CODING OF SENSORY INFORMATION

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Sensory system

- **Sensation:**

  It is the conscious or subconscious awareness of changes in the external or internal environment.

- **Perception:**

  It is the conscious interpretation of sensations – Function of cerebral cortex

- **Sensory modality**

Each unique type of sensation is called sensory modality – such as touch, pain, hearing.

- **Senses :**

- General Senses

(Somatic senses and Visceral senses **)**

- Special Senses – Vision**,** Audition, Gustation, Olfaction, Acceleration.

General Senses

Somaesthetic senses :

Epicritic – fine, well localized (Fine touch)

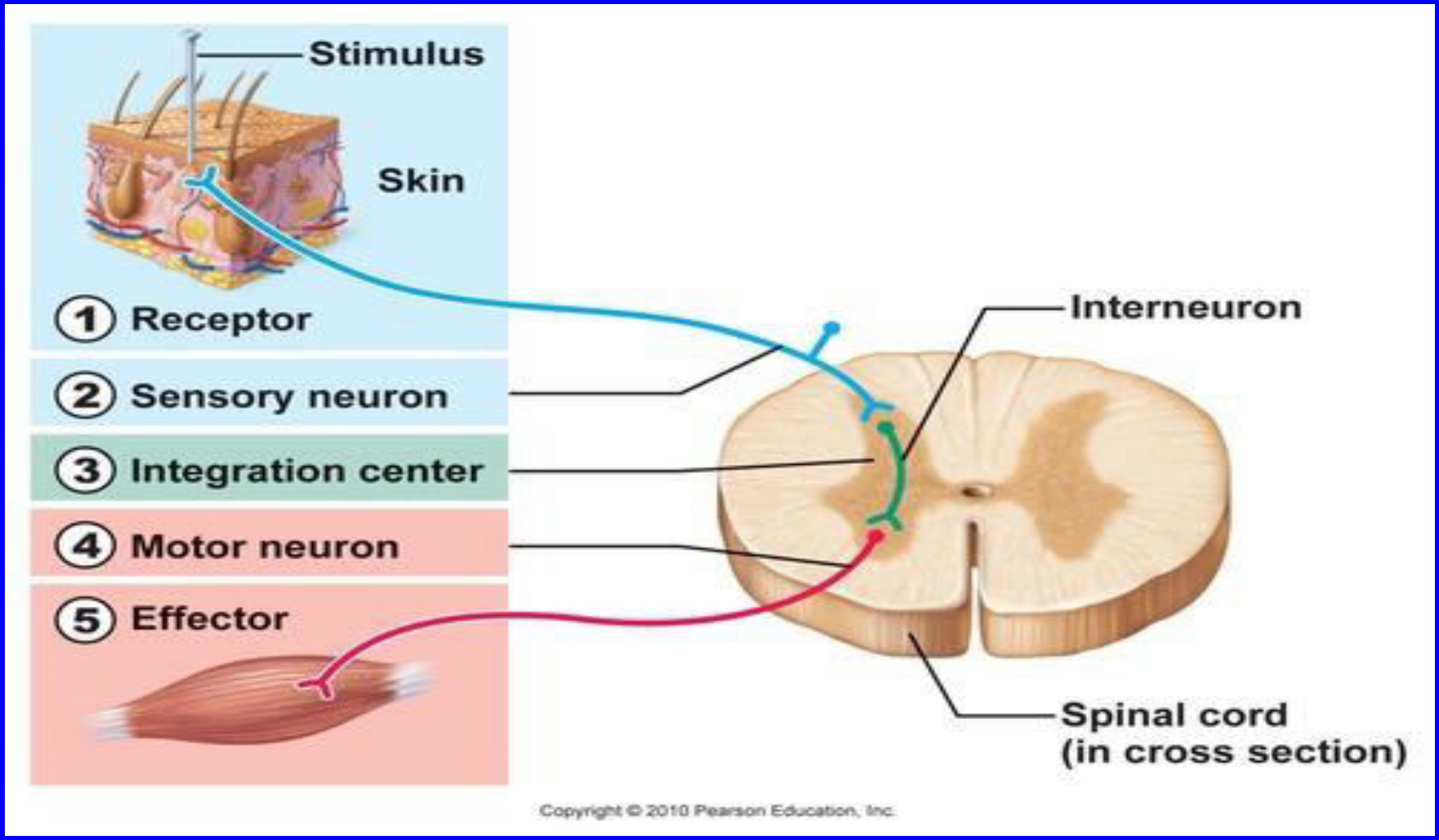
Protopathic – crude, not well localized(pain and temperature)

