

PHYSIOLOGY OF SENSORY SYSTEMS. SKIN ANALYSER.



SENSORY SYSTEM (I.P. PAVLOV)

- is a functional system of neurons which enables perception of external or internal environment changes,
- Conduction of impulse to CNS,
- its analyses,
- formation of sensation

3 DEPARTMENTS OF ANALYSER

- Peripheral (receptors)
- Conducting pathways
- Central (sensory cortex)

FUNCTIONS OF PERIPHERAL DEPARTMENT

- Encoding of information
- Primary analyses

CODING OF INFORMATION

- Perception of sensations or transformation of different stimuli (mechanical, chemical) into nervous impulses (AP)

PRIMARY ANALYSES

- ADEQUATE OR NOT?
- FORCE
- NEWNESS

FUNCTIONS OF CONDUCTING DEPARTMENT

- Conduct impulse to the cortex
- Performs secondary analysis to form reflex reactions (withdrawal, orientational reflex) & define important information (lateral inhibition in thalamus)

FUNCTIONS OF PERIPHERAL & CONDUCTING DEPARTMENTS

- Defence reflexes (blinking, lacrimation, withdrawal)
- Orientational behaviour
- Homeostasis
- Maintaining state of wakefulness for the brain (activation of RF)

FUNCTIONS OF CORTEX DEPARTMENT

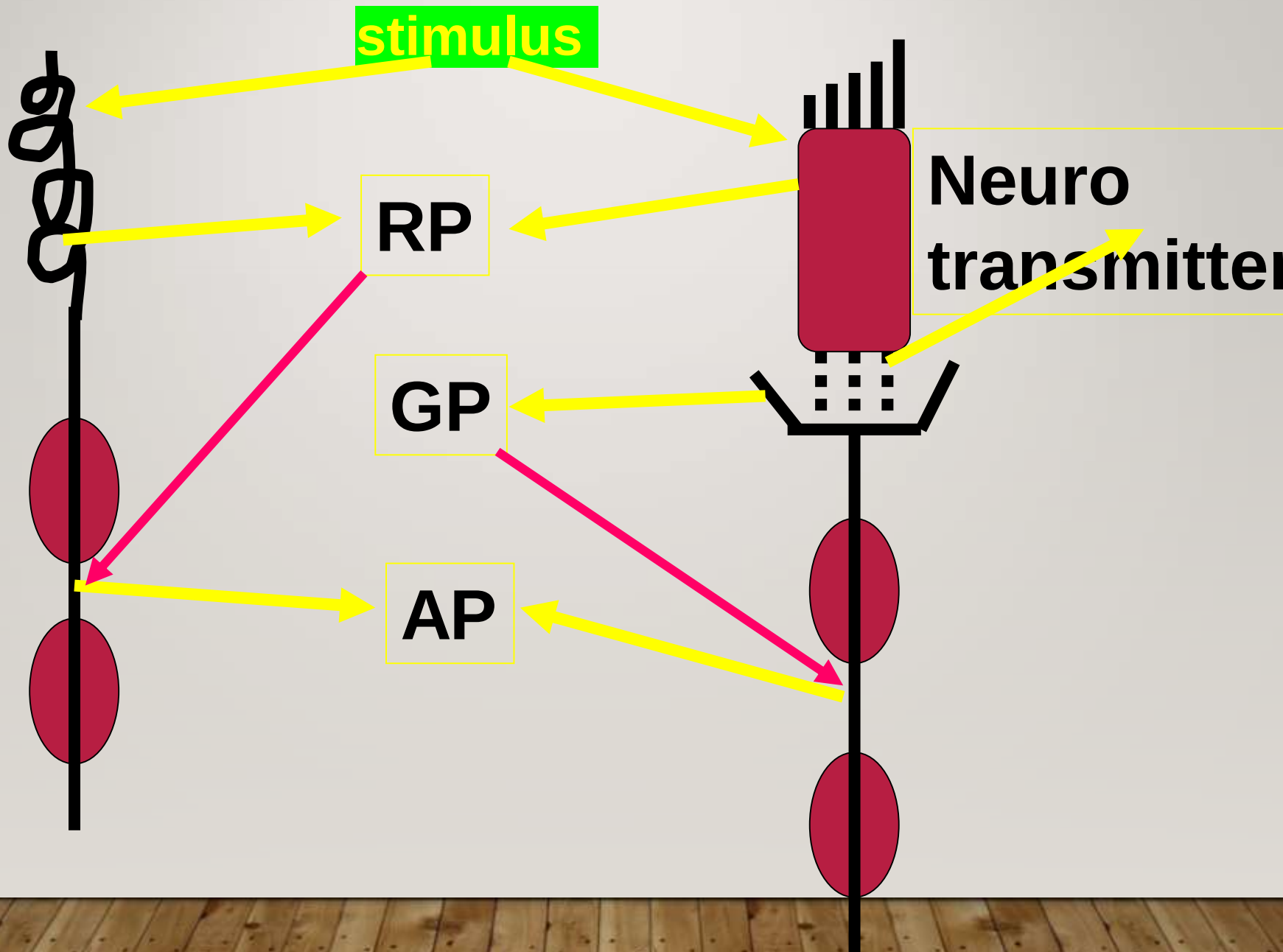
- Higher analyses – transformation of nervous impulse energy into perceptions
- Recognizing
- Decision making
- Adequate behaviour (+ associative cortex)

