

M U N I

M E D

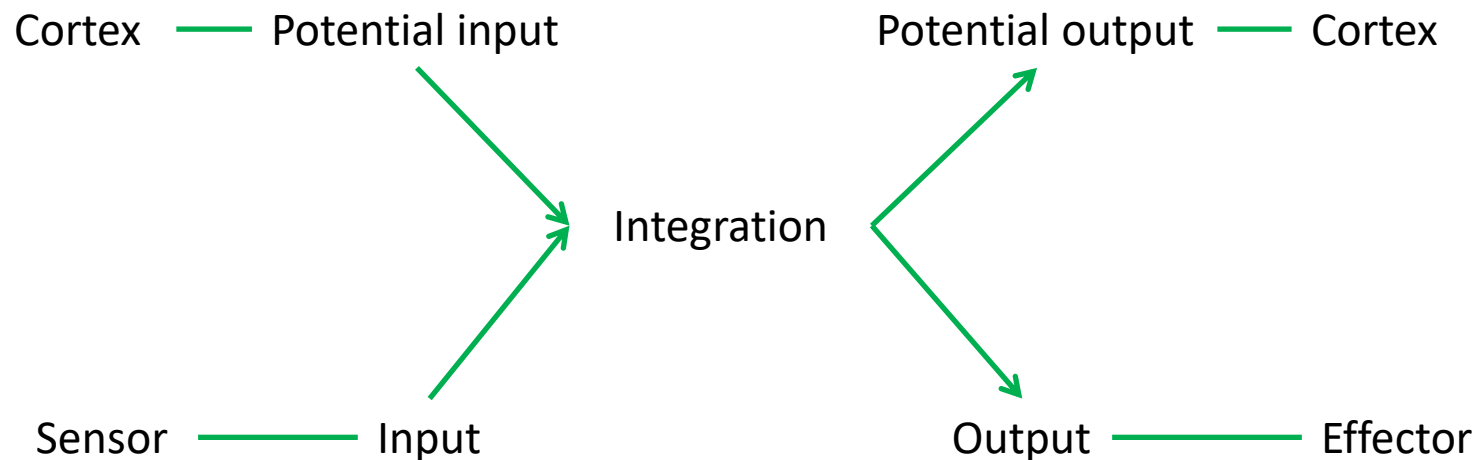
M U N I
M E D

5

Somatosensitivity, viscerosensitivity, proprioception and pain I

The role of nervous system

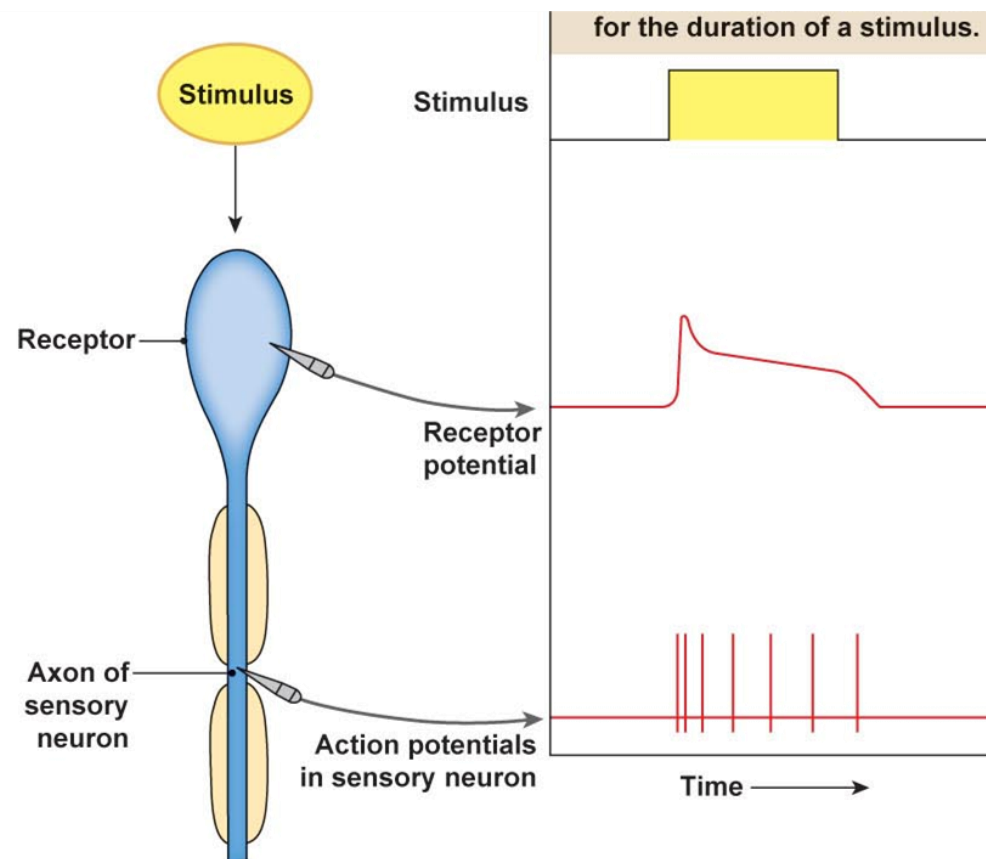
ANTICIPATION



REGULATION

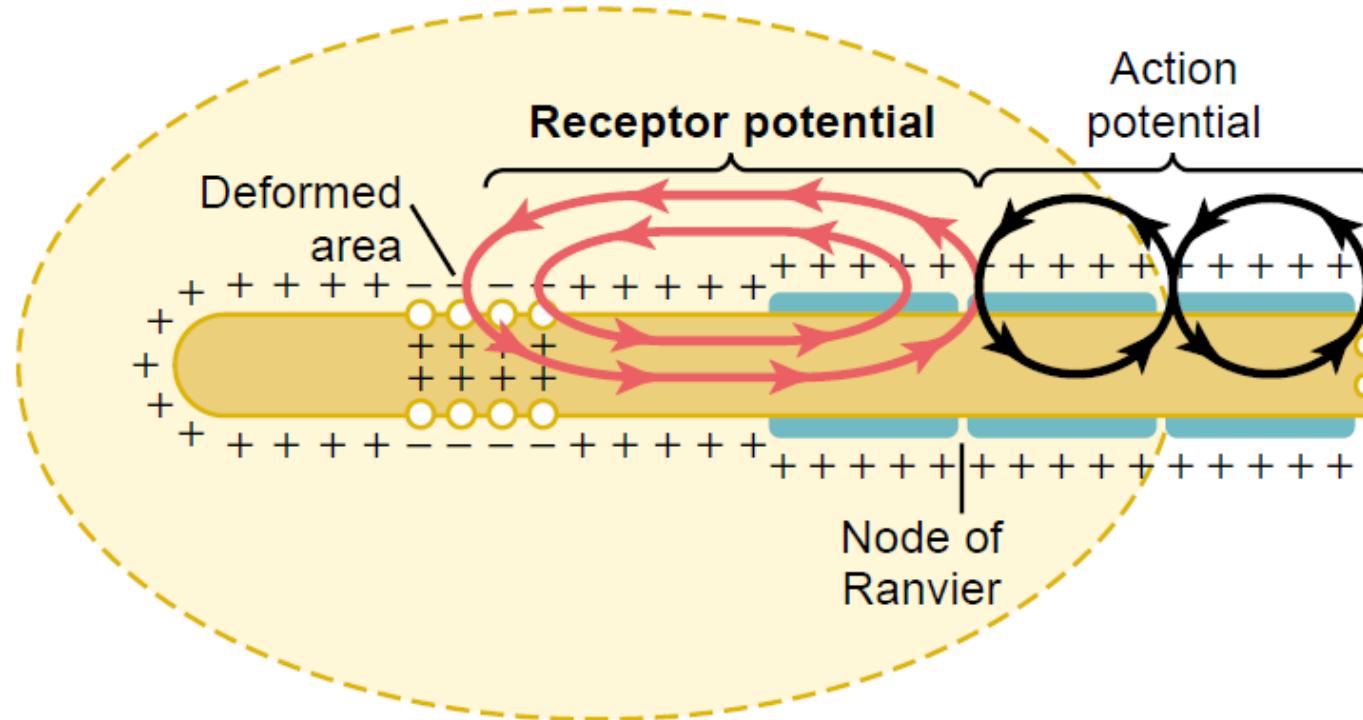
Receptors/sensors

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



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

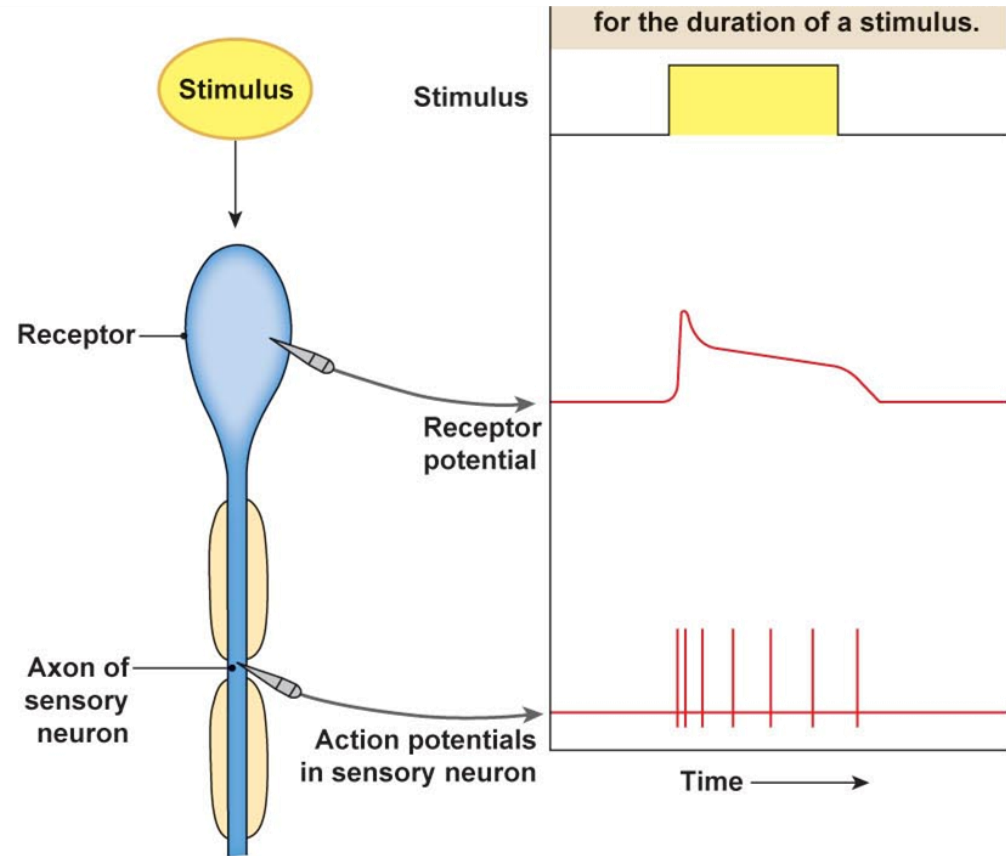
Receptor/generator and action potential



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

Receptors/sensors

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

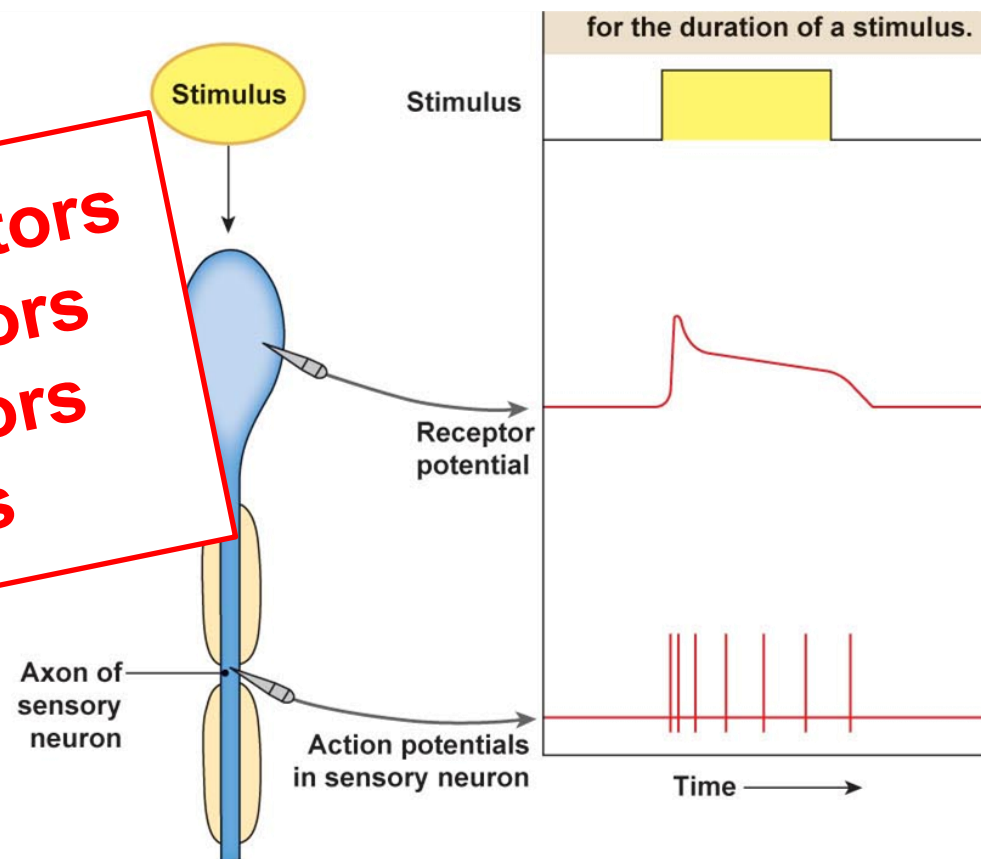


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Receptors/sensors

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



