - What?  
Localization - Where?

**Quantitative**  
Intensity - How much?  
**Duration**

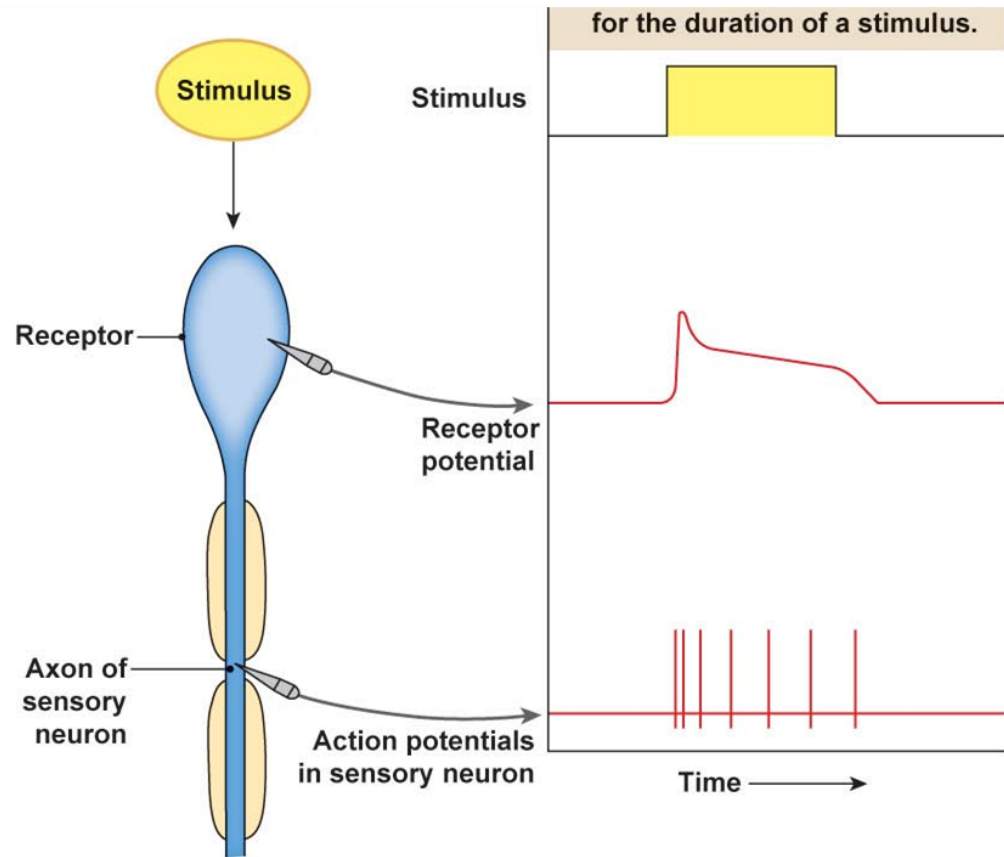


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# Intensity coding

How much?

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

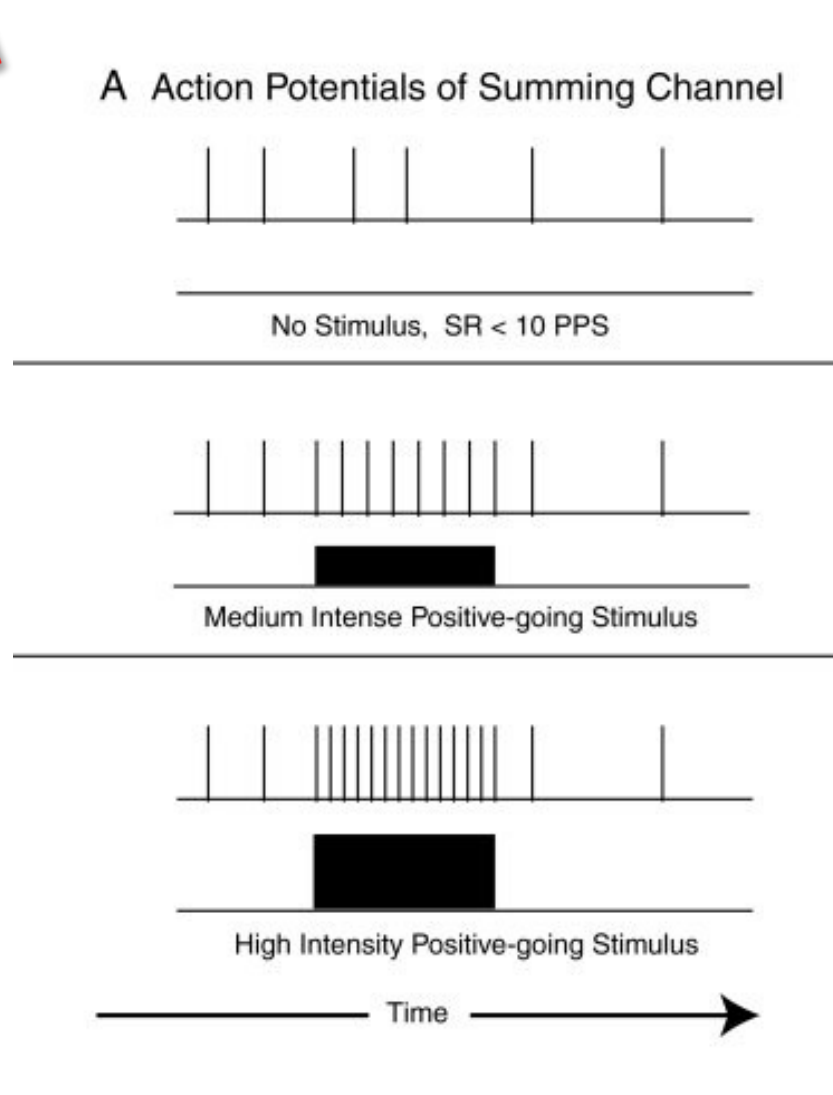


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# Intensity coding

How much?

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

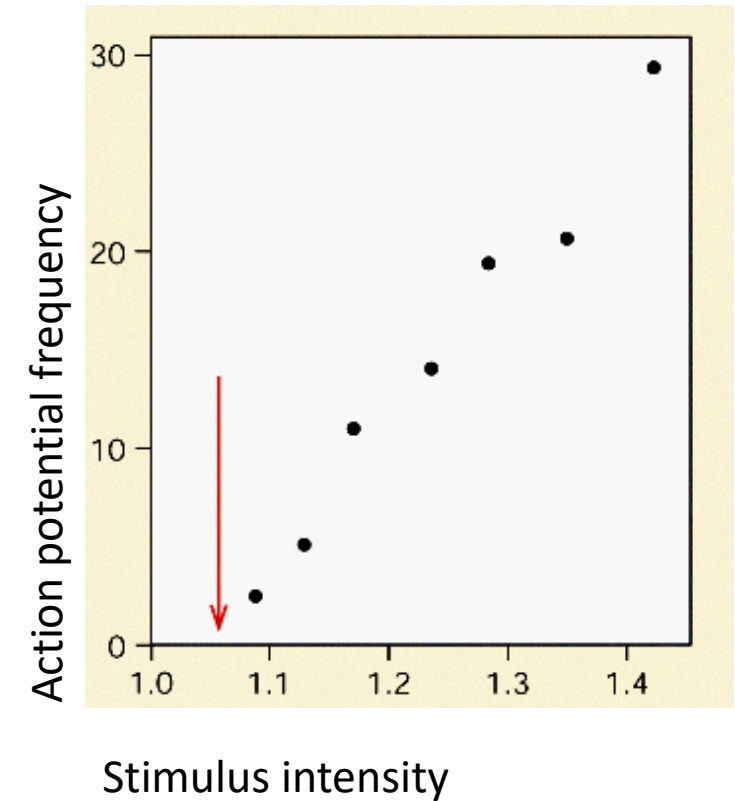
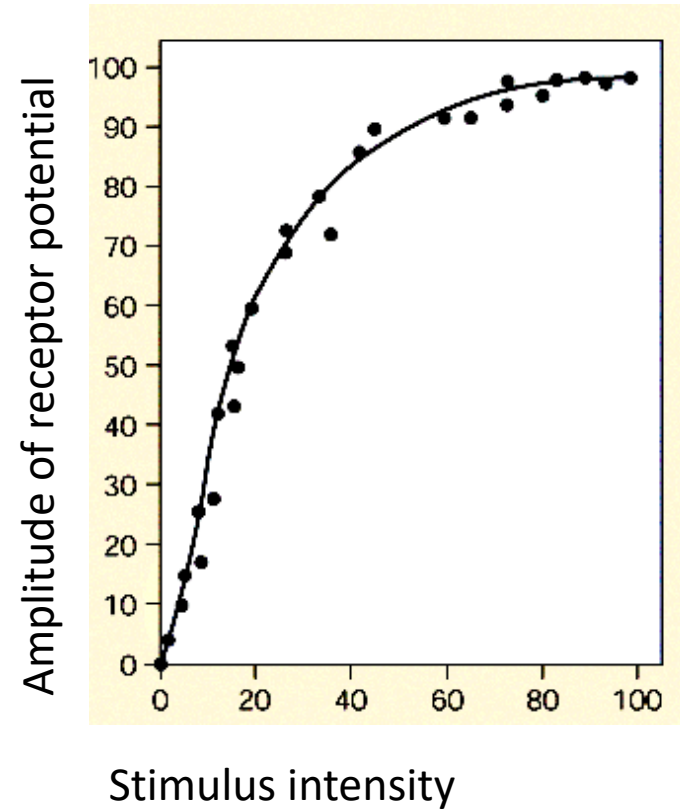


<http://neuronresearch.net/neuron/files/neuralcode.htm>

# Intensity coding

How much?