Visceral senses:

Components of Sensory system

- Sensory Receptors
- Ascending tracts
- Somato-sensory Cortex

- **Sensory Receptor :**



Classification

- **Based on source of stimulus (Sherrington's) :**

  Exteroceptors

  Interoceptors

  Teleceptors

  Proprioceptors

Based on type of stimuli to which receptor responds

- Mechano receptors – Touch and Pressure
- Chemo receptors – Chemical composition
- Thermo receptors – Changes in Temperature
- Nociceptors - Painful stimuli
- Photo Receptors - Light
- Osmo receptors – Changes in Osmotic pressure

- **Based on Adaptation**

  - Phasic Receptors (Rapidly Adapting)
    Ex; Pacinian Corpuscle

  - Tonic Receptors (Slowly Adapting)
    Ex; Pain Receptors

Clinical or anatomical Classification

– Superficial receptors – Present in Skin and Mucous membrane

– Deep receptors- Present in Muscles, Tendons and Joints

– Visceral receptors – Present in the Visceral organs

- **Based on Microscopic Structure**

  - **Free Nerve endings**

    Ex ; Receptors for Pain, Temperature,
    Tickle, itch

  - **Encapsulated Nerve endings**

    Ex ; Receptors for Touch

  - **Separate Cells**

    Ex ; Receptors for Hearing (Hair cells)