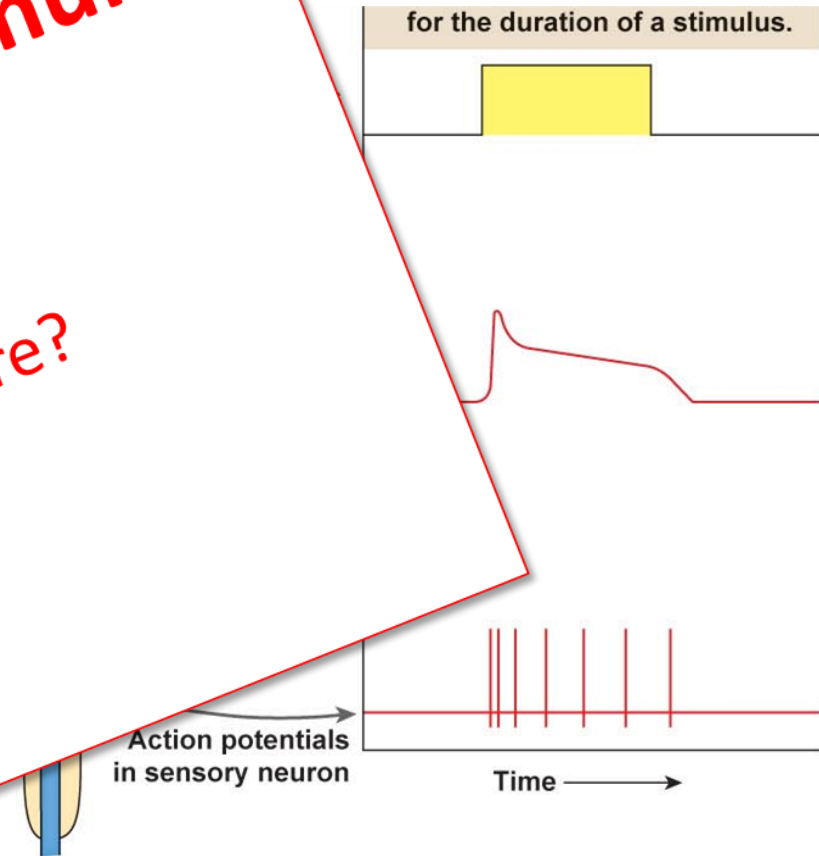
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Receptors/sensors

- Energy convertor
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Basic attributes of stimulus

Qualitative
Modality - What?
Localization - Where?



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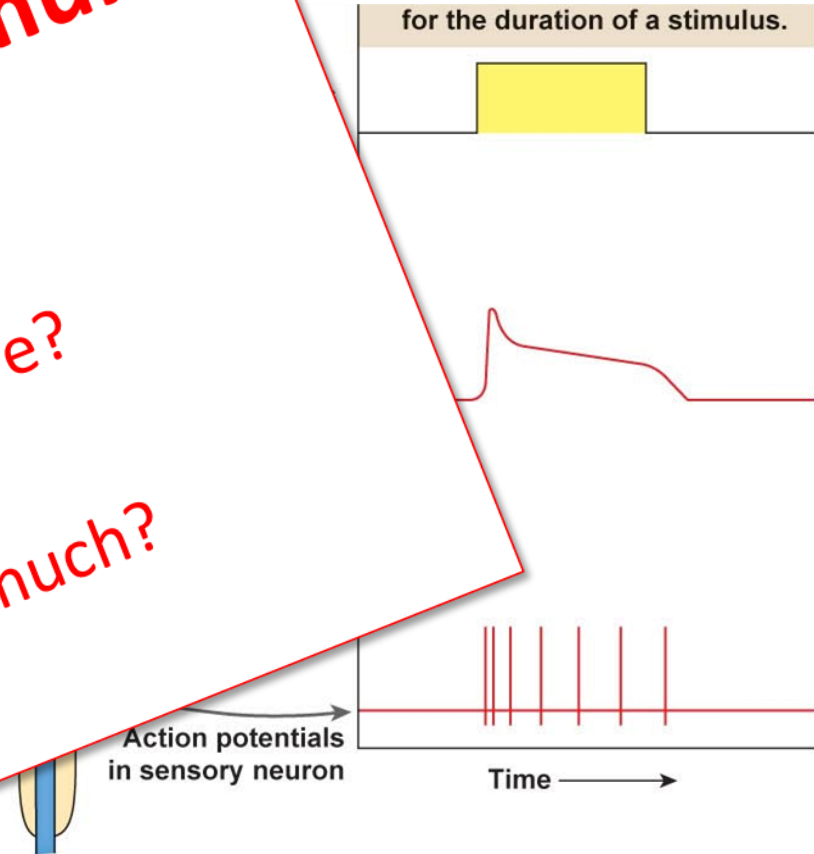
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Basic attributes of stimulus

Qualitative
Modality - What?
Localization - Where?

Quantitative
Intensity - How much?



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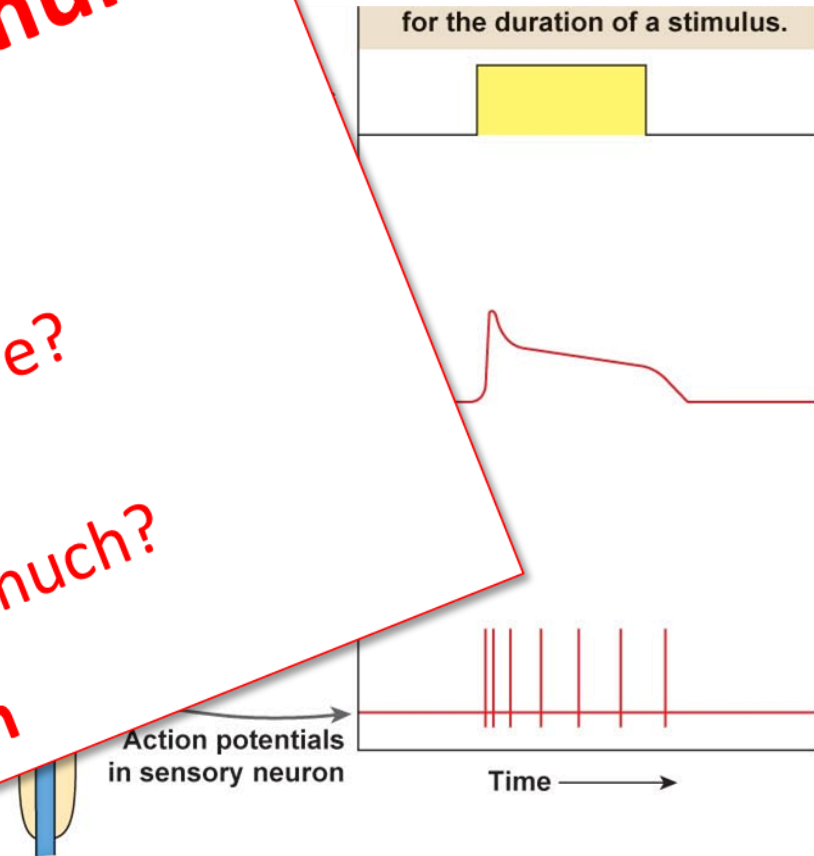
Receptors/sensors

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Basic attributes of stimulus

Qualitative
Modality - What?
Localization - Where?

