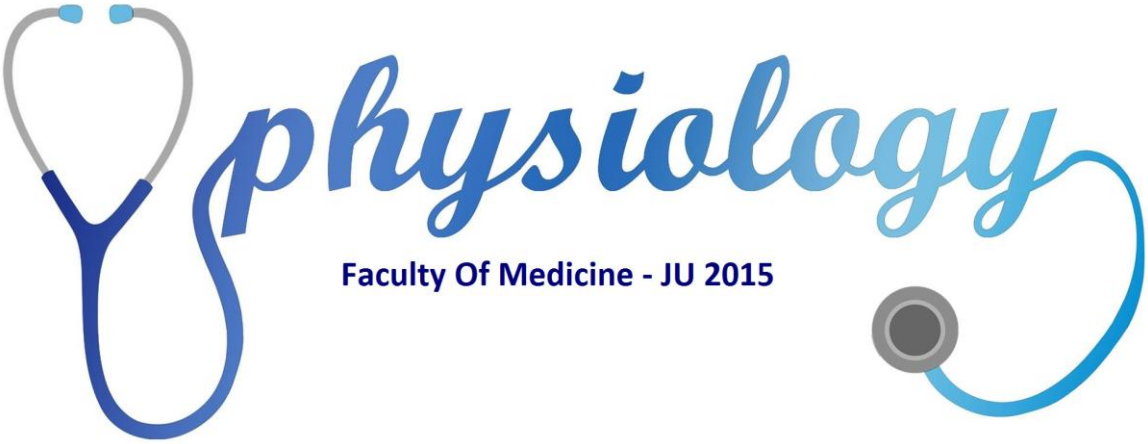

Lecture: 22

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Revision:

We defined sensory receptors as "transducers" which is a receptor that sense different kind sensation "modality sensations" and convert it into an electrical energy.

How they respond to the stimulus ???

By changing the membrane potential and we call this change in the membrane potential (receptor potential, generator potential)

Type of sensory	place	sensation	Nerve type	time
Free nerve ending	found everywhere in the skin and other tissues	Certain Touch ,temperature , pain, pressure .	Aδ nerve	5-30 m/sec
			C unmyelinated	0.5-2 m/sec
Expanded tip	----	pain	----	
Tactile hair	Hair shaft	Movement of the hair	Aβ nerve	30-70 m/sec
Pacinian corpuscle "onion"	Down in the dermis	Pressure and vibration	Aβ nerve	30-70 m/sec
Meissner's corpuscle	Down in the epidermis **nonhairy skin (glabrous skin)**	Touch, pain, movement of light object , rapidly adapting (within a fraction of a second).	Aβ nerve	30-70 m/sec
Rufina's end organ	----	slowly adapting and respond to continual deformation of the skin and joint rotation	Aβ nerve	30-70 m/sec
Krause's corpuscle	----	----	----	---
Muscles spindles	-----	----	----	
Markel's discs	**hairy as well a glabrous (non hairy) skin**	respond rapidly at first and then slowly adapt, detect the “steady state”	Aβ nerve	30-70 m/sec

They are very rabidly adapting receptors they respond to a very high frequency

"We major the frequency of the vibration by "hertz

In Pacinian they are sensitive to all most **1000 hertz**

Iggo dome (found in hairy skin) :

It is a group of Markel's discs " in the previous sheet I defined it as a group of receptors , in order not to confuse you " , these receptors must be connected to an afferent neuron these neurons are subdivided in to myelinated**" A"** neurons .

Revision :

- Myelinated (A)"α,γ,β,δ"
- Unmyelinated C

Another classification :