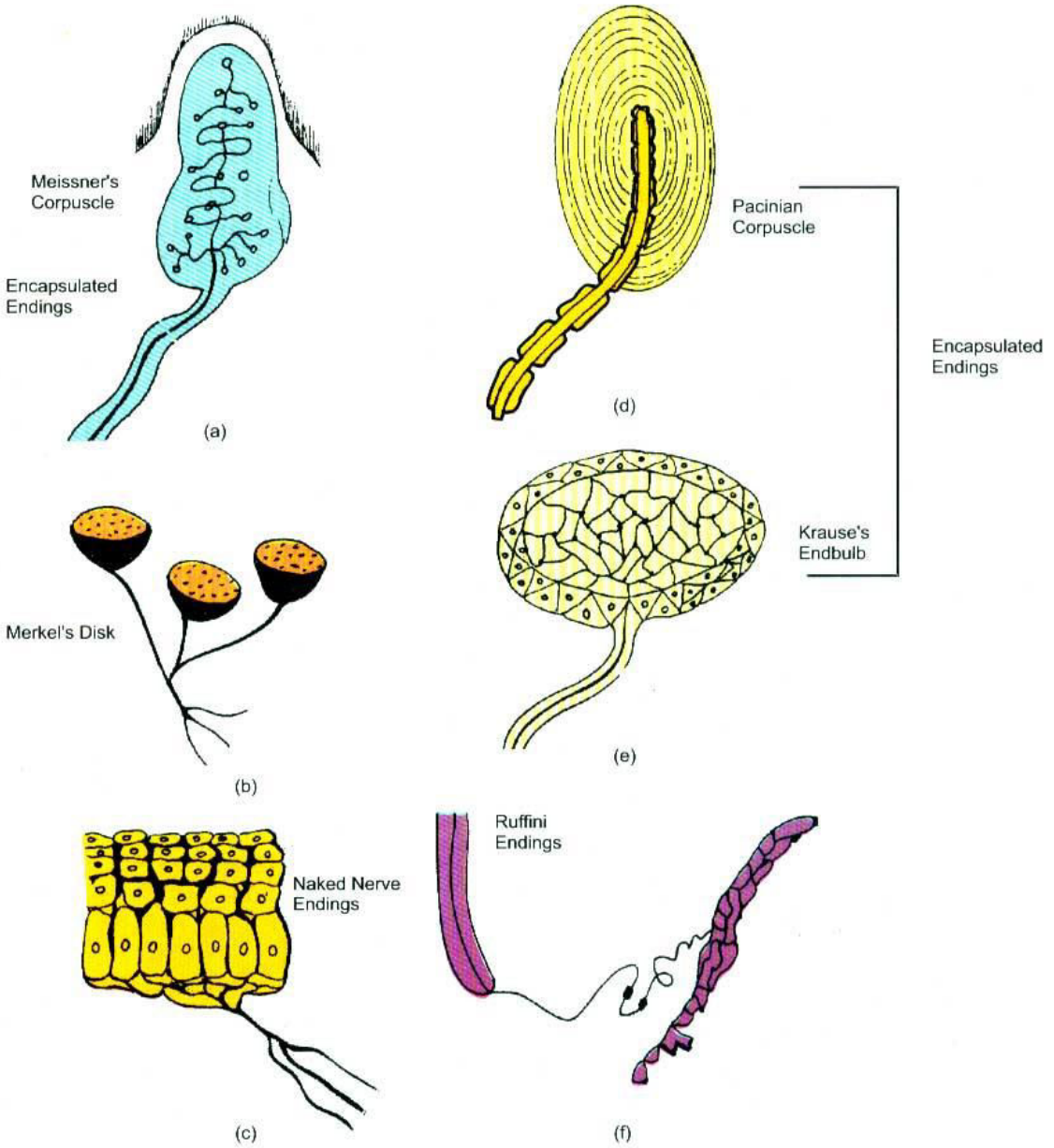


Fig. 8.15 : Sensory Receptors

Properties of receptors

- Adequate stimulus
- Generator Potential
- Adaptation

- Adequate Stimulus

The particular form of energy to which a receptor is most sensitive is called adequate stimulus.

Ex; Adequate stimulus for Rods & Cones is light

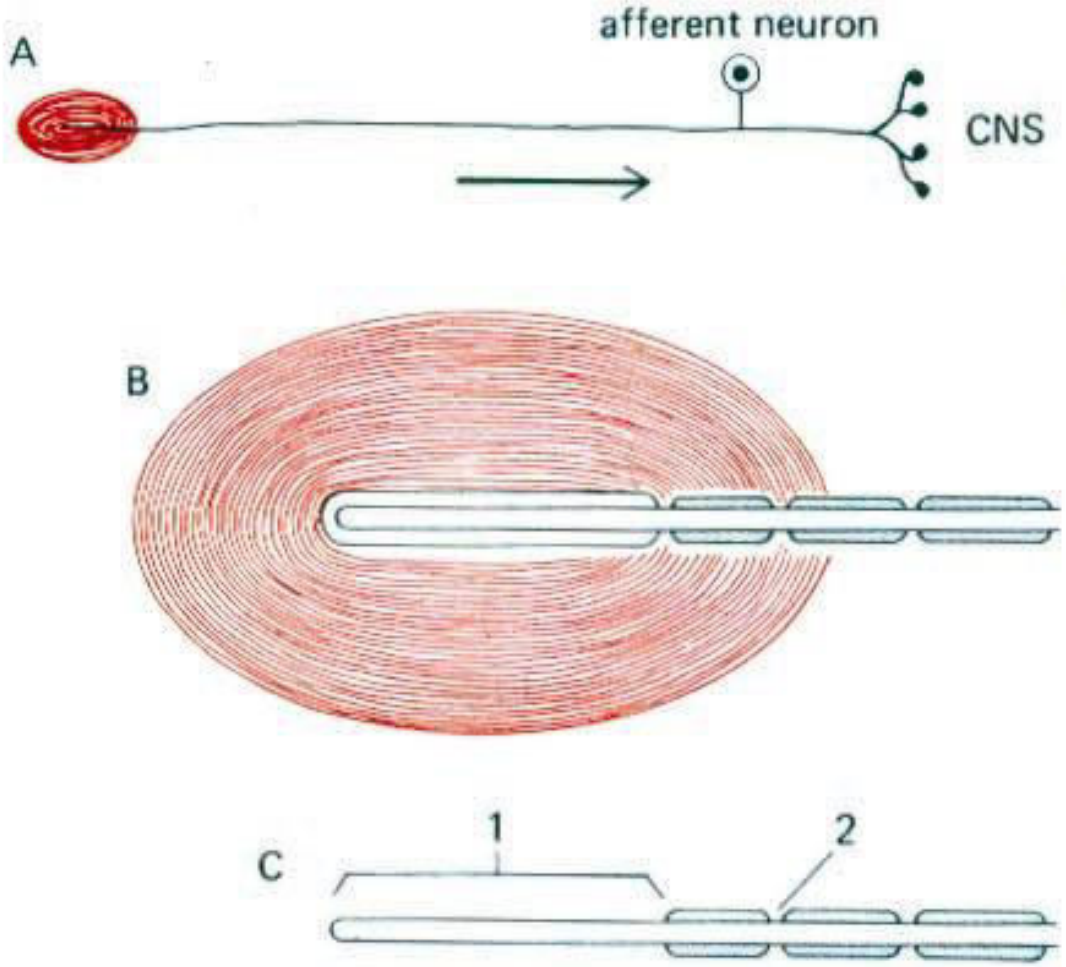


FIGURE 8-48. (A) An afferent neuron with a mechanoreceptor (pacinian corpuscle) ending. (B) A pacinian corpuscle showing the nerve ending modified by cellular structures. (C) The naked nerve ending of the same mechanoreceptor. The receptor potential arises at the nerve ending (1), and the action potential arises at the first node of the myelin sheath (2).