Quantitative
Intensity - How much?
Duration

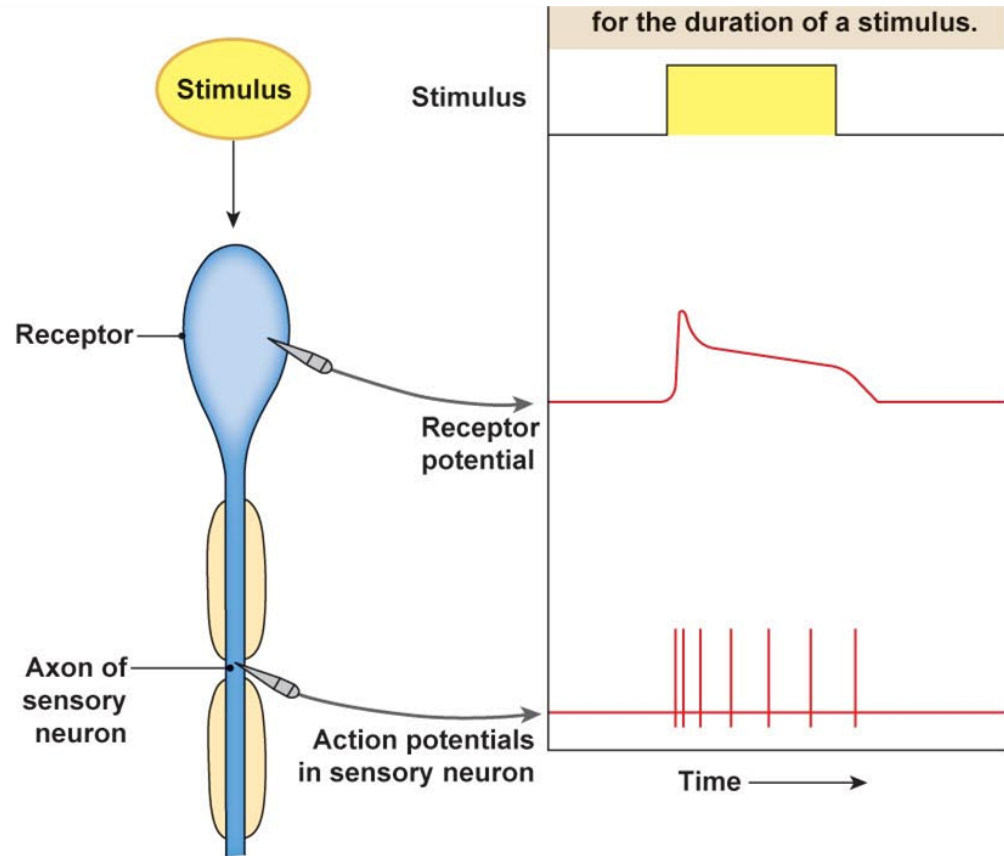


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Intensity coding

How much?

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

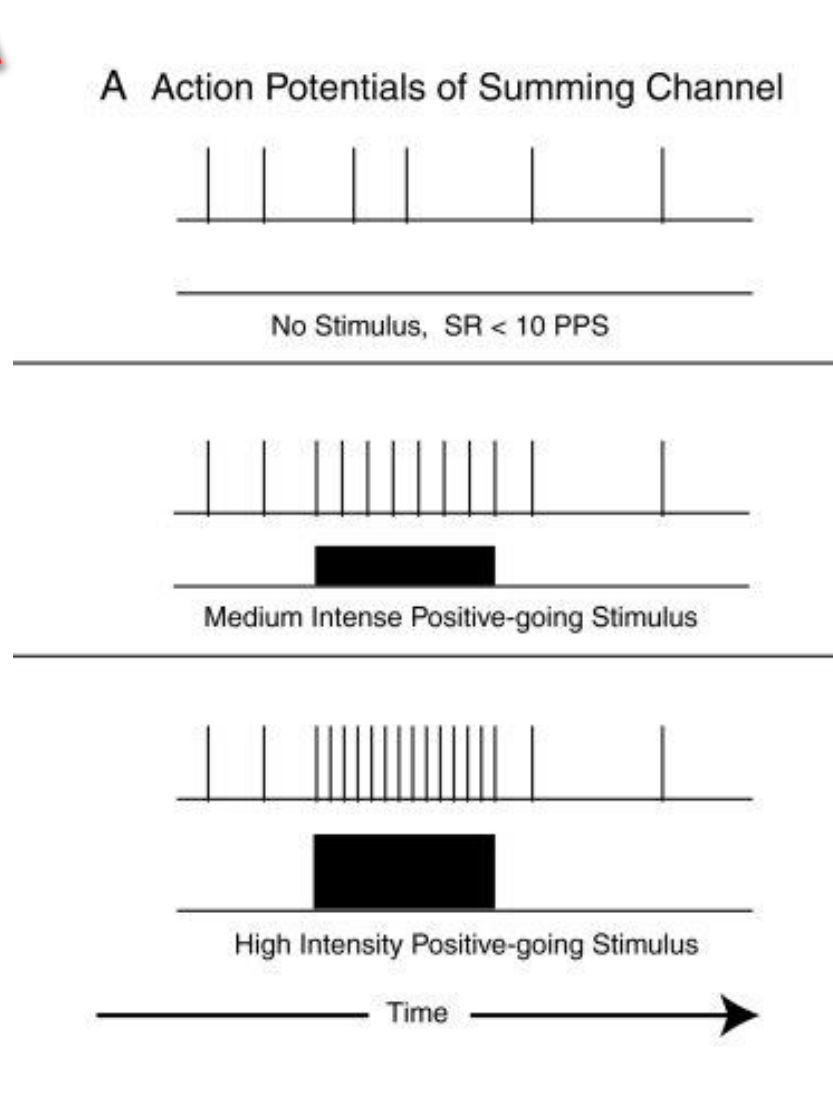


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Intensity coding

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

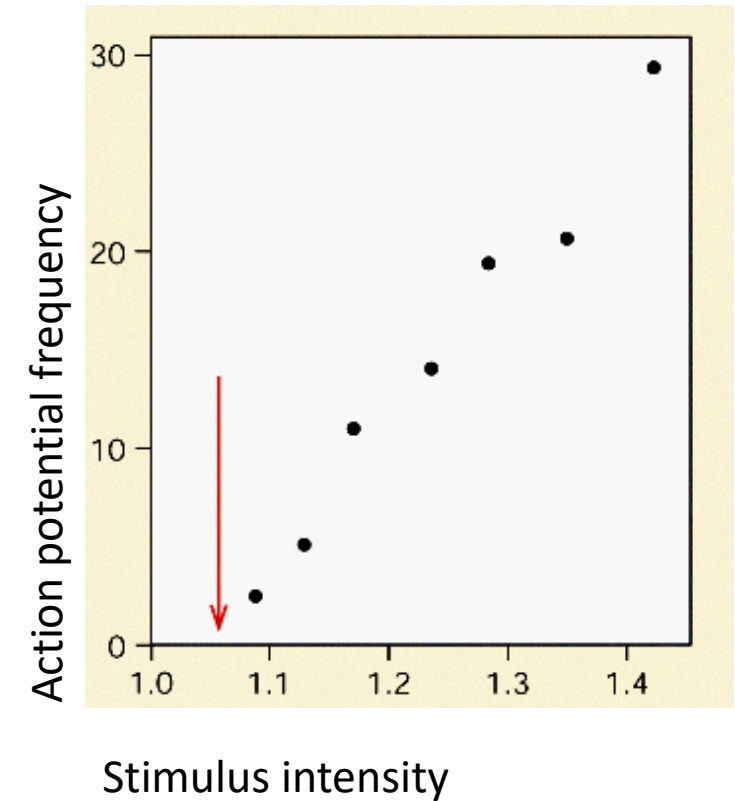
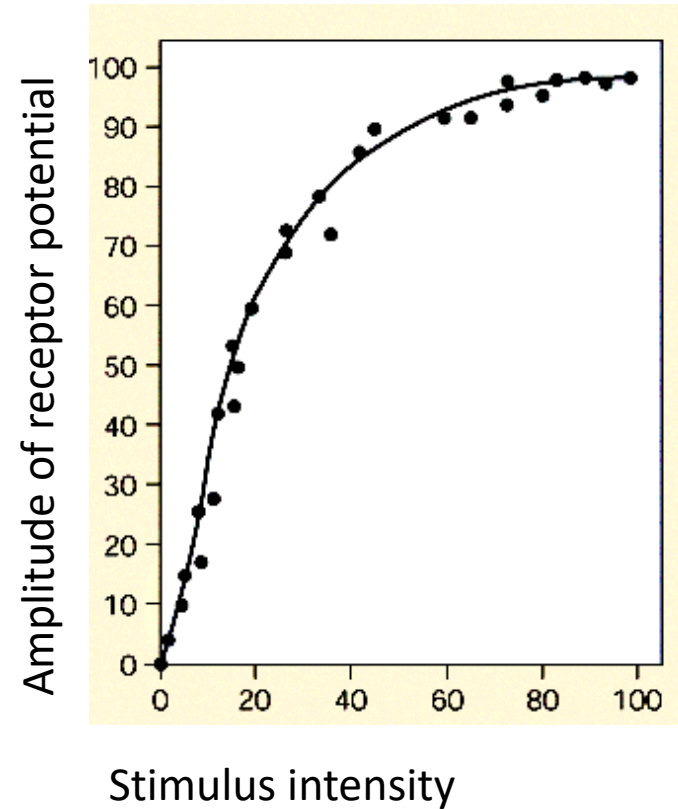


<http://neuronresearch.net/neuron/files/neuralcode.htm>

Intensity coding

How much?

- Relation between receptor and action potential is logarithmic



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

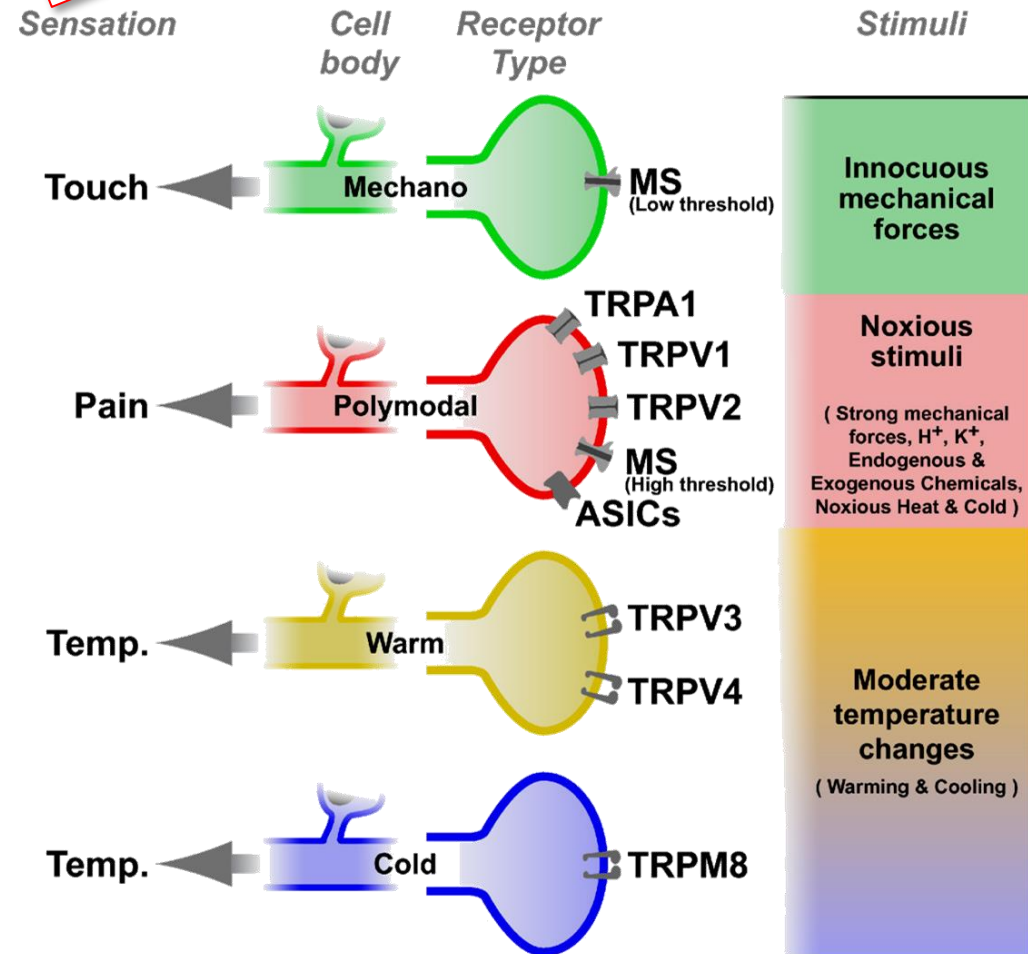
Qualitative information

What?
Where?