- Relation between receptor and action potential is logarithmic



<http://slideplayer.cz/slide/3217923/>

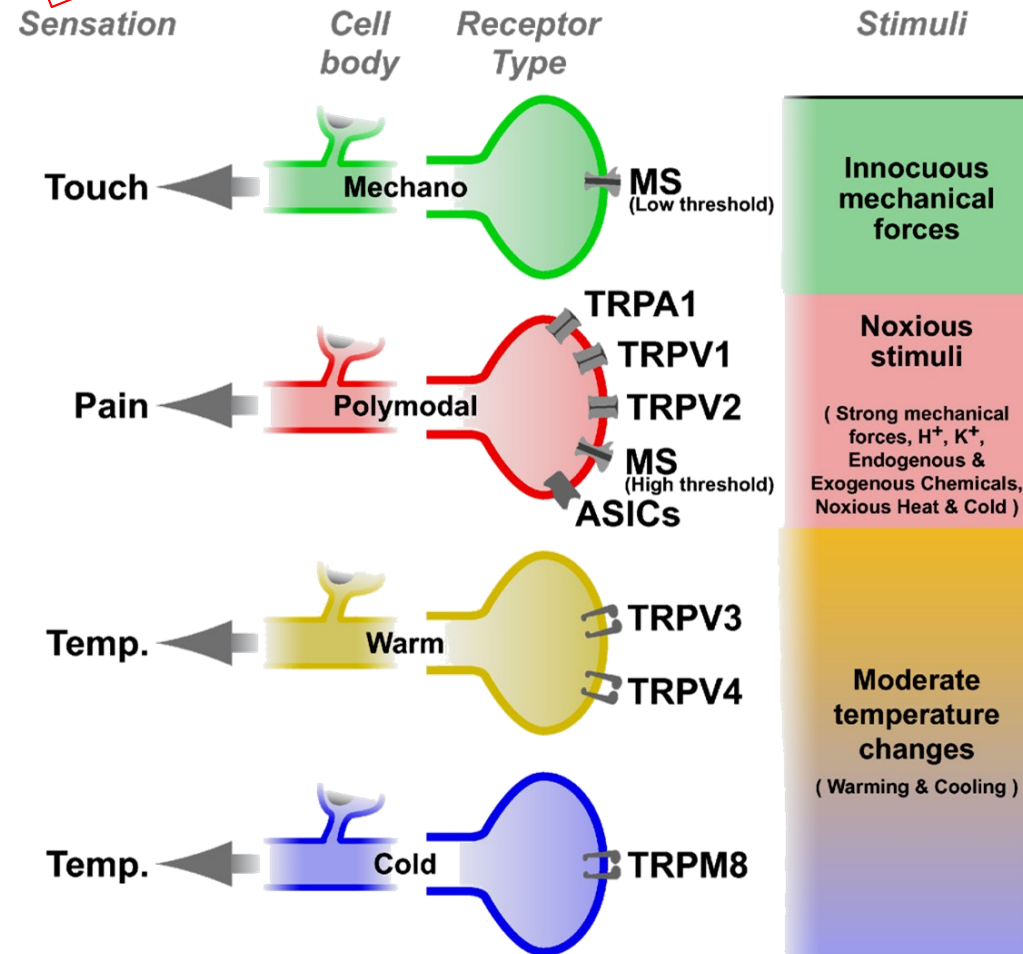
# Qualitative information

What?  
Where?

- The law of specific nerve energies:

The nature of perception is defined by the pathway over which the sensory information is carried

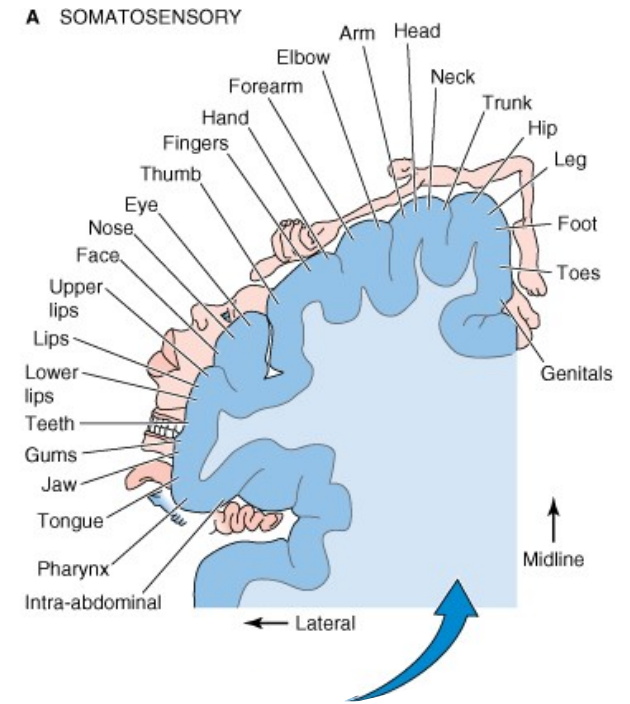
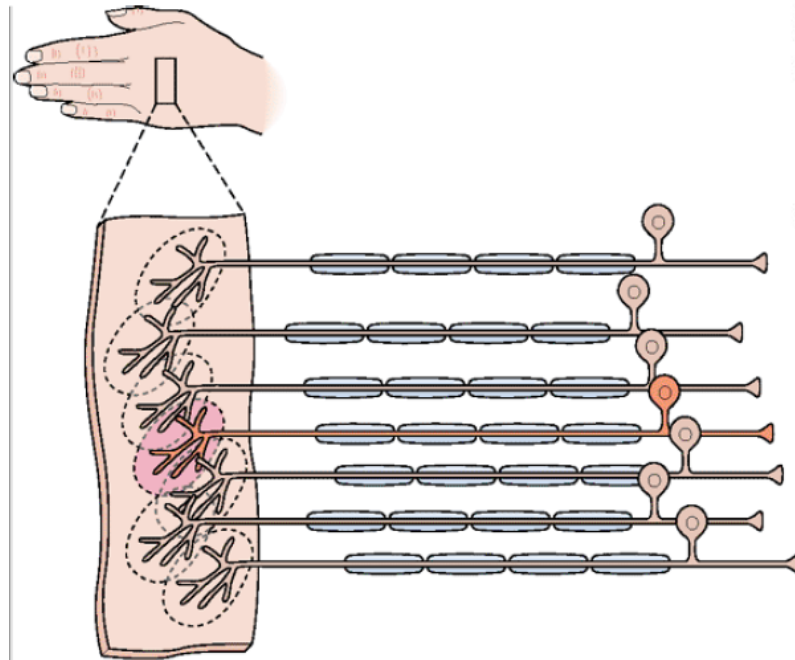
- Labeled line coding define the information about quality