Generator Potential or Receptor Potential

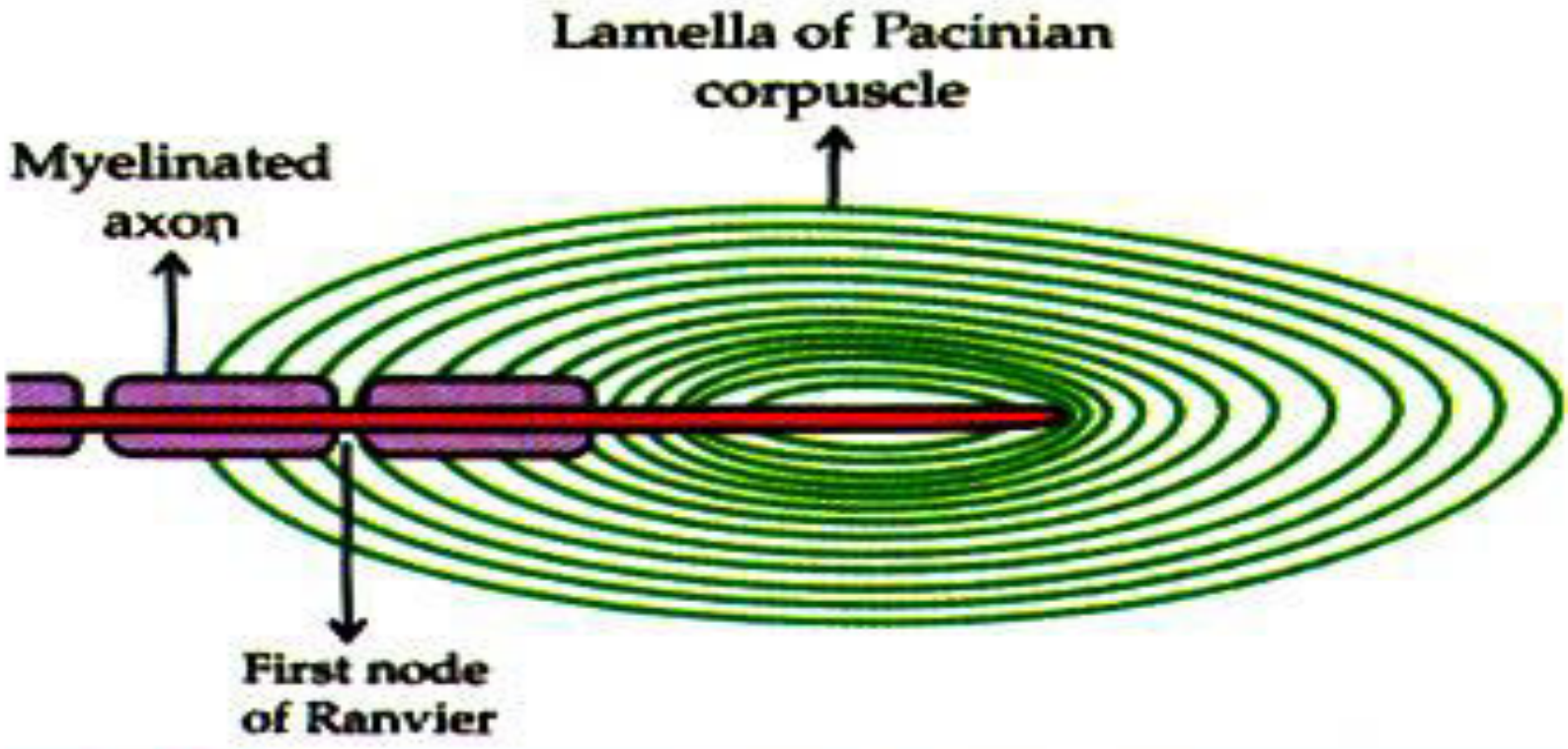


Figure 101.1 Pacinian corpuscle. Usually, first node of Ranvier remains within the lamella of the corpuscle.