GENERAL PRINCIPLES OF THE STRUCTURE OF SENSORY SYSTEMS

- **Layering**
- **Multichannel**
- **Sensory funnels**
- **Differentiation vertically and horizontally**

CLASSIFICATIONS OF RECEPTORS

- By the mechanism of excitation (primary & secondary sensitive)
- By the location in the body (external, internal, proprio-)
- By the nature of the stimulus (mechanical, chemical, baro-, thermo-)
- By the nature of caused sensations (visual, olfactory, gustatory, auditory)



CLASSIFICATIONS OF RECEPTORS

- By the distance from the stimulus (distant, contact)
- By the velocity of adaptation (slow adaptive, quickly adaptive, non-adaptive)

CODING OF INFORMATION IN THE RECEPTORS

- Binar code
- Coded parameters:

FORCE OF THE STIMULUS (frequency & spacial coding)

DURATION OF THE STIMULUS

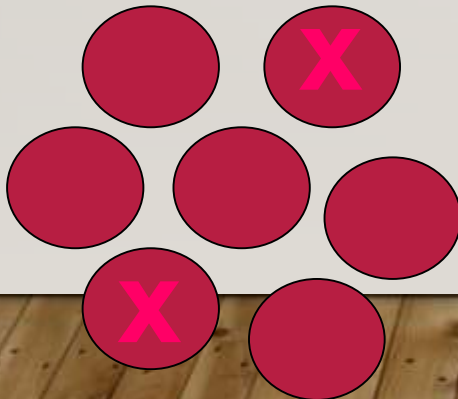
SIGNAL DISCRIMINATION

THRESHOLDS OF RECEPTORS SENSITIVITY

- ABSOLUTE
- The minimum force of irritation that can cause sensations
↓Absolute threshold - ↑sensitivity
- DIFFERENTIATIONAL
(differentiation threshold of force, spacial & temporal
differentiation thresholds)

SPATIAL THRESHOLD

- The minimum distance between two points at which two stimuli are felt
- In this case, between the two excited receptors there must be one unexcited



DIFFERENTIATIONAL THRESHOLD OF FORCE

- Weber-Fexner law – the increase of stimulus to be perceptible must exceed the acting stimulus by a definite proportion.
- $\Delta I/I = K$

ENCODING OF INFORMATION

Basic principles:

Spatial

Temporal

code - binary

SIGNAL DETECTION

- **Selective pick up by a sensory neuron of one or another sign of a stimulus that has behavioral significance**
- **on-neurons**
- **of-neurons**
- **on-of-neuron**