# Qualitative information

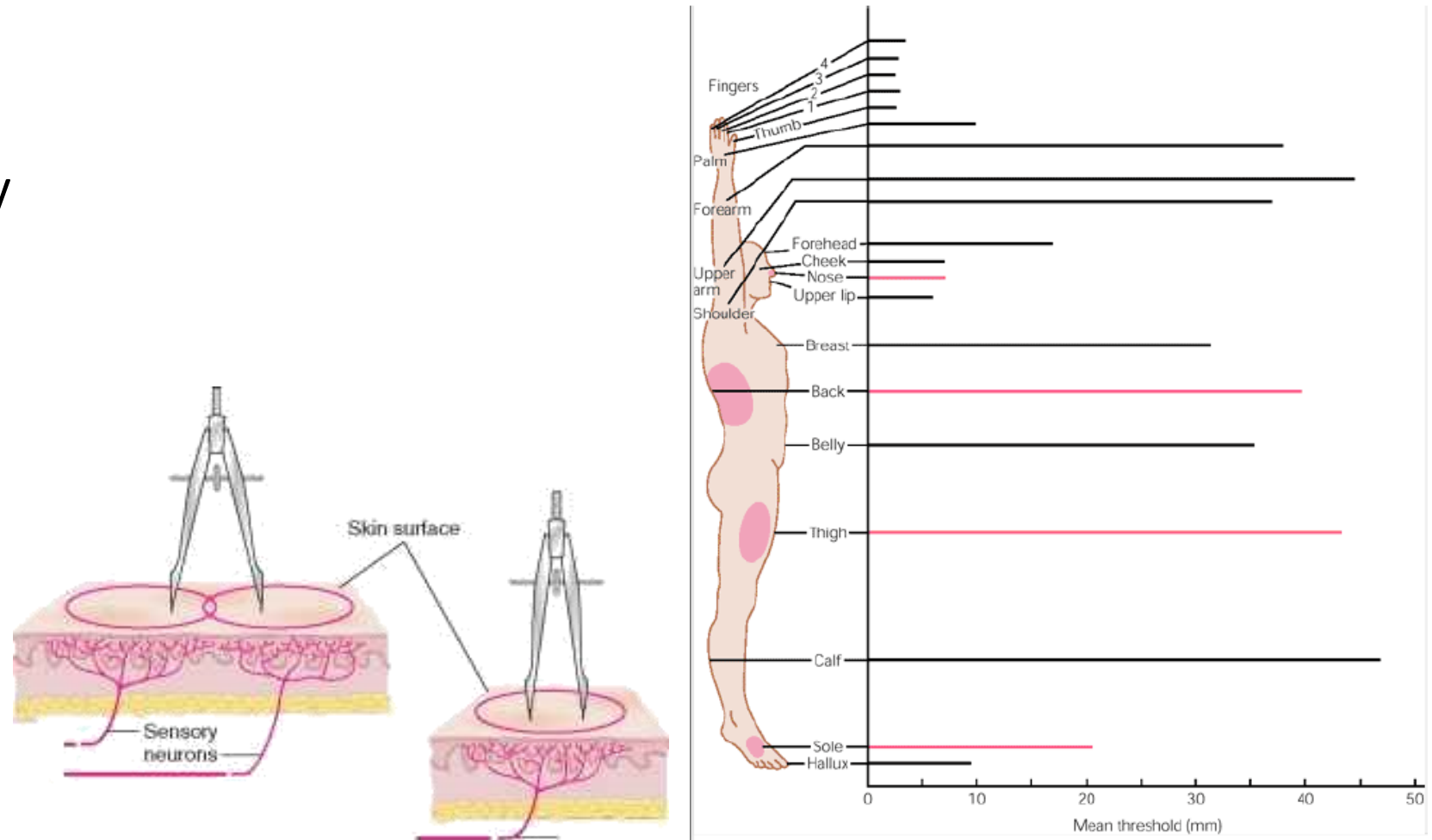
What?  
Where?

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



# Receptive fields

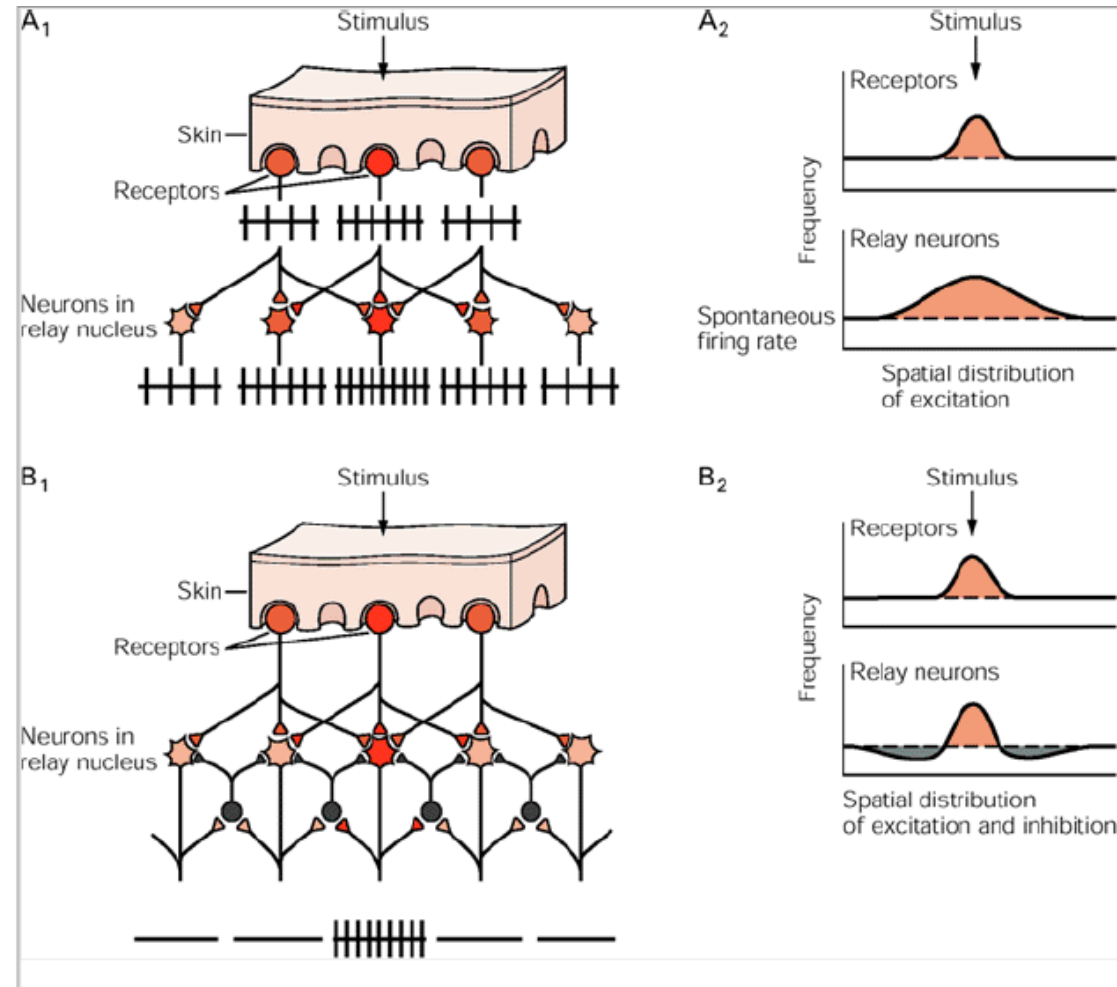
- Various size and overlap
- Small receptive field – high resolution
- Spatial resolving power increased by lateral inhibition