- **Mechanism**

Pressure on the Pacinian corpuscle

↓

Mechanical Distortion of lamellas

↓

Opens Stretch Sensitve Na+ Ion channels in Unmyelinated nerve terminal

↓

Influx of Na+

↓

Receptor potential generated

- Features

  - Local or Graded Potential
  - No refractory period
  - Can be summated
  - Does not obey All or None law
  - Decremental conduction
  - Duration is more (5-10ms)

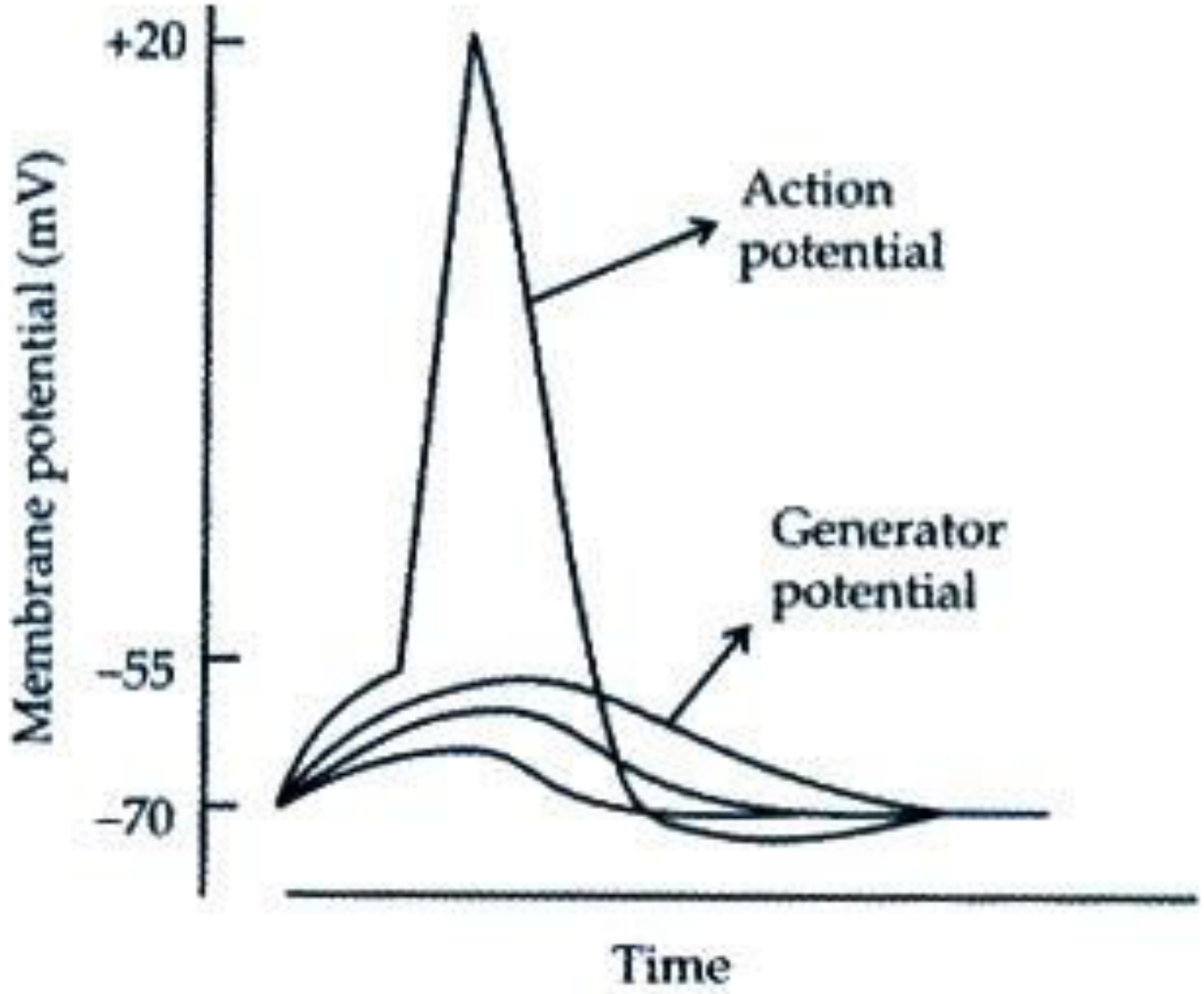


Figure 101.6 Receptor (generator) potential and action potential, formed in receptors.