Roman number : 1,2,3 myelinated and 4

Afferent = sensory

Efferent = motor

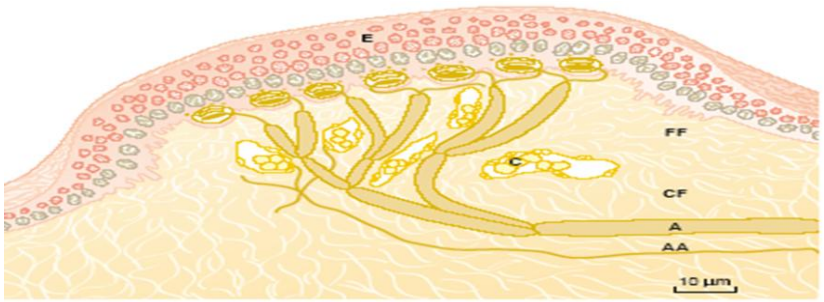


Figure 47–1

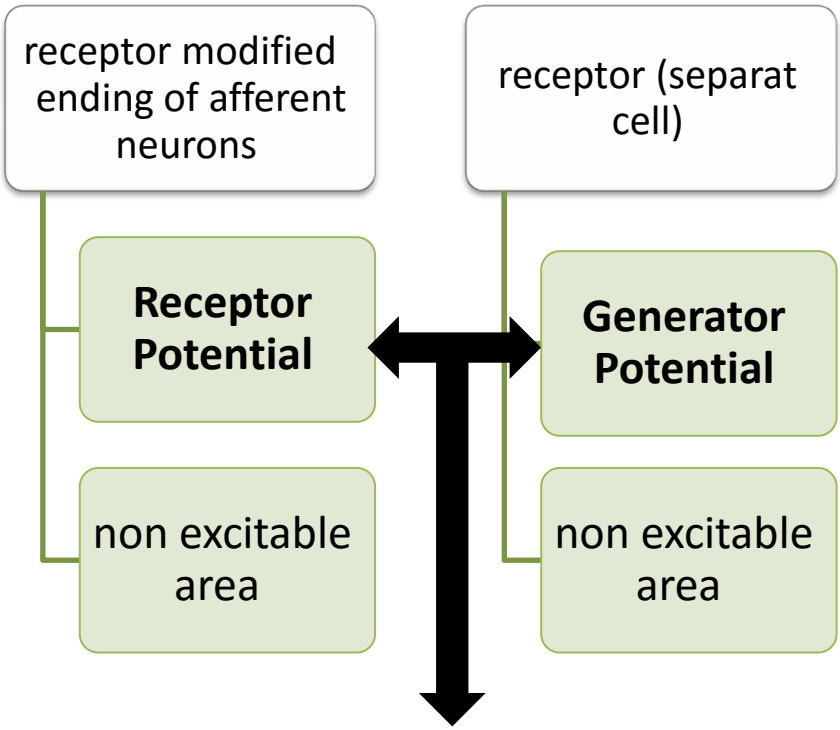
Iggo dome receptor. Note the multiple numbers of Merkel's discs connecting to a single large myelinated fiber and abutting tightly the undersurface of the epithelium. (From Iggo A, Muir AR: The structure and function of a slowly adapting touch corpuscle in hairy skin. J Physiol 200: 763, 1969.)

Now … different kind of receptors connected to a different kind of neurons:

- Free nerve endings (Aδ and C fibers)
- Meissner's corpuscles (Aβ)
- Merkel's discs (Aβ)

Sensory Receptors: General structure

Two kind of sensory receptors :



Dr.faisal said that they are both the same and there is no different between them

Receptors areas are not excitable areas ,which means:
Where there is a stimulus ,this stimulus what ever it strength is will not cause action potential ,it will cause receptor potential which **is graded, local and can be summated.**

Why it is not excitable?

To differentiate different intensities "if it is, which is "مصيبة" you will feel the same feeling when you hit your hand by knife or feather which is not good at all".

What happen if we supposed that the receptor areas are excitable ?

- Whatever the strength of the stimulus "must reach the threshold" the rate of the action potential in the Afferent neuron **will be the same**
- The Afferent neuron in this case cannot differentiate between weak, moderate, strong stimulus .

Example :

- **Stimulus ⟶ membrane potential from (-70)-(30) ~~amp~~litude =100 ~~this~~ difference will cause for example 1000 impulses /sec in the afferent neuron .**
- **The next time we used a stronger stimulus "above the threshold" we will also reach the same rate of action potential "1000".**

Non excitable receptor :

To understand the system we will put some example :