- The law of specific nerve energies:

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

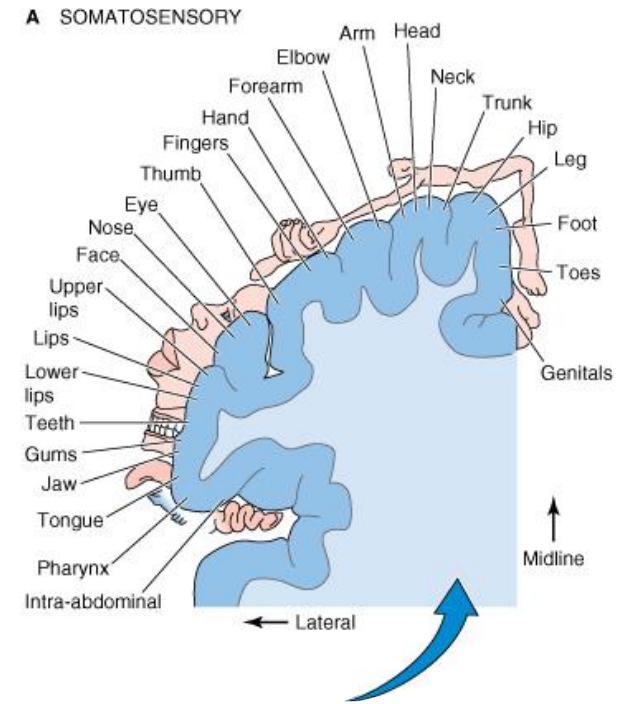
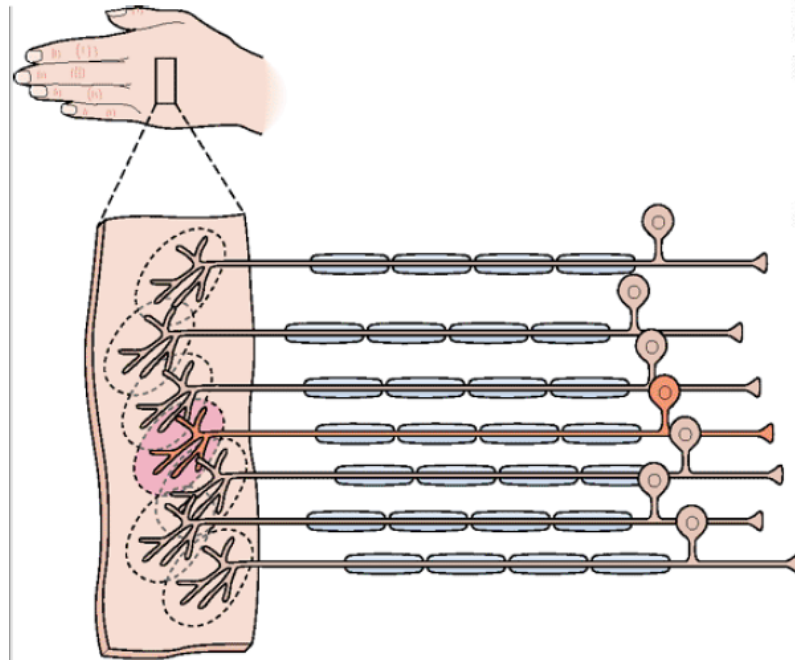
- Labeled line coding define the information about quality



Qualitative information

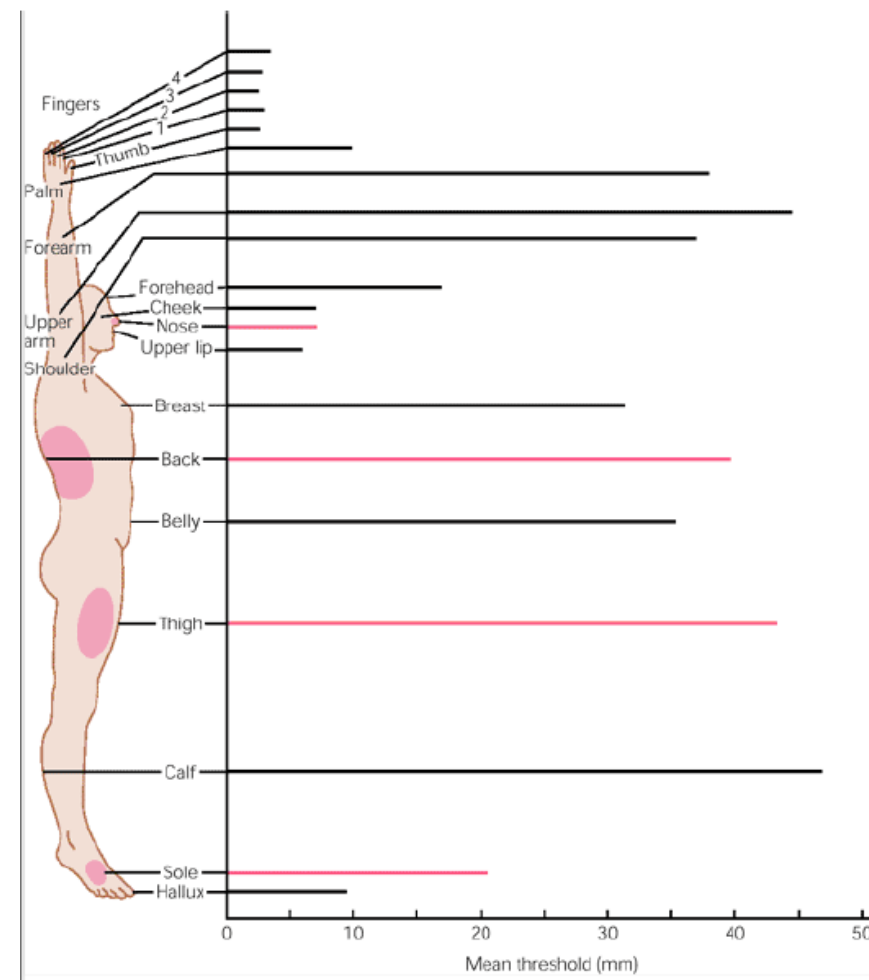
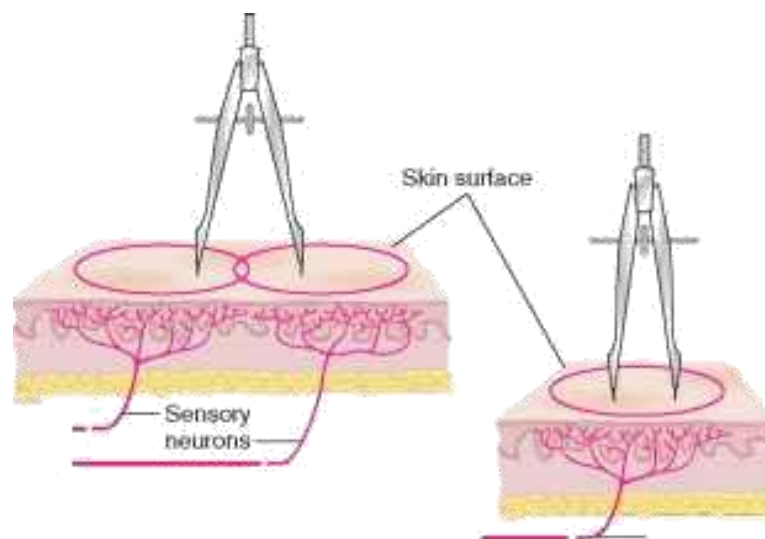
What?
Where?