<http://www.slideshare.net/drpsdeb/presentations>



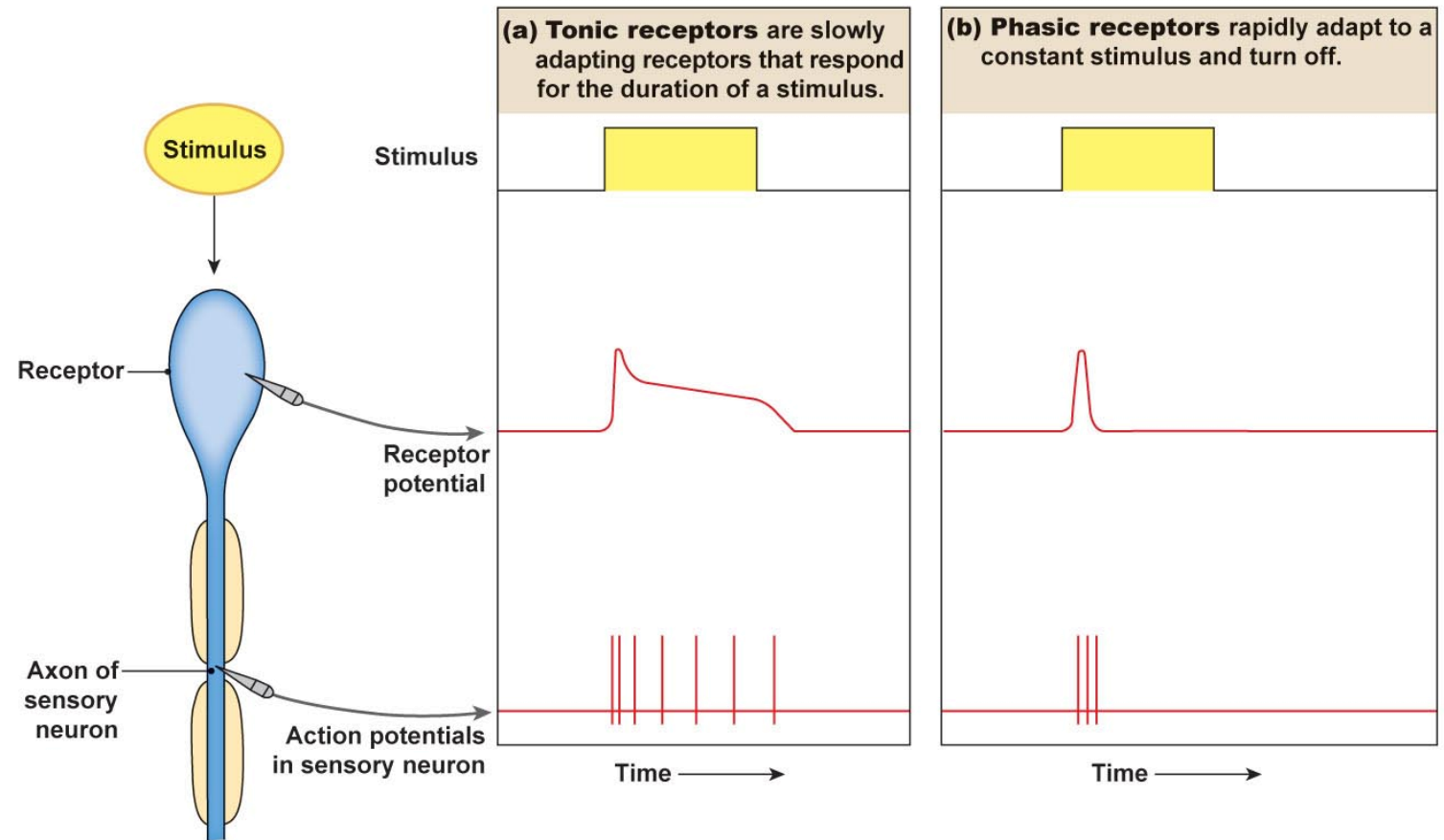
# Lateral inhibition



<http://www.slideshare.net/drpsdeb/presentations>

# 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



<http://www.slideshare.net/CsillaEgri/presentations>

# Receptors

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

# Receptors

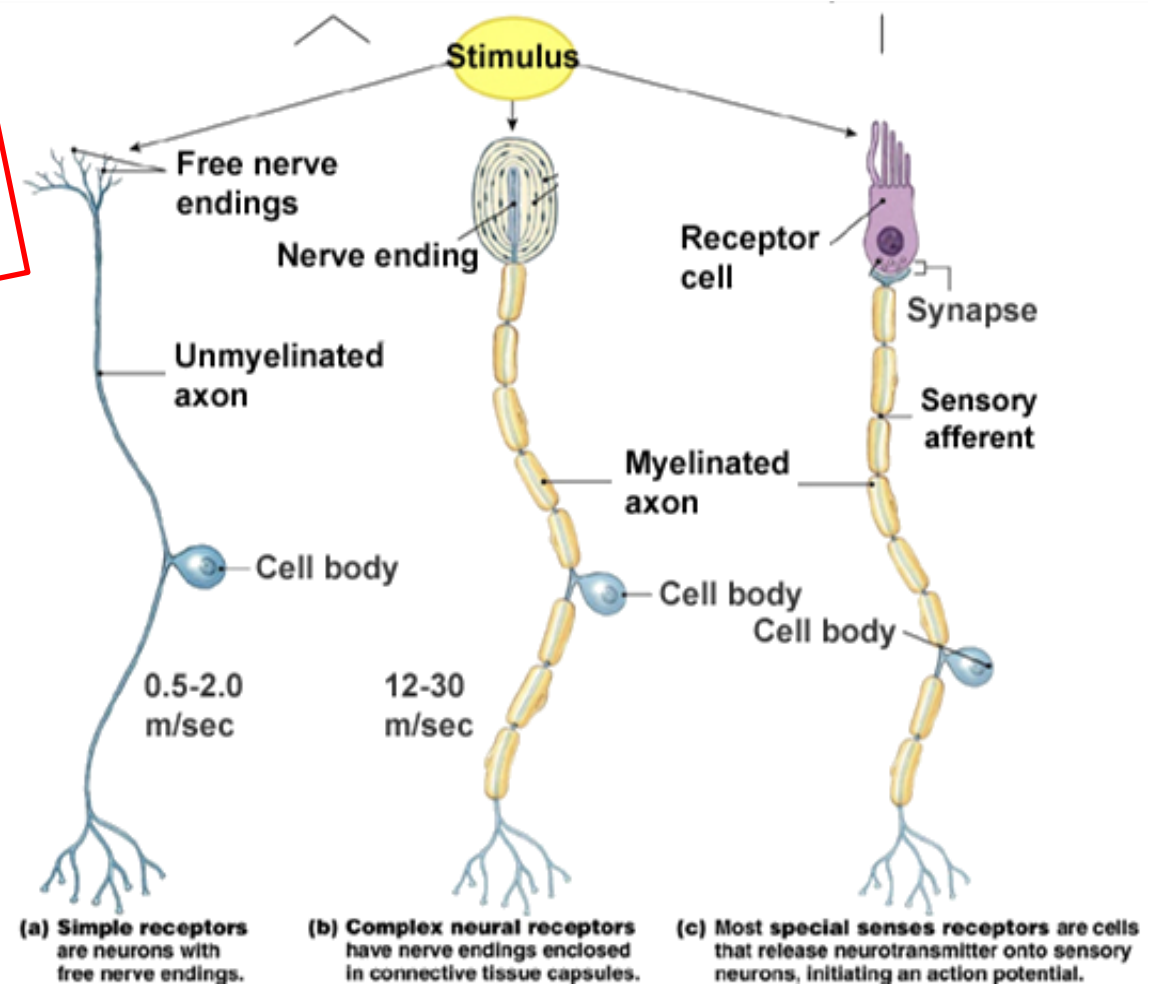
- ✓ **Mechanoreceptors**
- ✓ **Thermoreceptors**
- ✓ **Chemoreceptors**
- ✓ **Fotoreceptors**

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

# Receptors

- ✓ Mechanoreceptors
- ✓ Thermoreceptors
- ✓ Chemoreceptors
- ✓ Fotoreceptors

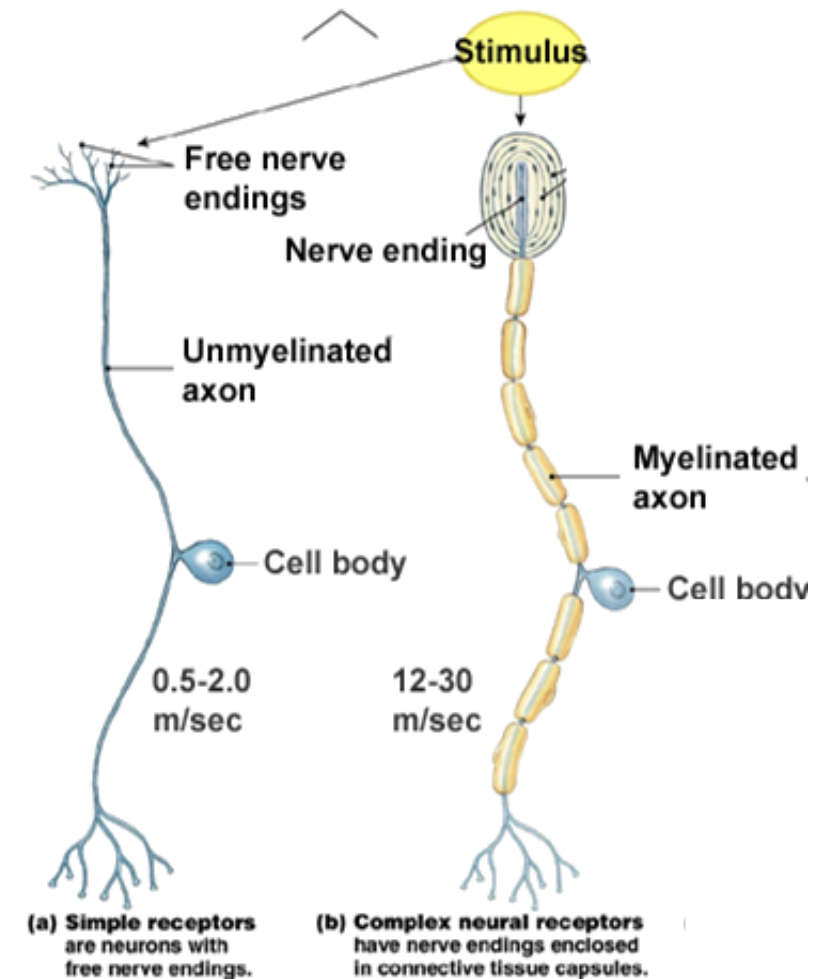
- Simple
  - Superficial – somatosensors
  - Deep – viscerosensors
  - Muscles, tendons, joints – proprioceptors
- General
  - Part of sensory organs
- Special
  - Part of sensory organs