1. A stimulus changes the membrane potential from :

-70 to -40 mV

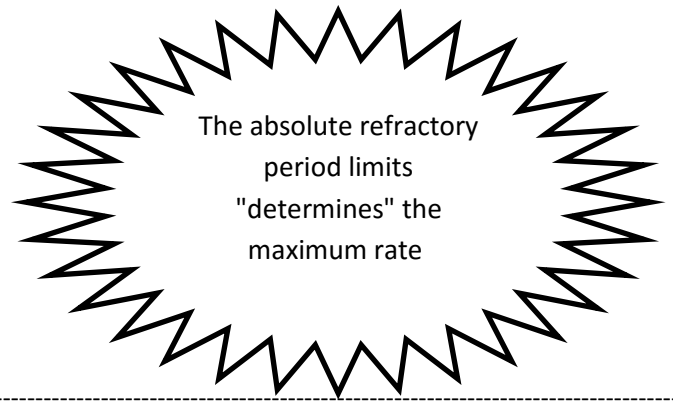
amplitude 30mV"equals the threshold exactly"

cause an action potential in the afferent neuron =10m.sec

the rate of action potential per second :(1sec=1000m.sec)

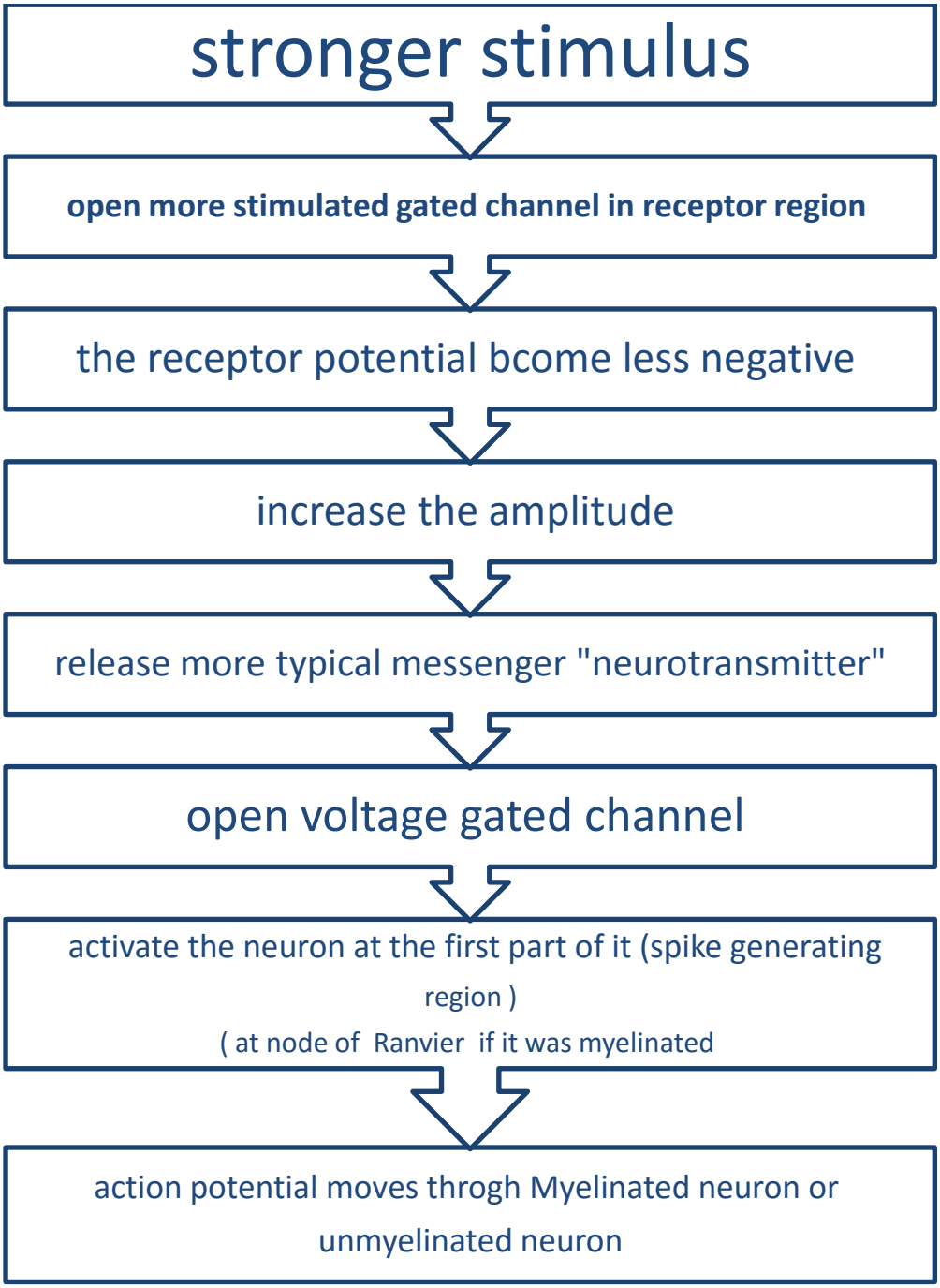
1000m.sec/10m.sec = 100(number of action potential in afferent neuron).