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



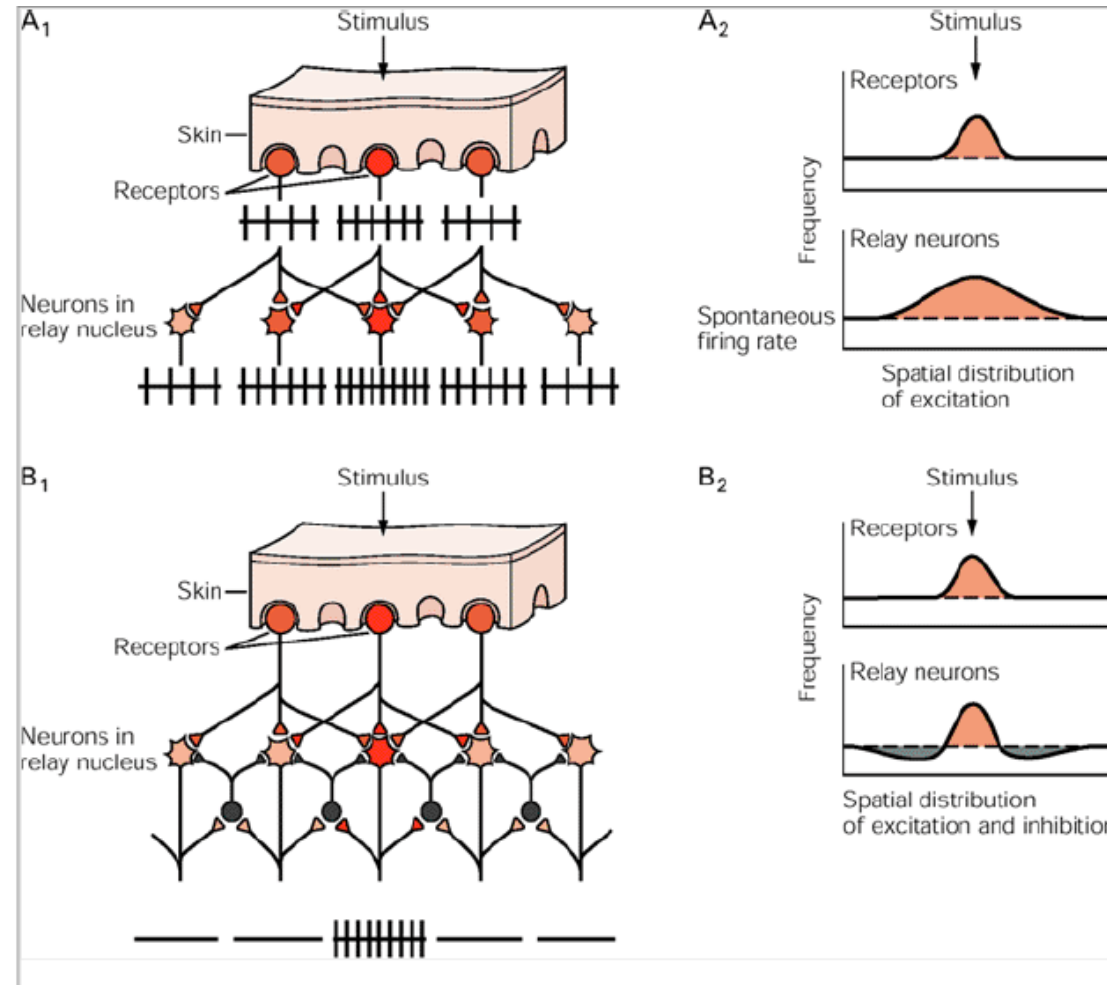
Receptive fields

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



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

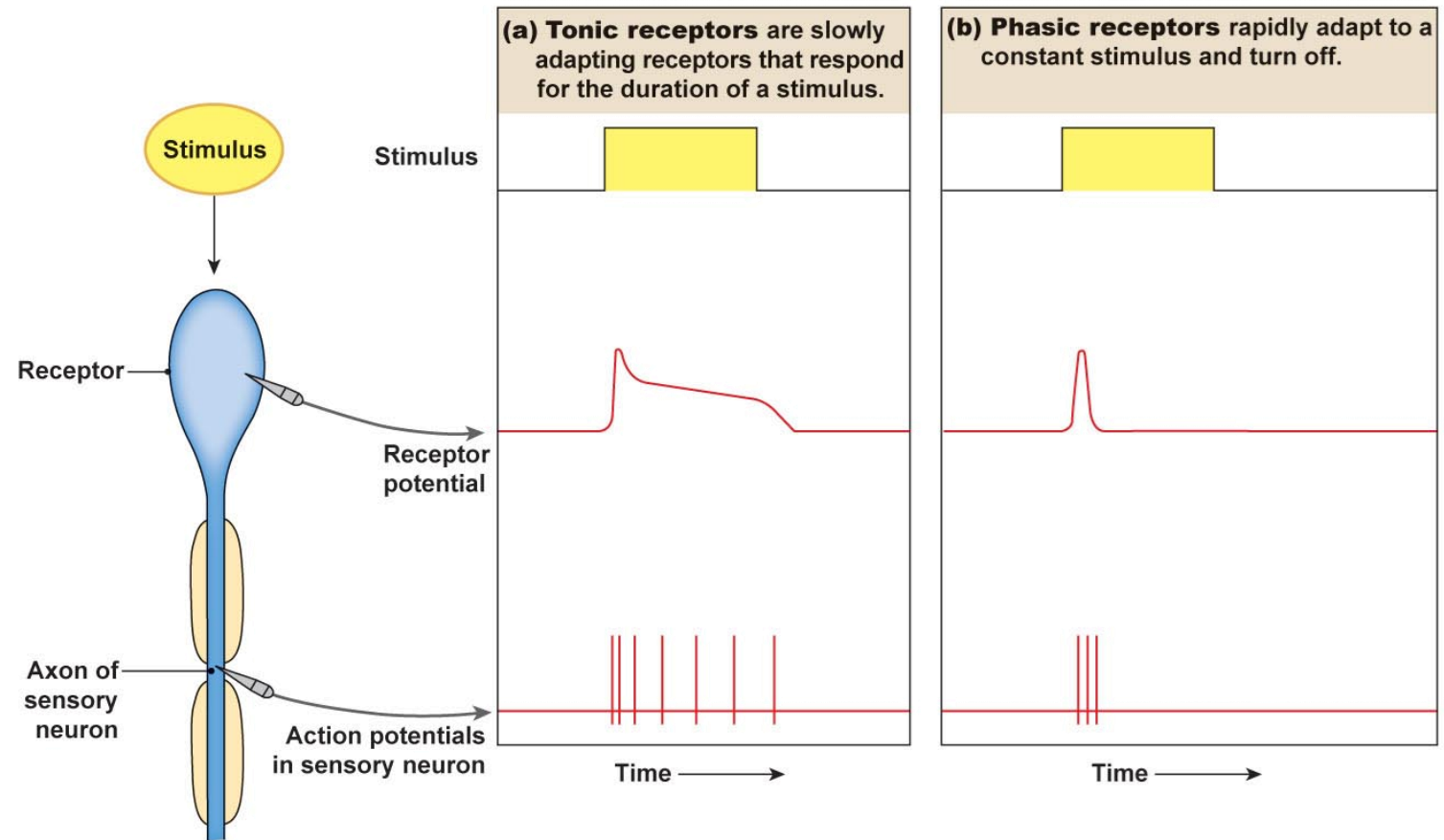
Lateral inhibition



<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

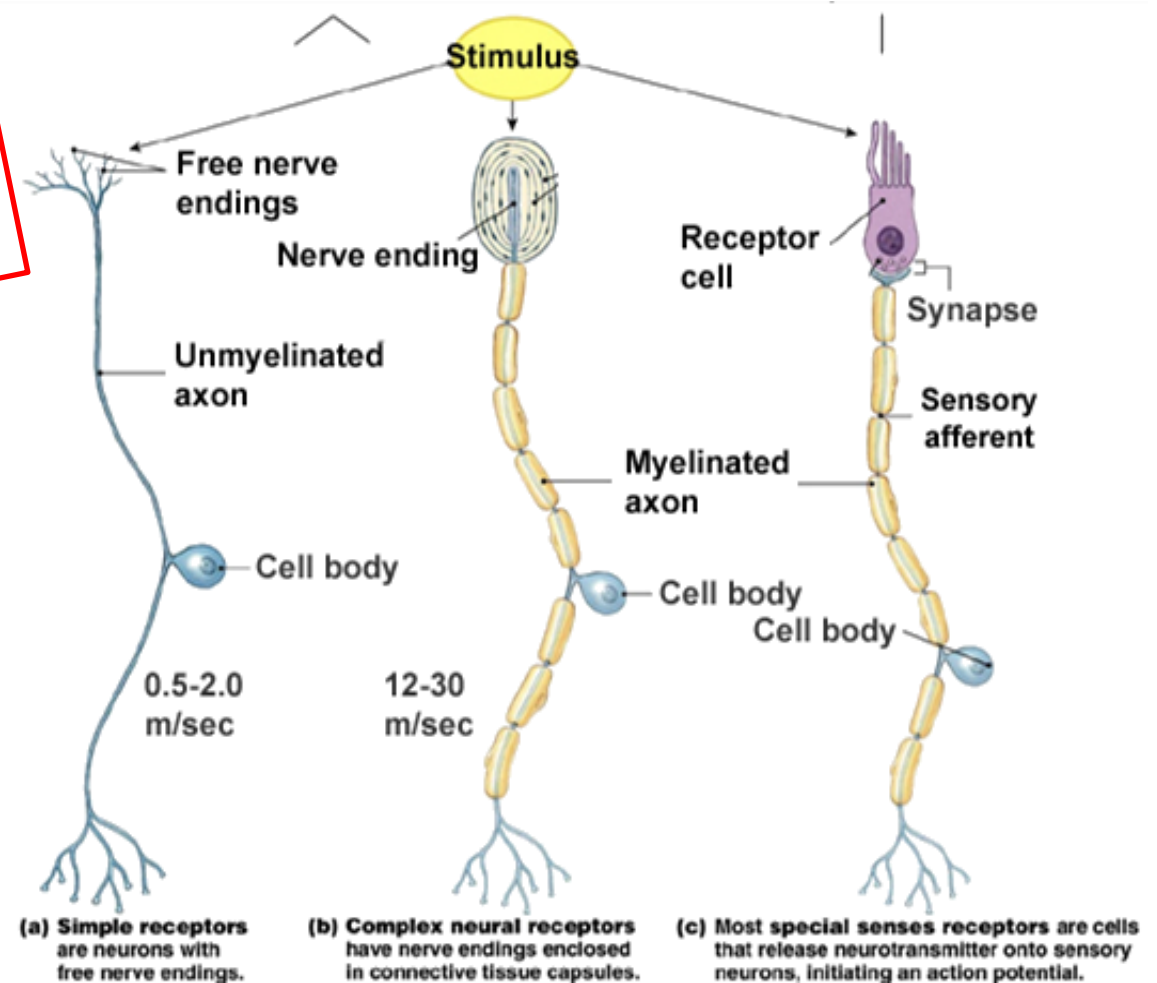
- ✓ **Mechanoreceptors**
- ✓ **Thermoreceptors**
- ✓ **Chemoreceptors**
- ✓ **Fotoreceptors**

- **General**
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Receptors

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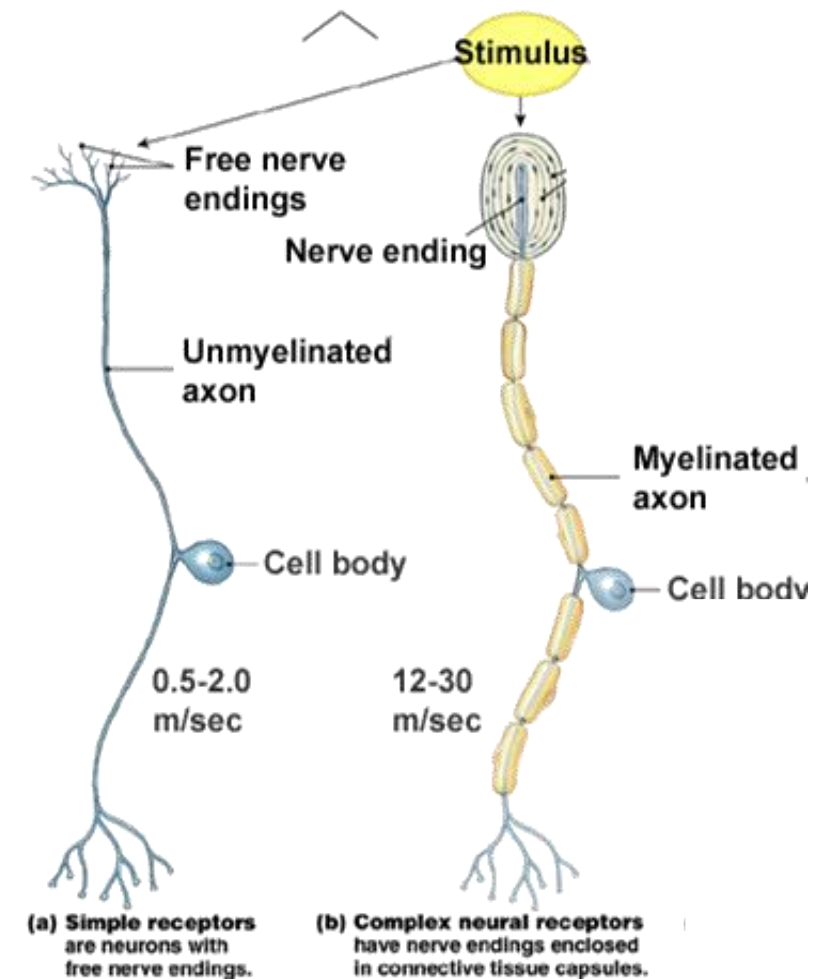
- Simple
 - Superficial – somatosensors
 - Deep – viscerosensors
 - Muscles, tendons, joints – proprioceptors
- General
 - Part of sensory organs
- Special
 - Part of sensory organs