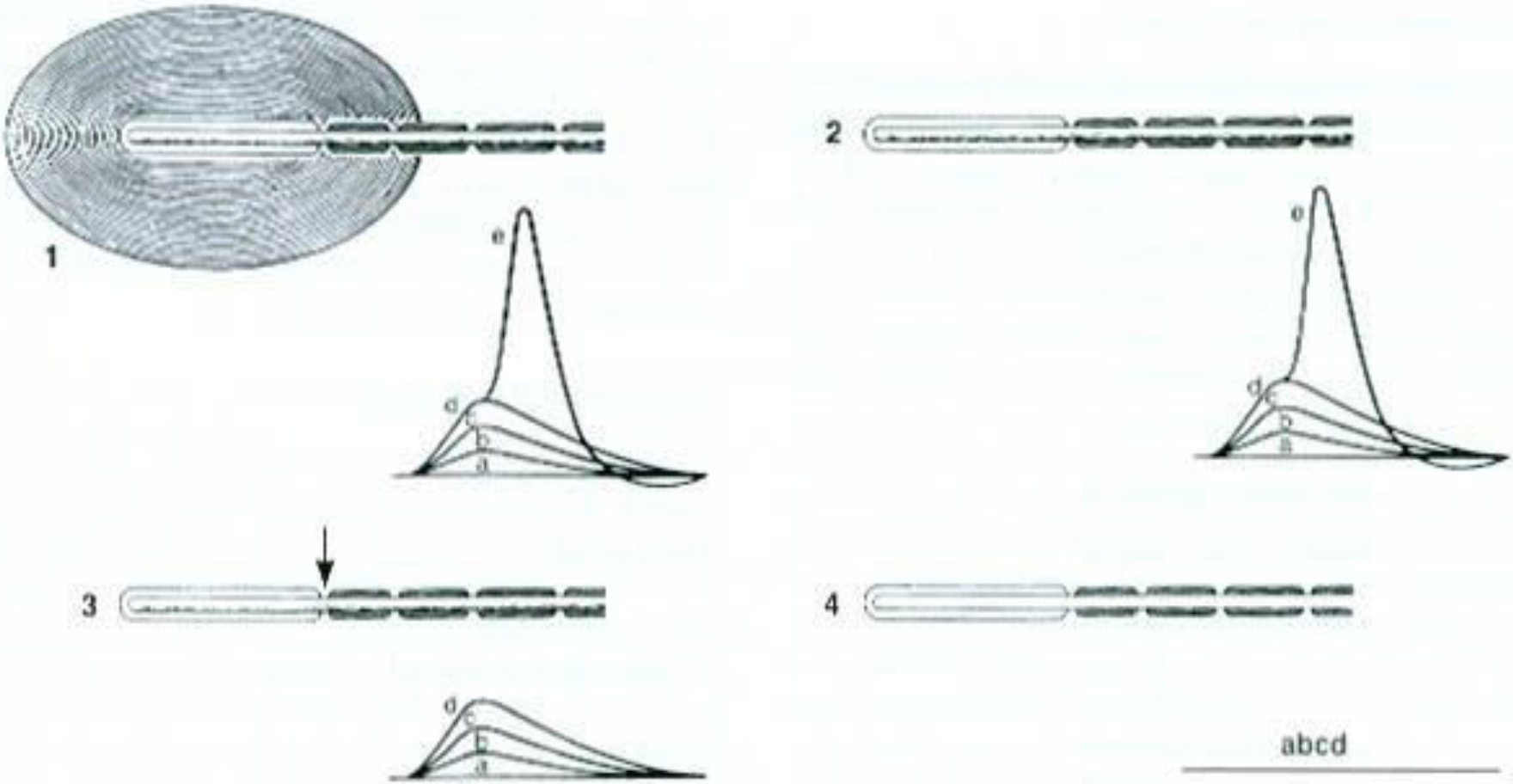


Figure 5–1. Demonstration that the generator potential in a pacinian corpuscle originates in the nonmyelinated nerve terminal. **1:** The electrical responses to a pressure of 1× (record a), 2× (b), 3× (c), and 4× (d) were recorded. The strongest stimulus produced an action potential in the sensory nerve (e). **2:** Similar responses persisted after removal of the connective tissue capsule, except that the responses were more prolonged because of partial loss of adaptation. **3:** The generator responses persisted but the action potential was absent when the first node of Ranvier was blocked by pressure or with narcotics (arrow). **4:** All responses disappeared when the sensory nerve was cut and allowed to degenerate before the experiment.

- **Adaptation**

When a stimulus of constant strength is applied continuously to a receptor, the frequency of Acton potentials in it's sensory nerve declines over a period of time.