<http://www.slideshare.net/CsillaEgri/presentations>

# Somato/viscero/ proprio

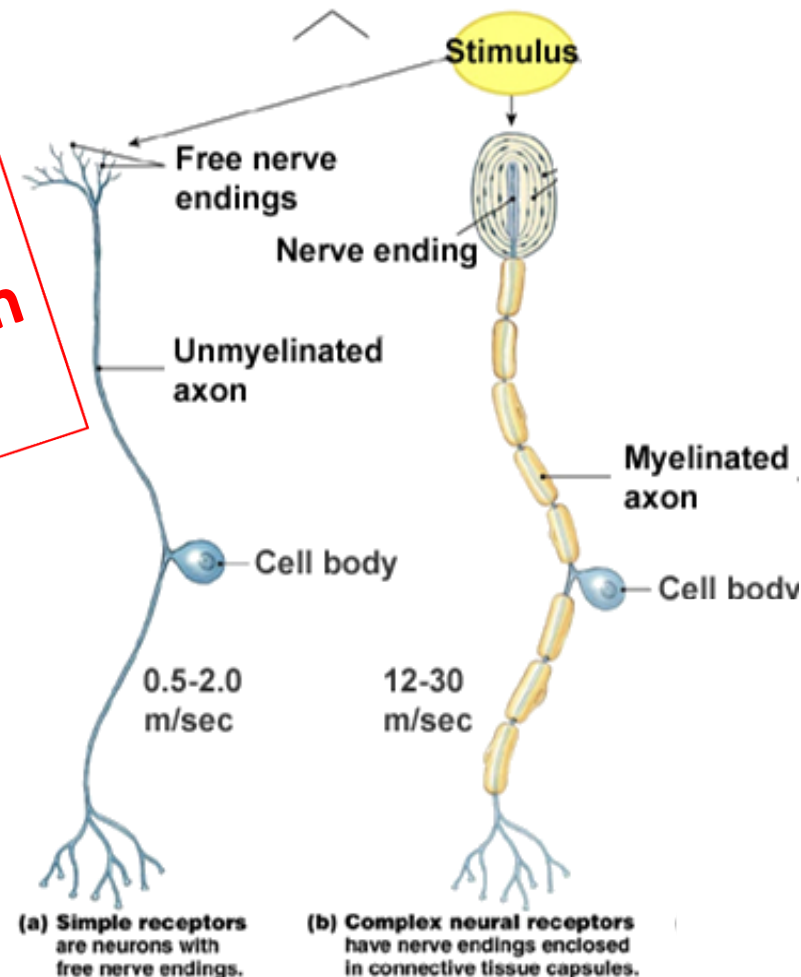
- Somatosensitivity
  - Pain
  - Temperature
  - Touch
- Viscerosensitivity
  - Pain
- Proprioception
  - Position
  - Movement



# Somato/viscero/ proprio

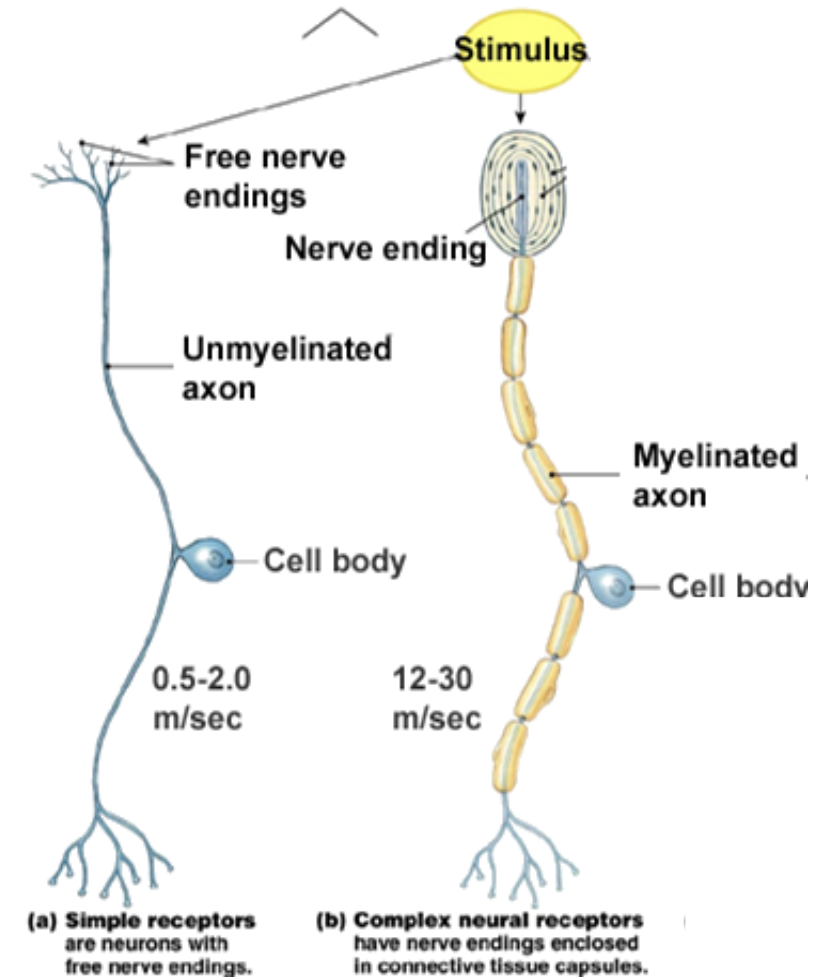
- Somatosensitivity
  - Pain
  - Temperature
  - Touch
- Viscerosensitivity
  - Pain
- Proprioception
  - Position
  - Movement

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



# Evolutionary point of view

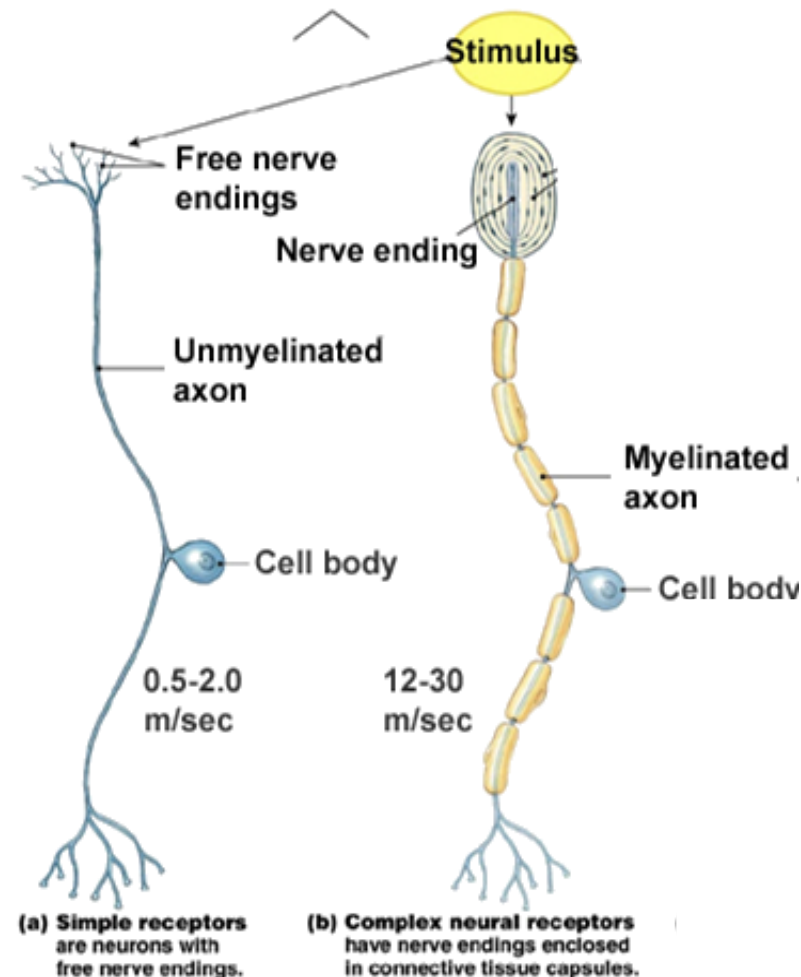
- The signals indicating potential damage are the most important and the corresponding systems evolved early
  - Pain
  - Temperature