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Somato/viscero/ proprio

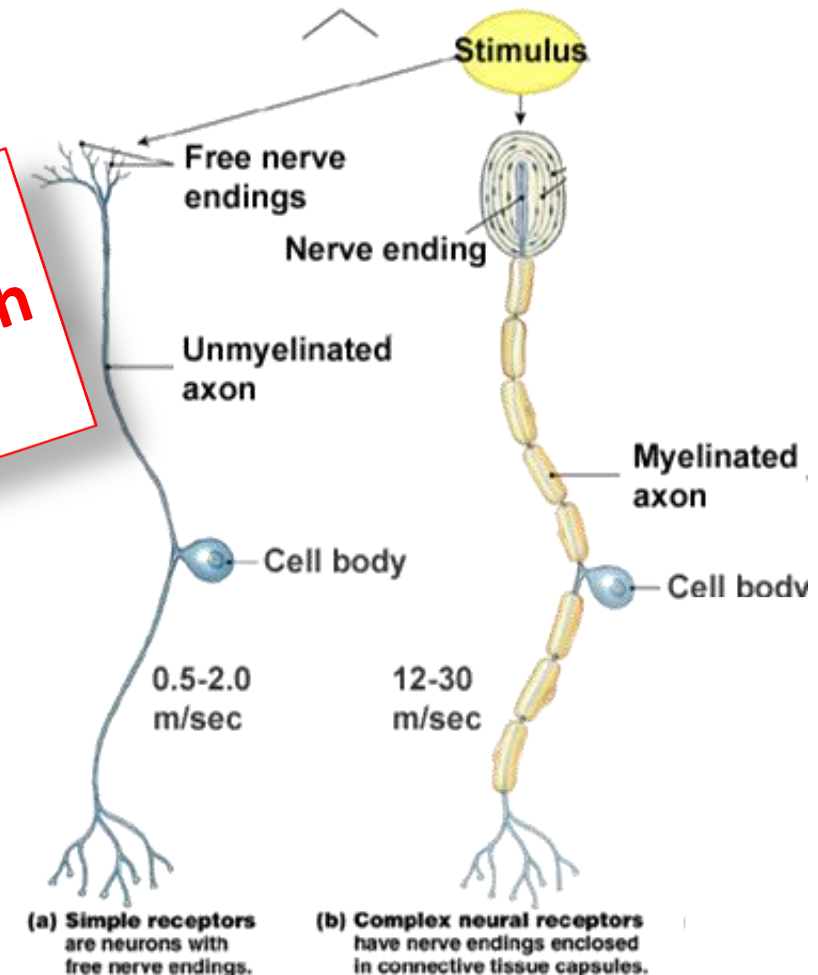
- Somatosensitivity
 - Pain
 - Temperature
 - Touch
- Viscerosensitivity
 - Pain
- Proprioception
 - Position
 - Movement



Somato/viscero/ proprio

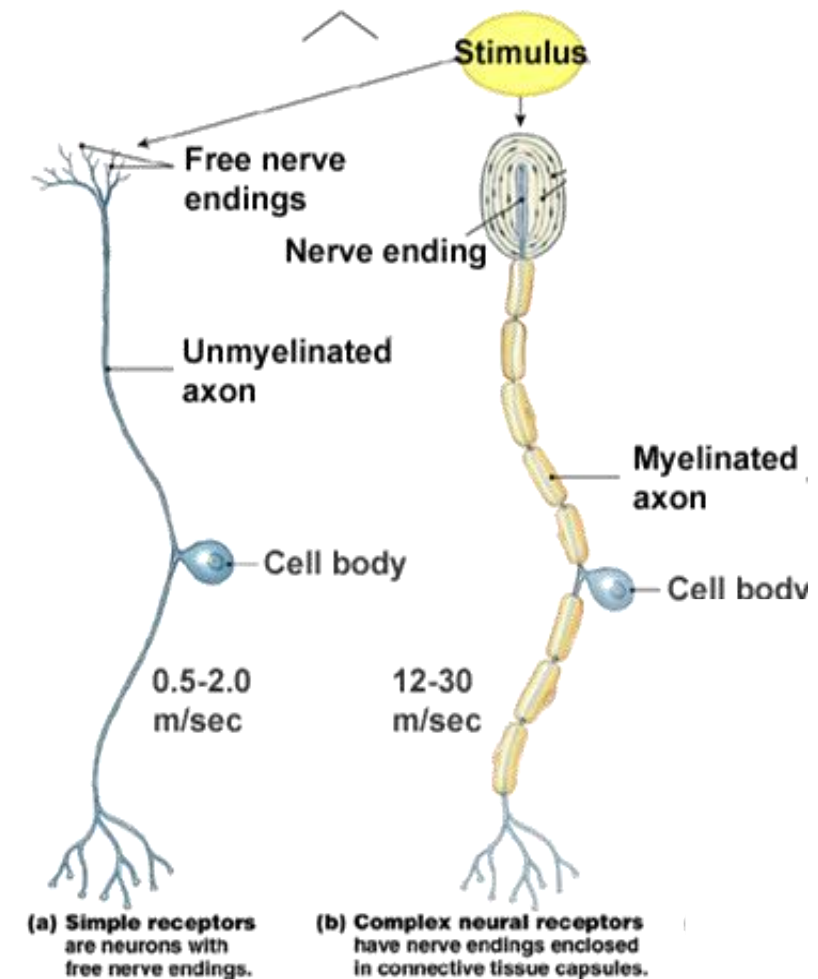
- Somatosensitivity
 - Pain
 - Temperature
 - Touch
- Viscerosensitivity
 - Pain
- Proprioception
 - Position
 - Movement