2. The next time we used a strong stimulus that changes the membrane potential from (-70to-30)
    - Amplitude:40mV (higher than 30 in the previous example , which means that it is higher than the threshold) so it is able to stimulate the afferent neuron during the relative refractory period
    - The action potential during this time =5m.sec
    - The rate of action potential =1000m.sec/5=200(stranger than the case in the first EX).
3. Another strong stimulus that changes the membrane potential from:
    - -70 to zero
    - Amplitude 70mV (higher than the two previous EX + can stimulate the afferent neuron during relative refractory period)
    - Action potential =2m.sec
    - The rate of action potential =1000/2=500 "stronger"

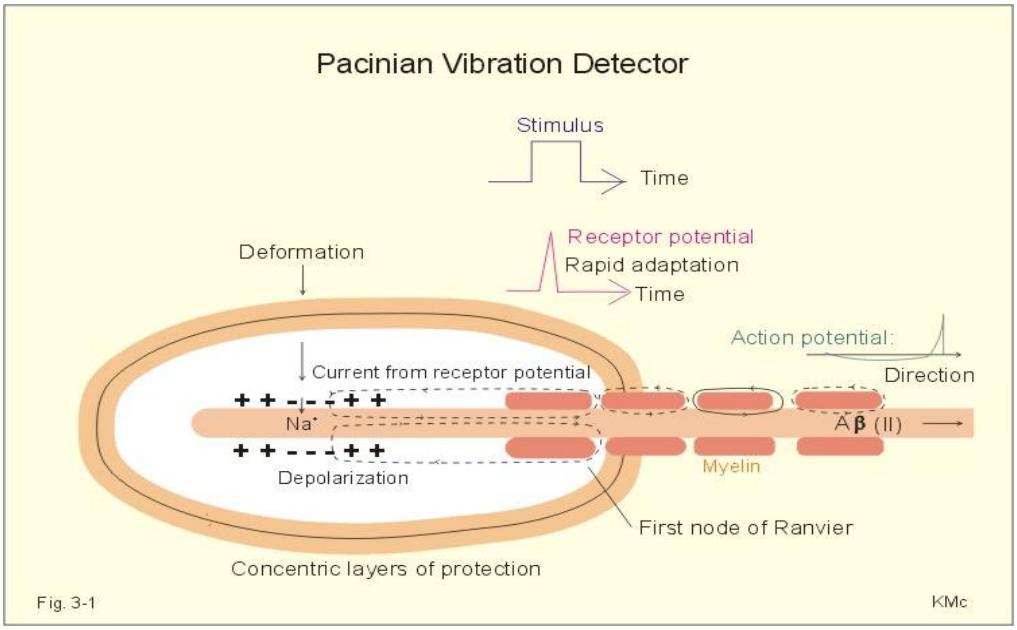


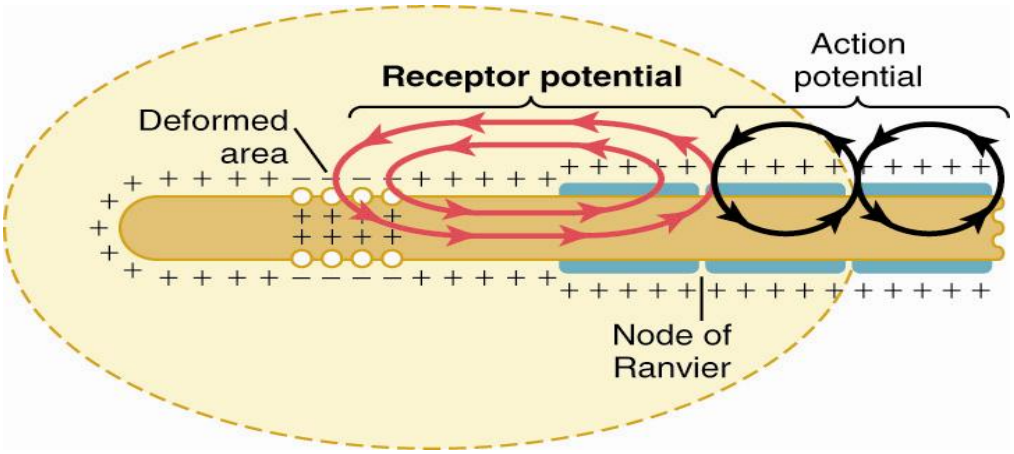
As we took previously : in nervous system specific number of neurotransmitter coming from presynaptic membrane binding with their receptors ⟶ open specific number of ligand gated sodium channels depend on the number of neurotransmitter .