- Fast Adapting or Phasic receptors

  Ex; Pacinian corpuscle

  Advantageous

- Slow Adapting or Tonic receptors

  Ex; Muscle spindle, Nociceptors

  Survival value

- **“Coding” of sensory information**

  - Stimulus Modality

  - Stimulus Localization

  - Stimulus Intensity

- **Labelled Line Principle or Muller's doctrine of specific nerve energies**

The specific sensory pathways from the receptor to the cerebral cortex are discrete and are called **labelled lines**.

"No matter how or where a particular sensory pathway is stimulated along its course to the cerebral cortex, the sensation evoked is that for which the receptor is specialized".

- Different sensory modalities are encoded by this mechanism

- **Law of Projection**

"No matter where a particular sensory pathway is stimulated along its course to cerebral cortex, the sensation produced is referred to the location of receptors".

Stimulus localization is encoded by this mechanism

Ex; Phantom Limb

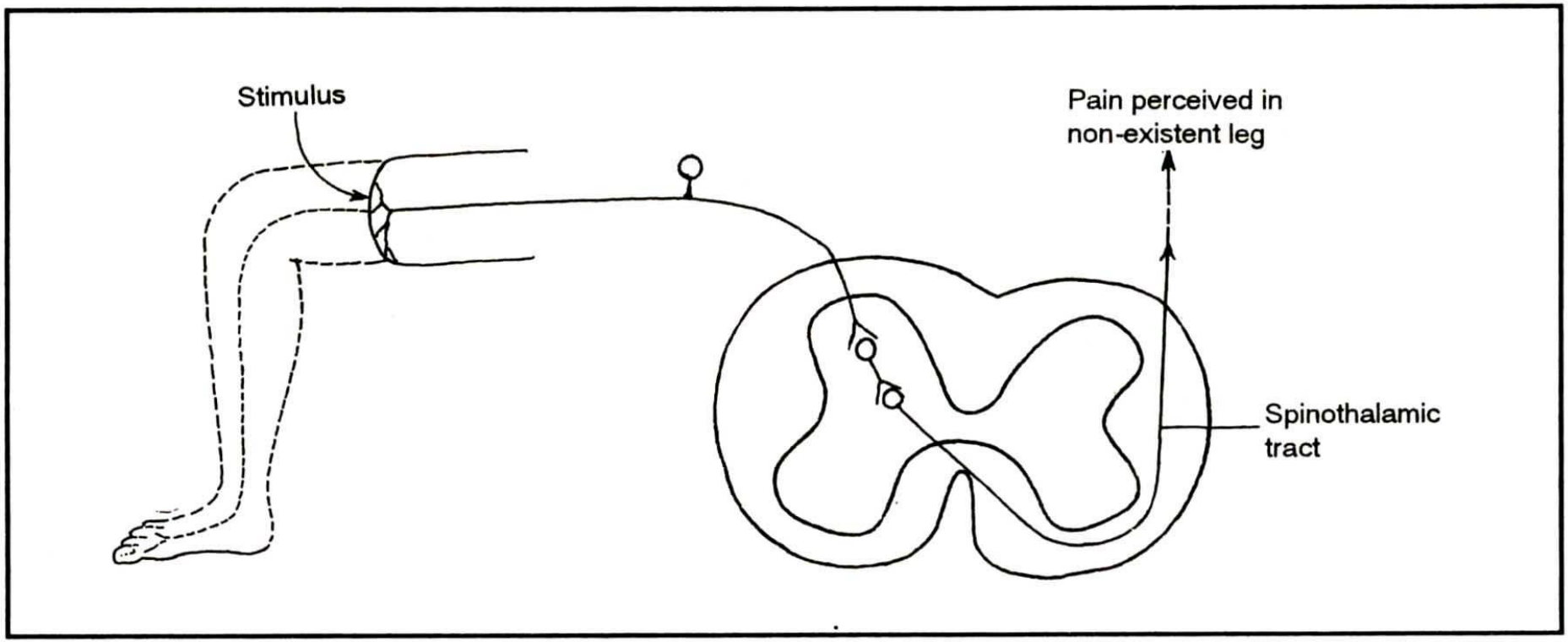


Fig. 12.7.9: *Explanation for the phenomenon of phantom pain. The stump may actually become hypersensitive because the cut nerve fibre may proliferate, forming a neuroma.*