The majority of information does not reach consciousness



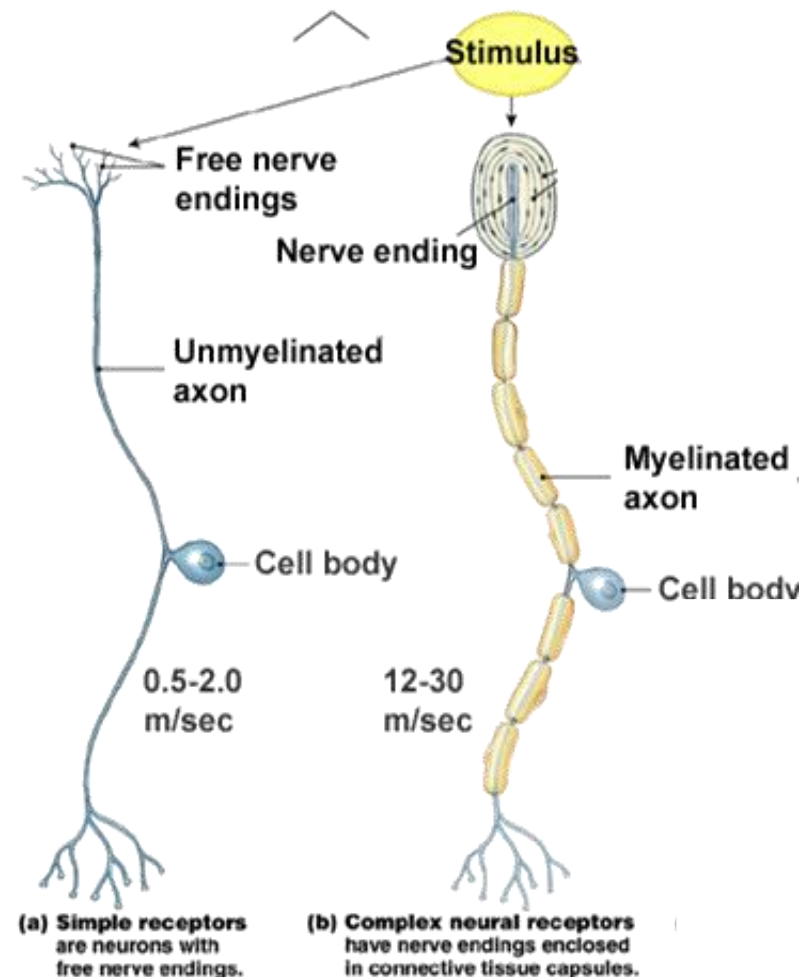
Evolutionary point of view

- 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

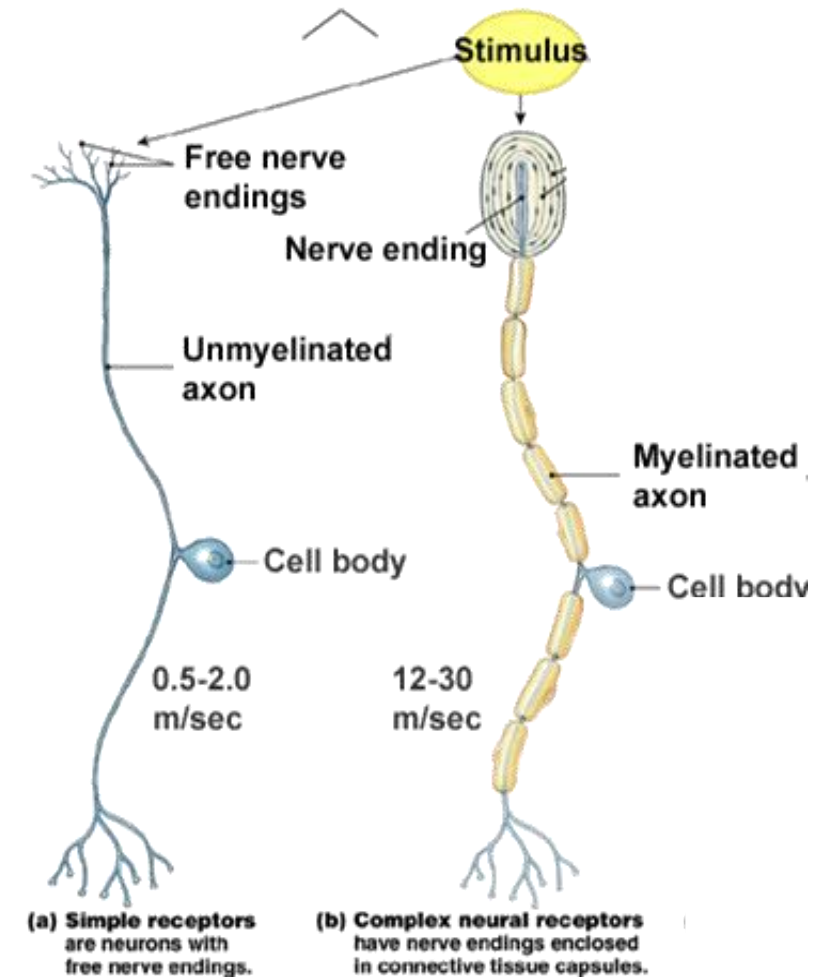


Evolutionary point of view

- 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

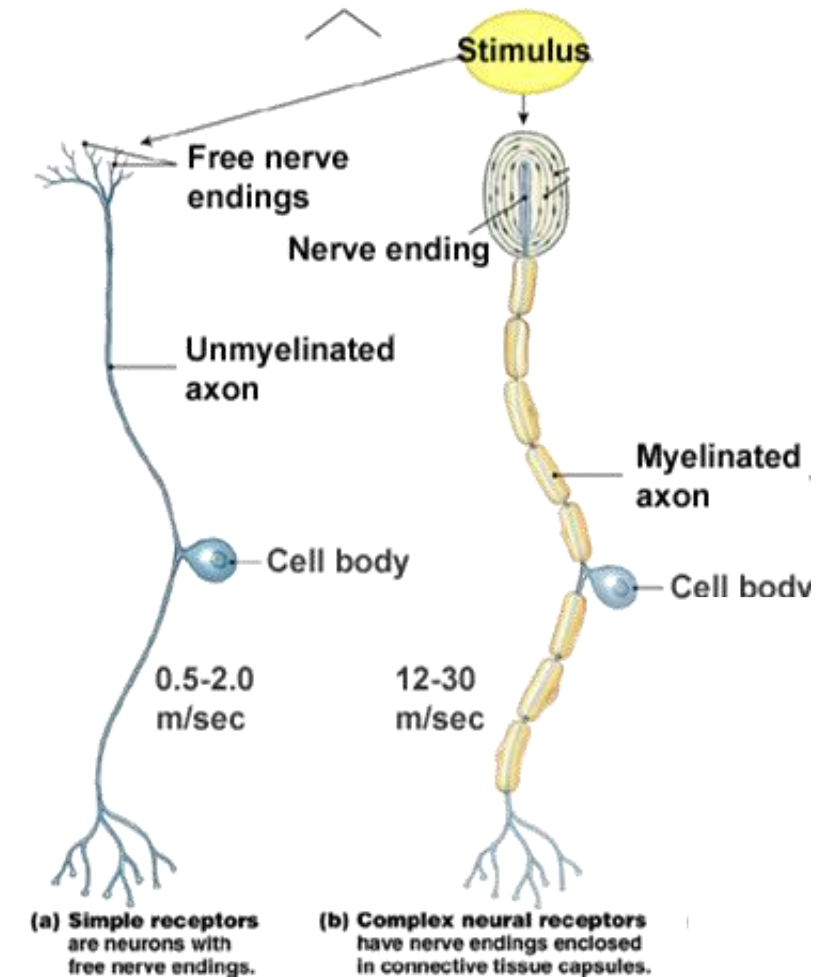
Immediate survival

Long-term survival



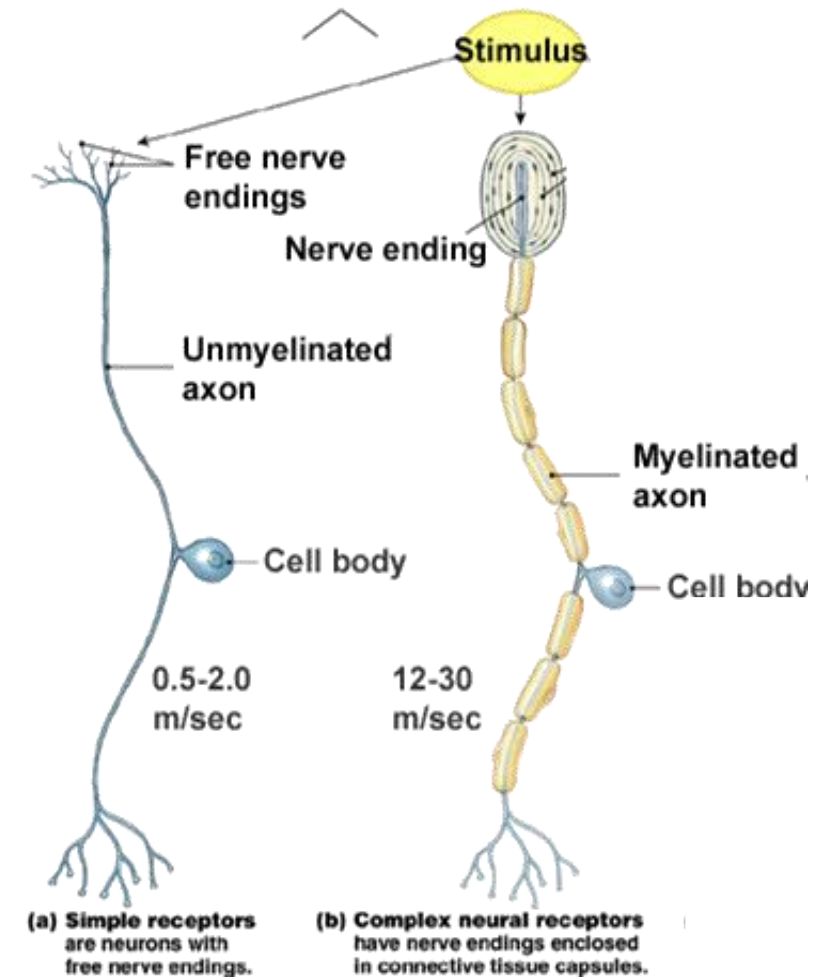
Evolutionary point of view

- 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
 - Immediate survival
 - Long-term survival
- The structure of the receptor, nerve fibers and pathways reflects the evolution

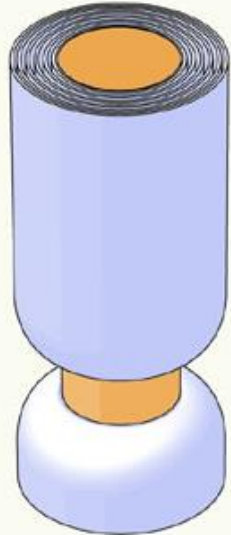

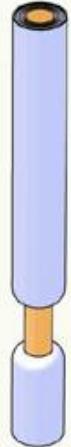



Free nerve endings

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



Nerve fibres

	A α	A β	A δ	C
Axons from skin				
Axons from muscles	Group I	II	III	IV
				
Diameter (μm)	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

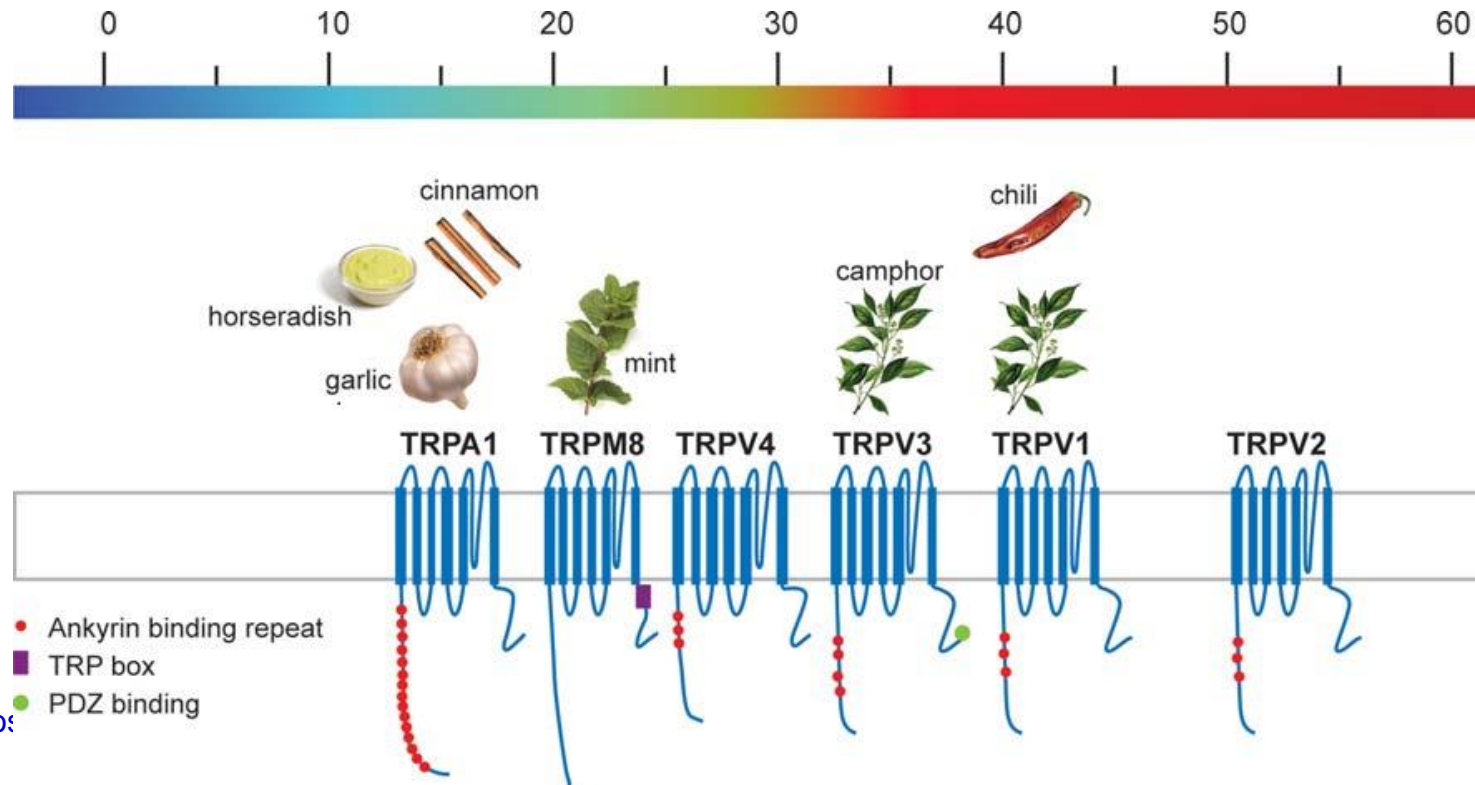
- Free nerve endings responding to high-intensity stimuli
- Stimulus
 - Mechanical
 - ✓ High pressure
 - ✓ Sharp object
 - Thermal
 - ✓ Above approx. 45°C
 - ✓ Low threshold – variable
 - Chemical
 - ✓ pH
 - ✓ Mediators of inflammation and so on