- In the receptor potential or generator potential the stimulus will open stimulus gated channel :



The greater the intensity of the stimulus the greater the receptor potential and the greater the rate of action potential generation





Properties of receptors:

1-The receptor is sensitive for one kind of sensation (**the receptor is specific)**

- The receptor for touch senses touch
- The receptor for pain senses pain
- The receptor for pressure senses pressure

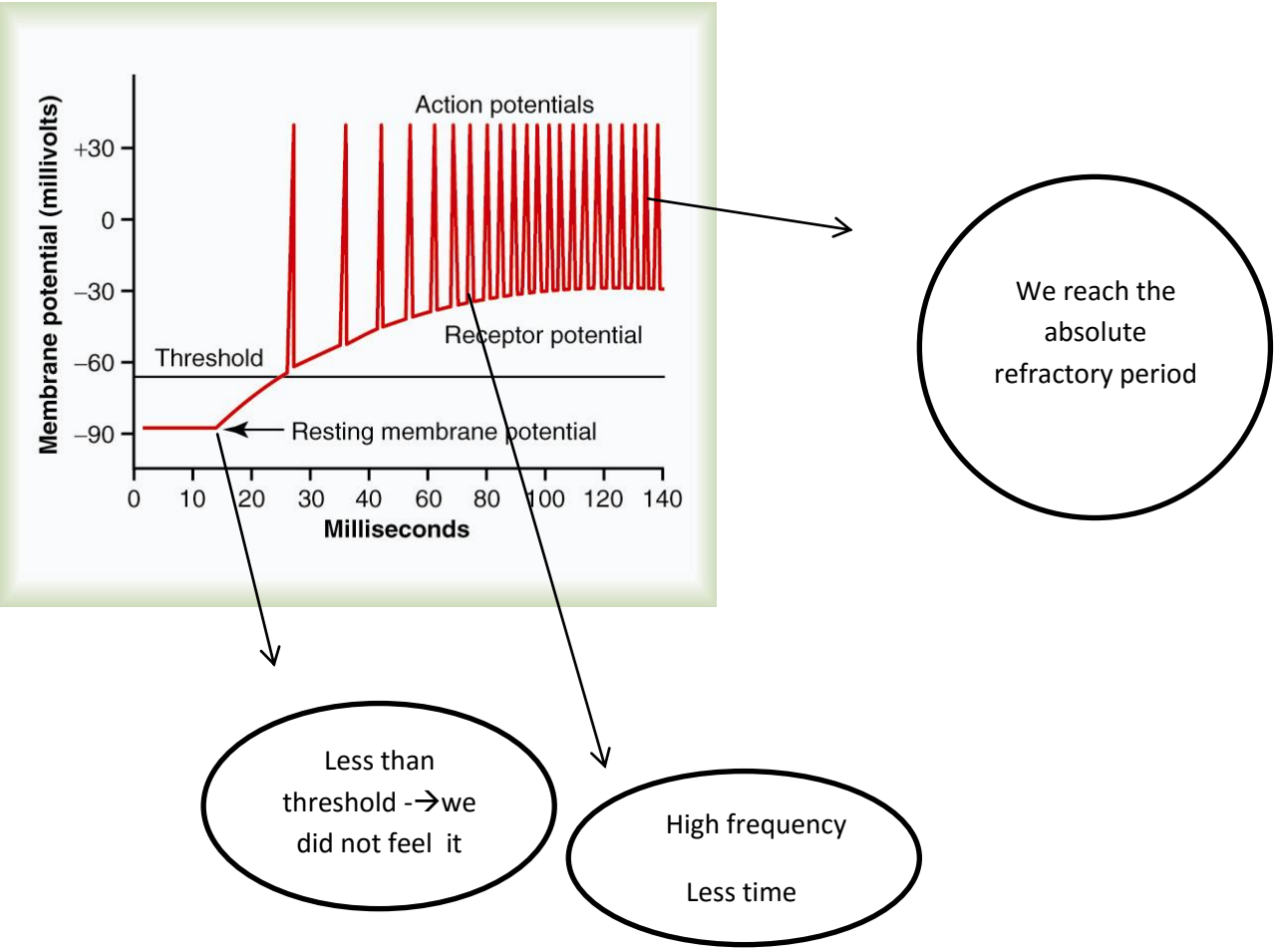
By this mechanism we can know what type of sensation we feel