# 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

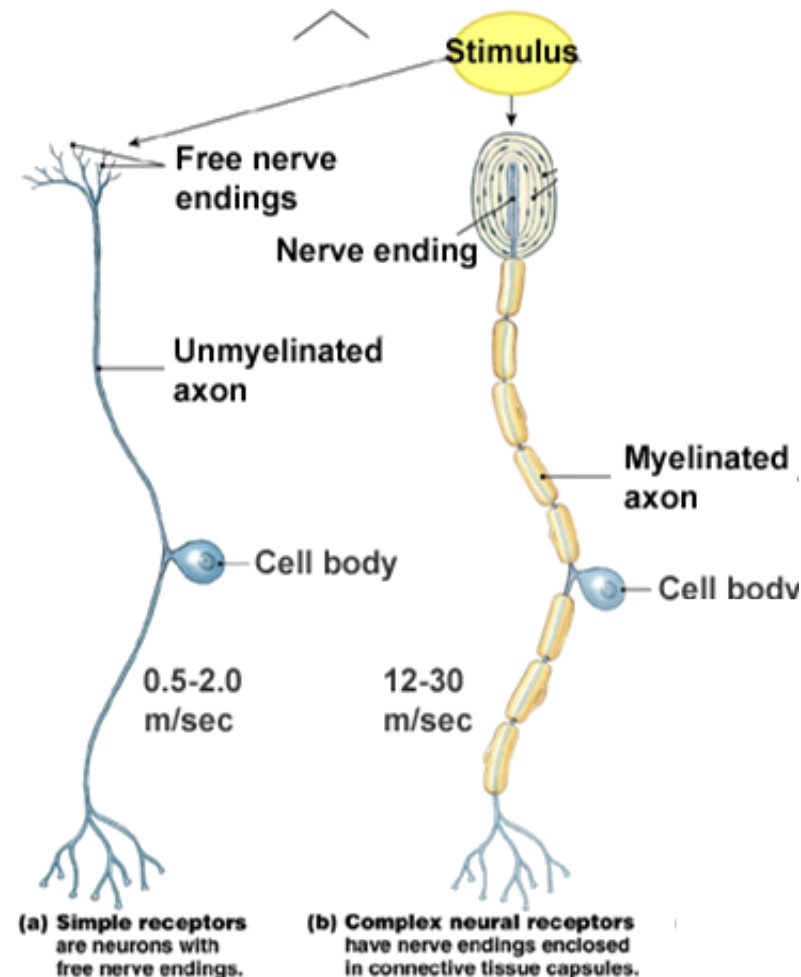


# Evolutionary point of view

- The signals indicating potential damage are the most important for the corresponding early evolution involved
  - temperature
- The touch receptor has an adaptive value and a higher conduction velocity

**Immediate survival**

**Long-term survival**

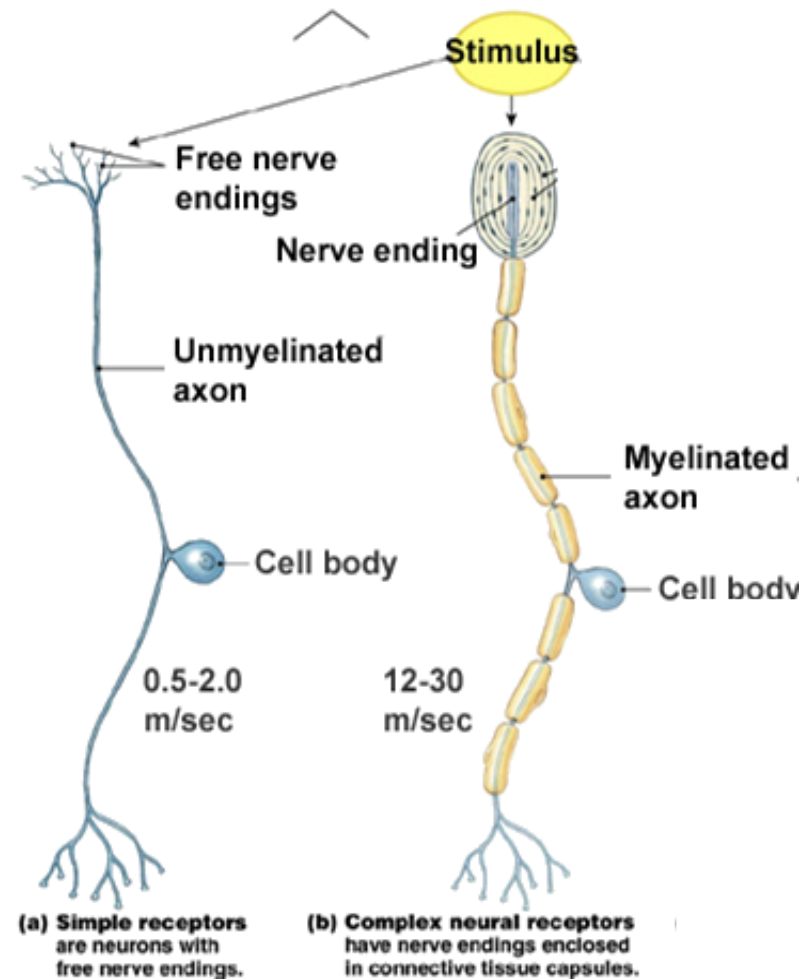


# Evolutionary point of view

- The signals indicating potential damage are the most important for the corresponding early survival involved
  - Temperature
- The touch receptors have adaptive value and are more complex
- The structure of the receptor, nerve fibers and pathways reflects the evolution

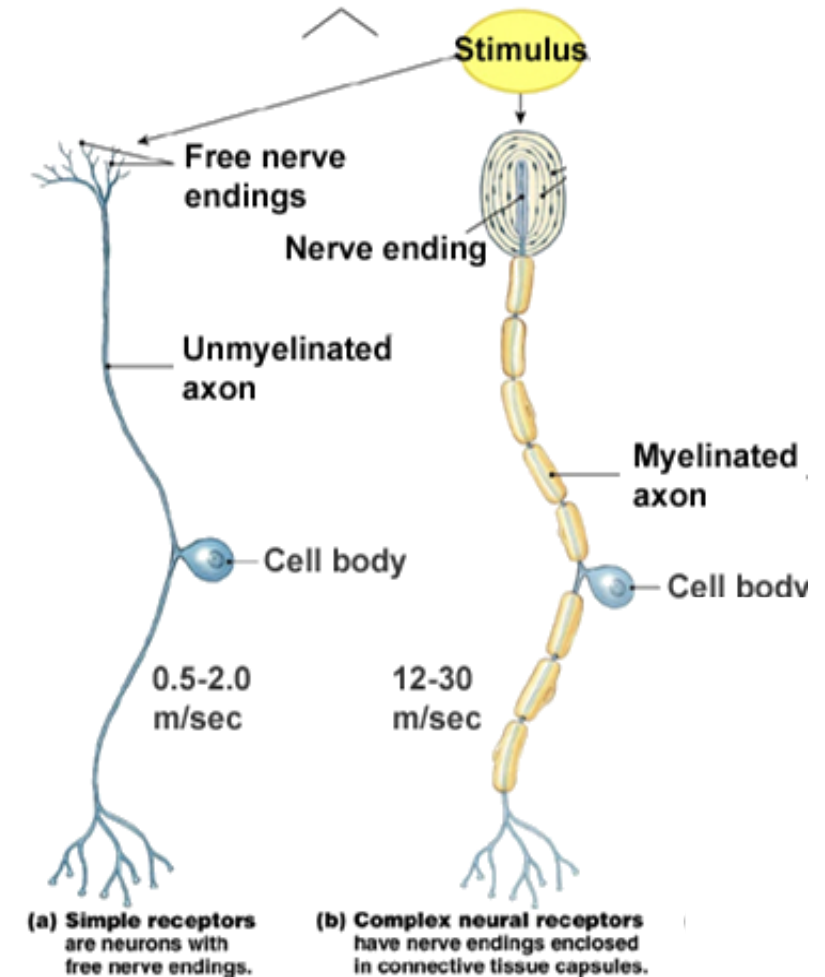
**Immediate survival**

**Long-term survival**

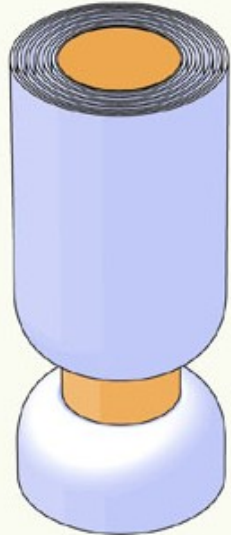

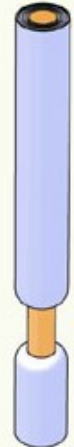



# Free nerve endings

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



# Nerve fibres

	A $\alpha$	A $\beta$	A $\delta$	C
Axons from skin				
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