A delta fibers
– sharp, localised pain

C fibers
– dull, diffuse pain

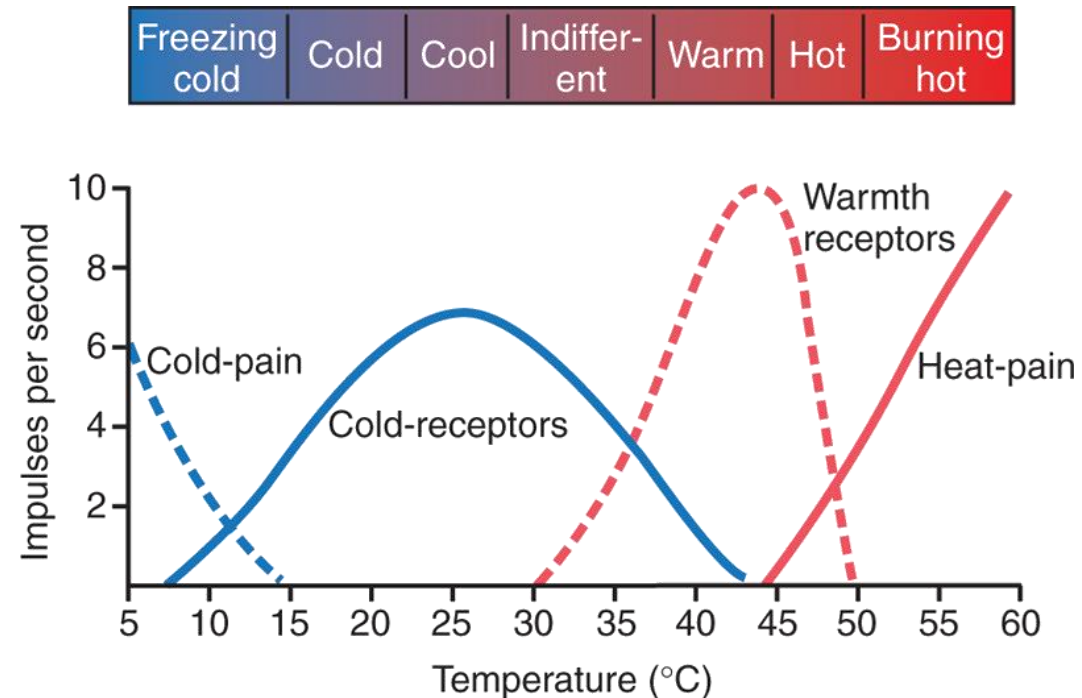
Thermoreceptors

- 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

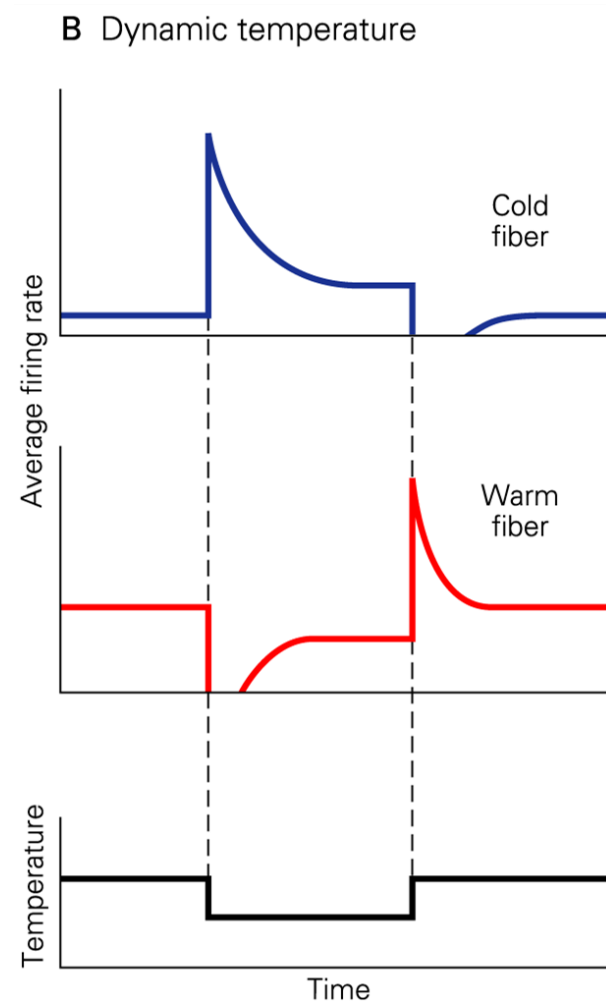


Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition
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Thermoreceptors

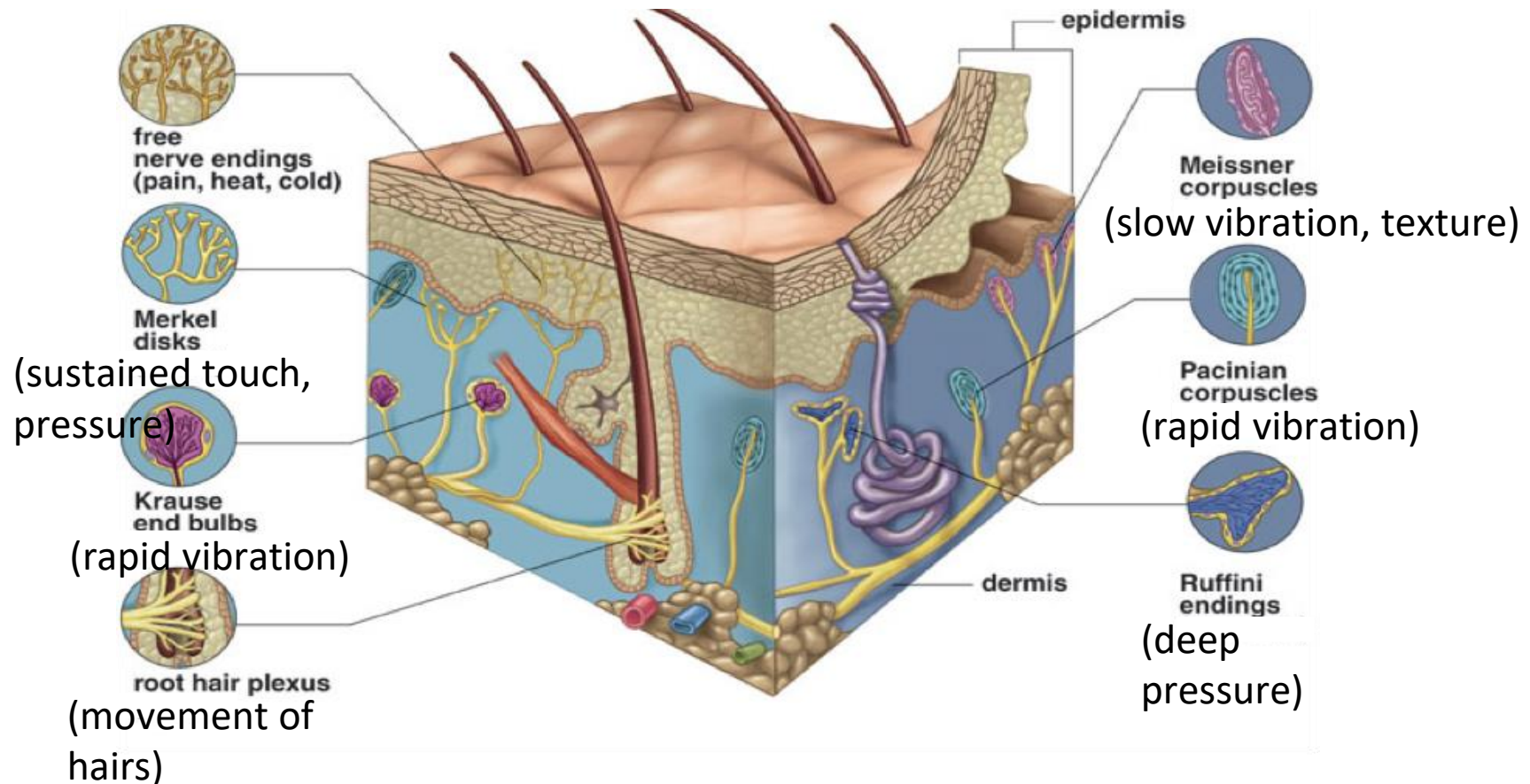
- Mostly phasic response



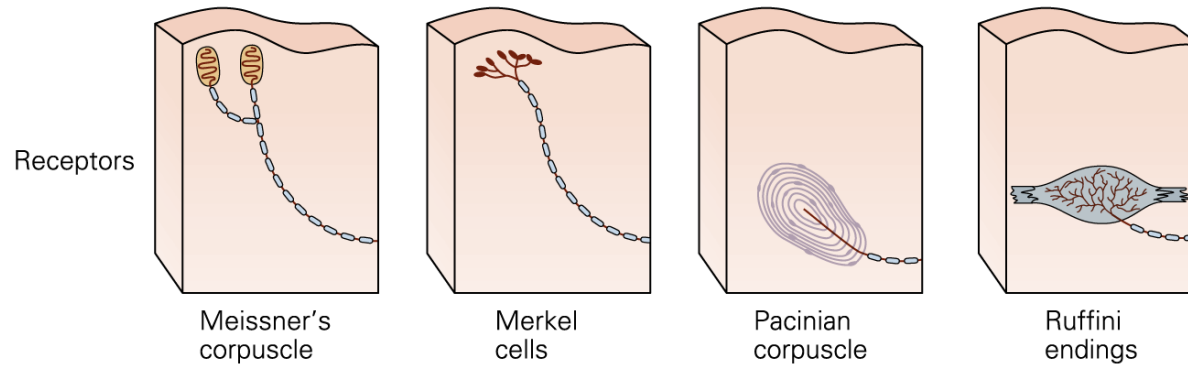
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The receptors of the skin

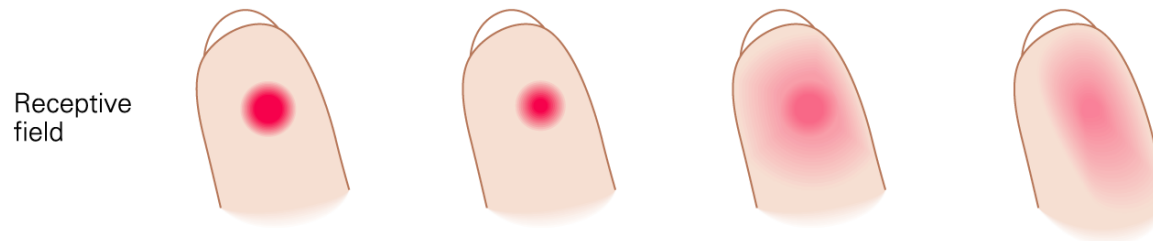
- Simple versus complex



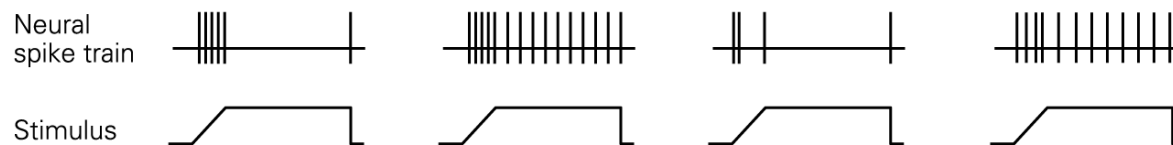
The receptors of the skin



B Location



C Intensity and time course



The receptors of the skin

Receptor	Type	Sensation	Signals	Adaptation
Meissner corpuscle	Encapsulated & layered	Touch: Flutter & Movement	Frequency/Velocity & Direction	Rapid
Pacinian corpuscle	Encapsulated & layered	Touch: Vibration	Frequency: 100-300 Hz	Rapid
Ruffini corpuscle	Encapsulated collagen	Touch: Skin Stretch	Direction & Force	Slow
Hair follicle	Unencapsulated	Touch: Movement	Direction & Velocity	Rapid
Merkel complex	Specialized epithelial cell	Touch, Pressure, Form	Location & Magnitude	Slow
Free Nerve Ending	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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