- **Stimulus Intensity**

Intensity is discriminated by

- Frequency of Action Potentials
- Recruitment of Sensory Units

-Receptor associated with non neuronal cells that surround it – **Sense organ**

- A single sensory axon and all its peripheral branches – **Sensory Unit**
- The area from which a stimulus produces a response in the sensory unit – **Receptive field**

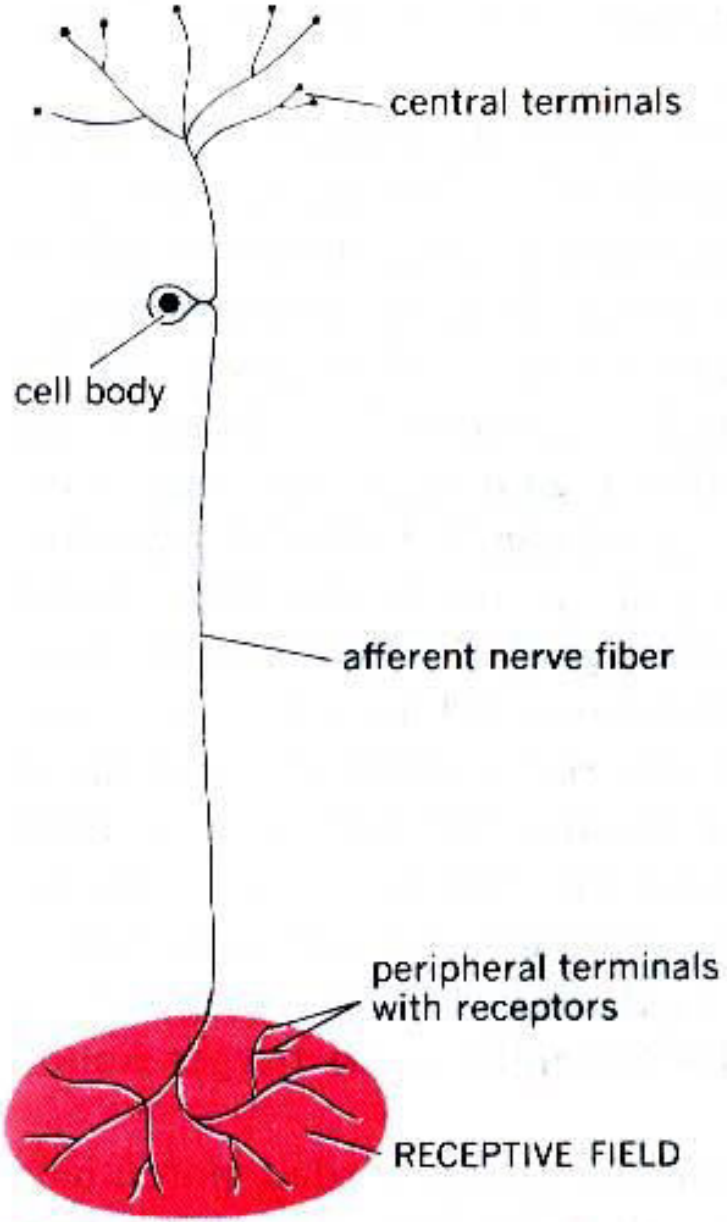


FIGURE 8-52. Sensory unit and receptive field.

- **Weber-Fechner Law**

"The magnitude of sensation felt is proportionate to the log of intensity of stimulus".

$$R = KS^A$$

R - sensation felt

S - Intensity of stimulus

K & A – Constants

Intensity of stimulus - Magnitude of sensation

10 - 1

100 - 2

1000 - 3

- safety mechanism

Electronic Nose and Its Applications: A Survey

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Abstract:

In the last two decades, improvements in materials, sensors and machine learning technologies have led to a rapid extension of electronic nose (EN) related research topics with diverse applications.

The food and beverage industry, agriculture and forestry, medicine and health-care, indoor and outdoor monitoring, military and civilian security systems are the leading fields which take great advantage from the rapidity, stability, portability and compactness of ENs.

Although the EN technology provides numerous benefits, further enhancements in both hardware and software components are necessary for utilizing ENs in practice. This paper provides an extensive survey of the EN technology and its wide range of application fields, through a comprehensive analysis of algorithms proposed in the literature, while exploiting related domains with possible future suggestions for this research topic. Keywords: Artificial intelligence, machine learning, pattern recognition, electronic nose (EN), sensors technology.

Analogy between the biological olfactory system and the Electronic nose

Odorant Particles

Nose	_	Sensor array
Brain	_	Data analysis


Thank
You!