2-The receptor has a very low threshold for adequate stimulus (we use adequate stimulus in terms of quality (touch pressure pain) not quantities

- The receptor for touch their adequate stimulus is touch
- The receptor for pain their adequate stimulus is pain
- The receptor for heat their adequate stimulus is heat
  " they can respond to other kind of stimulus but with high threshold "

  EX: pain receptor can respond to stimulus other than tissue damage such as extreme heat or cold "burns and ice bite "

  Note
- How many action potential depends on the amplitude of receptor potential
- Receptor potential didn't follow all or non principle.



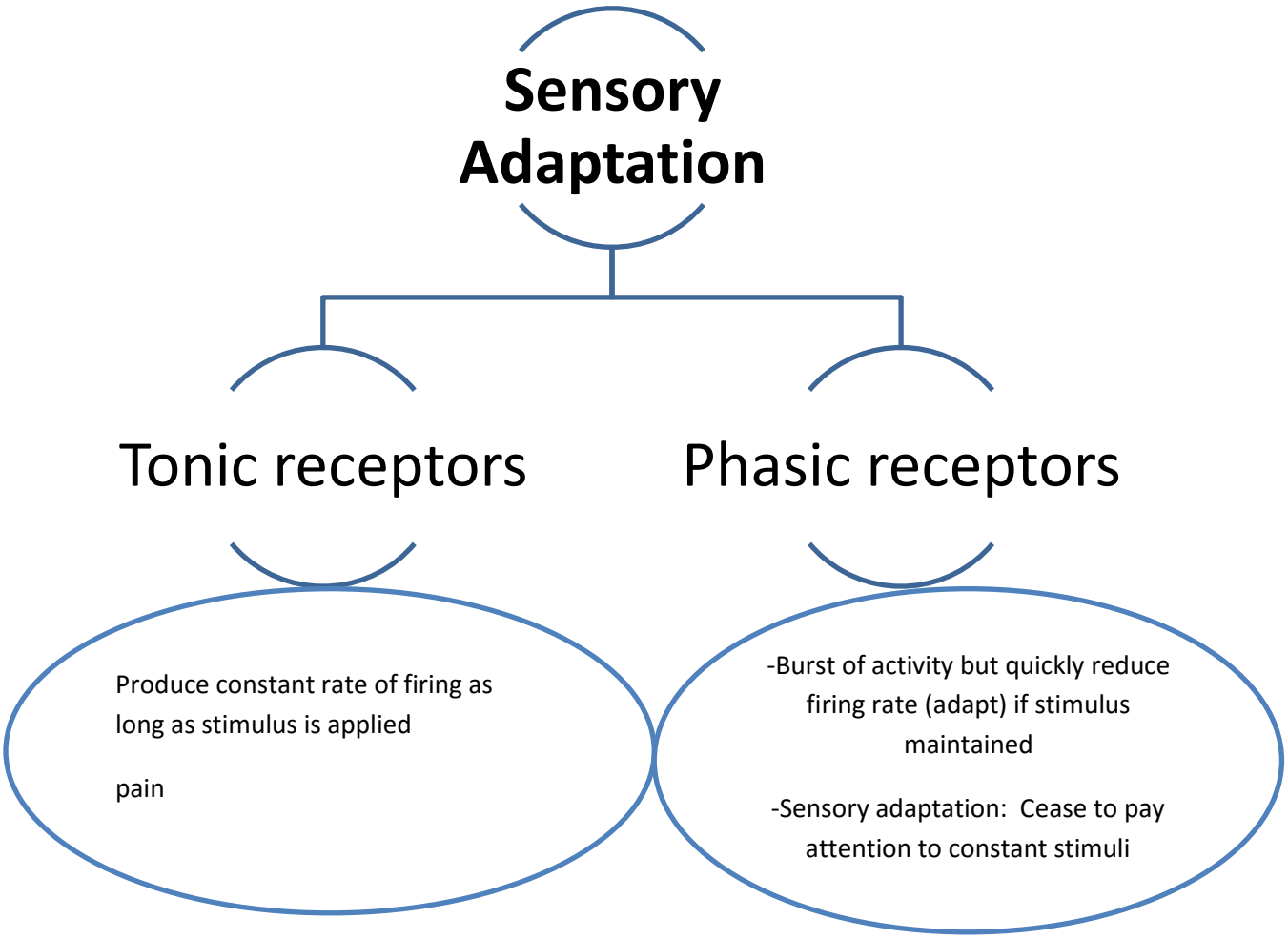
Adaptation of Receptors

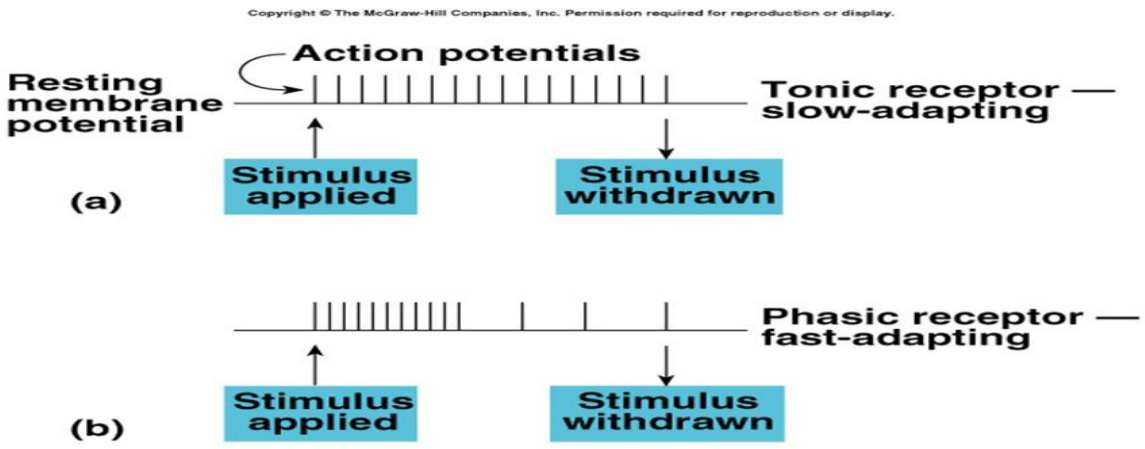
- When a continuous stimulus is applied, receptors respond rapidly at first, but response declines until all receptors stop firing
- Rate of adaptation varies with type of receptor.

  EX : when you wear your clothes at first you feel the touches on your skin then you adapt and stop feeling

Adaptation of Sensory Receptors

- Receptors responding to pressure, touch, and smell adapt quickly
- Receptors responding slowly include Merkel's discs**, Ruffini's** corpuscles, and **interoceptors** that respond to chemical levels in the blood
- Pain receptors and proprioceptors do not exhibit adaptation





Slowly Adapting (Tonic) Receptors

- continue to transmit impulses to the brain for long periods of time while the stimulus is present
- keep brain apprised of the status of the body with respect to its surroundings
- will adapt to extinction as long as the stimulus is present, however, this may take hours or days
- these receptors include: *muscle spindle*, *golgi tendon apparatus, Ruffini's endings, Merkels discs, Macula, chemo- and baroreceptors*

Rapidly Adapting (Phasic) Receptors

- respond only when change is taking place
- Rate and Strength of the response is related to the Rate and Intensity of the stimulus
- important for predicting the future position or condition of the body
- very important for balance and movement
- types of rapidly adapting receptors: *pacinian corpuscle, semicircular canals* in the inner ear