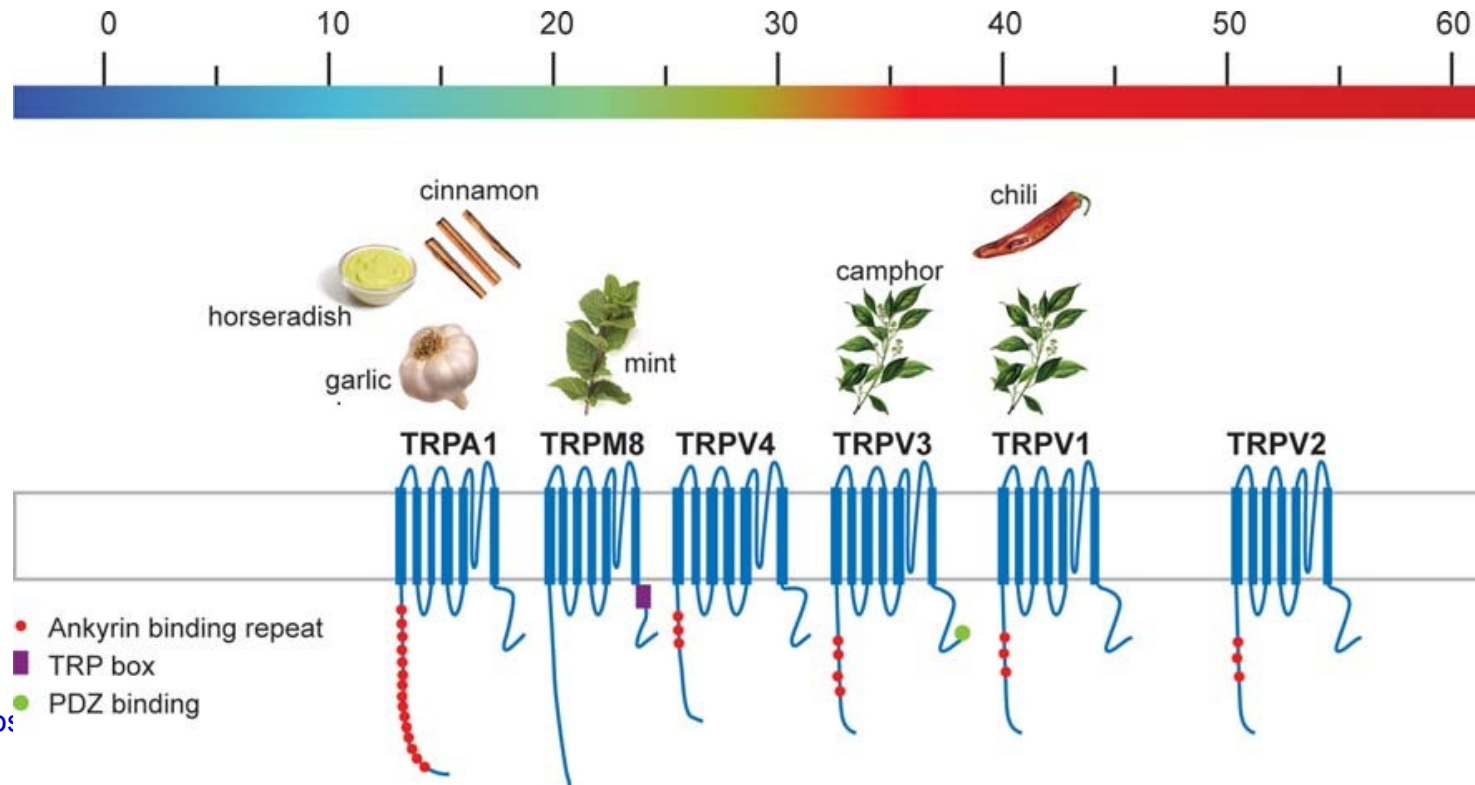
- Free nerve endings responding to high-intensity stimuli
- Stimulus
  - Mechanical
    - ✓ High pressure
    - ✓ Sharp object
  - Thermal
    - ✓ Above approx. 45°C
    - ✓ Low threshold – variable
  - Chemical
    - ✓ pH
    - ✓ Mediators of inflammation and so on

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

**C fibers**  
– dull, diffuse pain

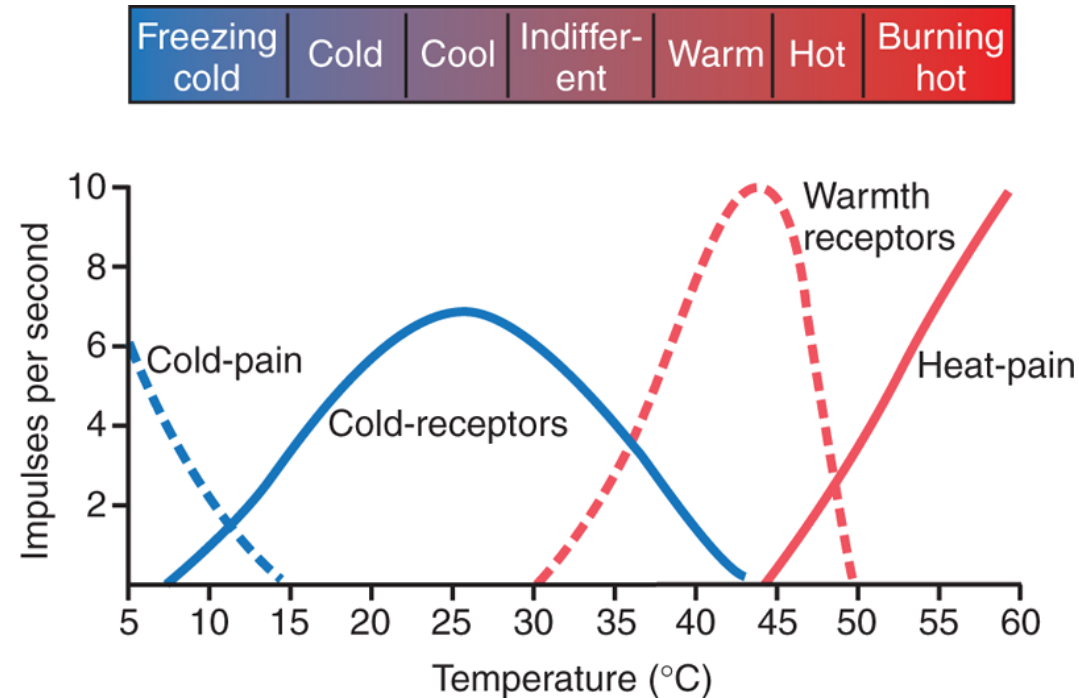
# Thermoreceptors

- Free nerve endings receptive to thermal stimuli
- TRP (transient receptor potential) channels
  - Polymodal receptor (chemoreception, thermoreception)
  - Present also in many cells (including neurons, keratinocytes, mechanoreceptors)



# Thermoreceptors

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



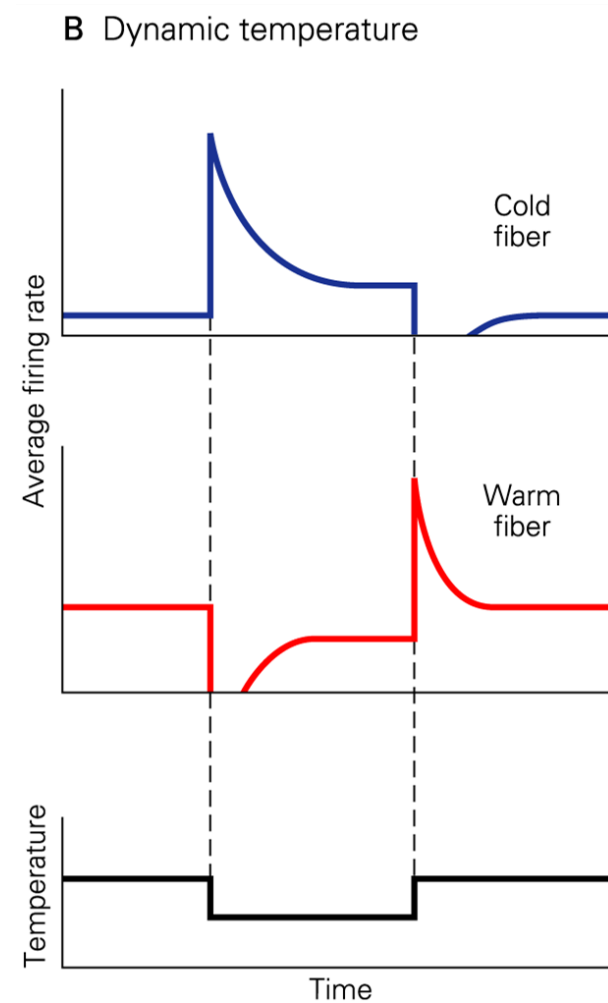
Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition  
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# Thermoreceptors

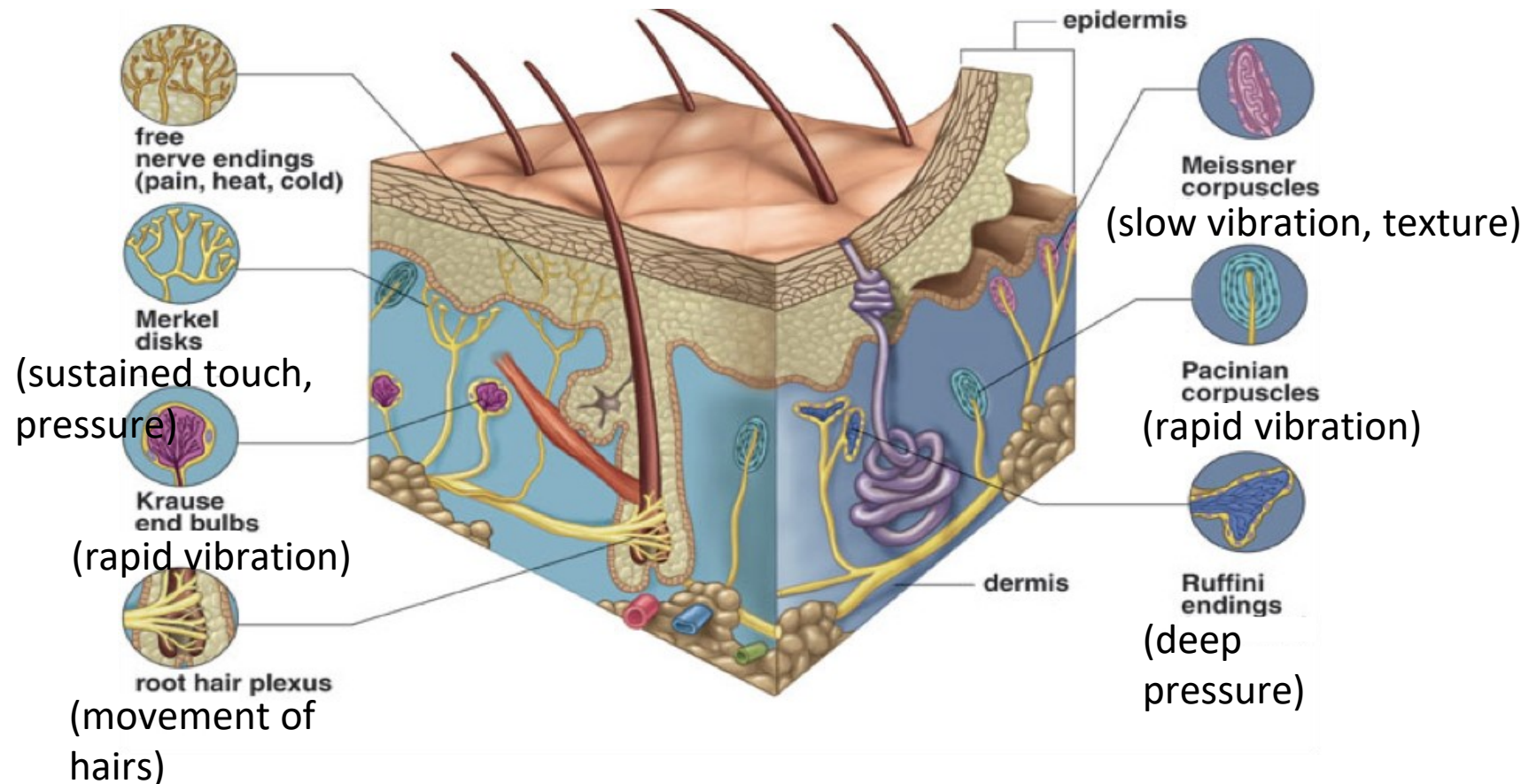
- Mostly phasic response



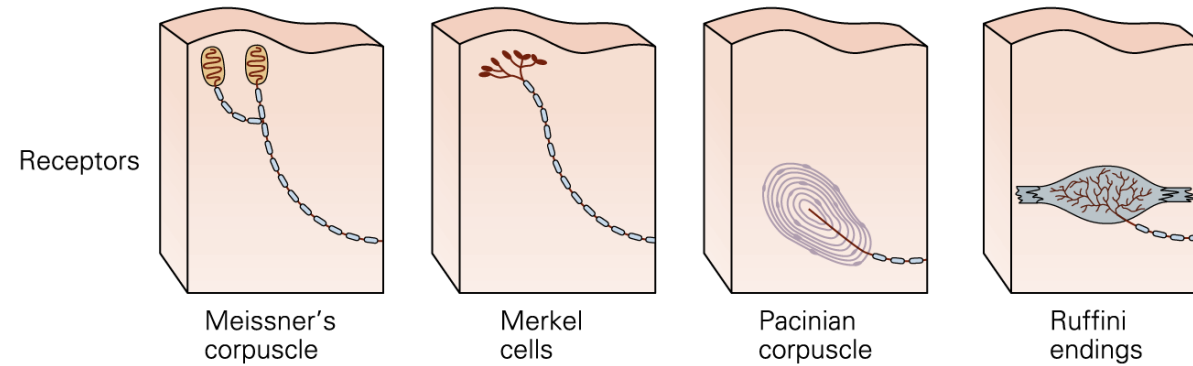
<http://www.slideshare.net/CsillaEgri/presentations>

# The receptors of the skin

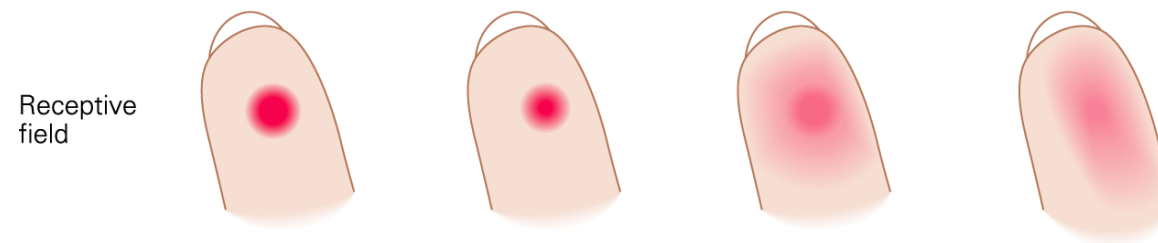
- Simple versus complex



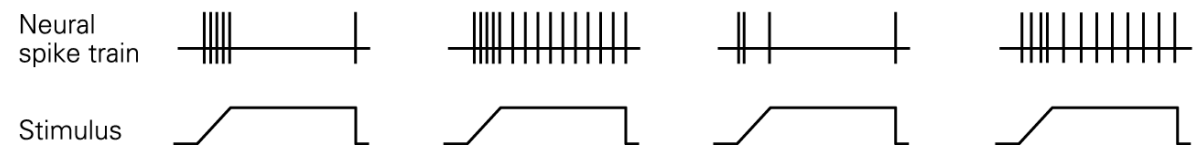
# The receptors of the skin



## 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

<http://neuroscience.uth.tmc.edu/s2/chapter02.html>

## 72. Receptors, receptor potential vs. action potential, receptive field

- ✓ Receptor definition (energy converter)
- ✓ Receptor potential vs. Action potential
  - RP – analogue (amplitude), AP – digital (frequency)
  - RP – various ionic mechanisms, AP - Na-K based
- ✓ Basic attributes of stimulus
  - Modality, localization, intensity, duration
  - The law of specific nerve energies (labeled line coding)
- ✓ Receptive field
- Definition
- Examples of large and small receptive fields, association with resolution
- Lateral inhibition
- Receptor adaptation (tonic and phasic response)
- ✓ Various classifications of receptors
  - Brief overview of the skin receptors

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M E D