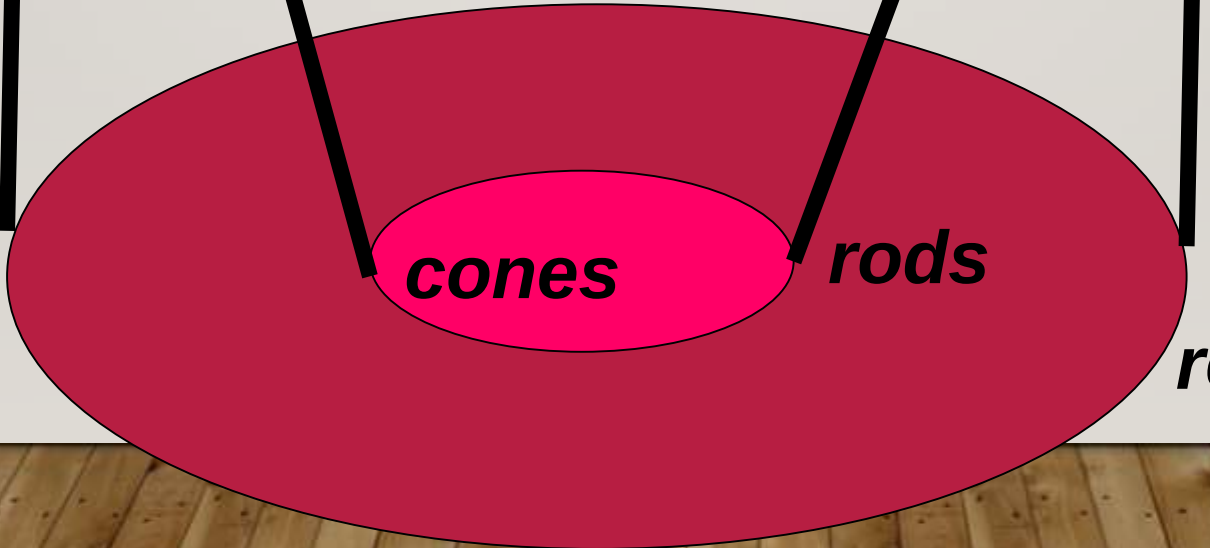
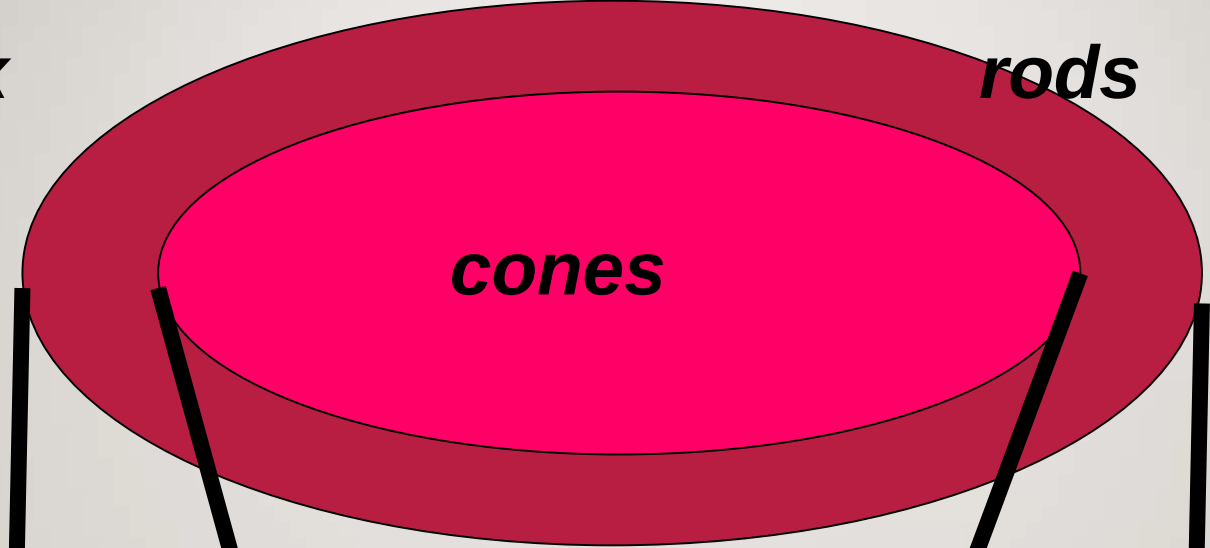
RECEPTIVE FIELD

- a set of receptors, signals from which go to one neuron
- Representation in the cortex is somatotopic - corresponds to the number of receptive fields, not receptors

cortex

rods

cones



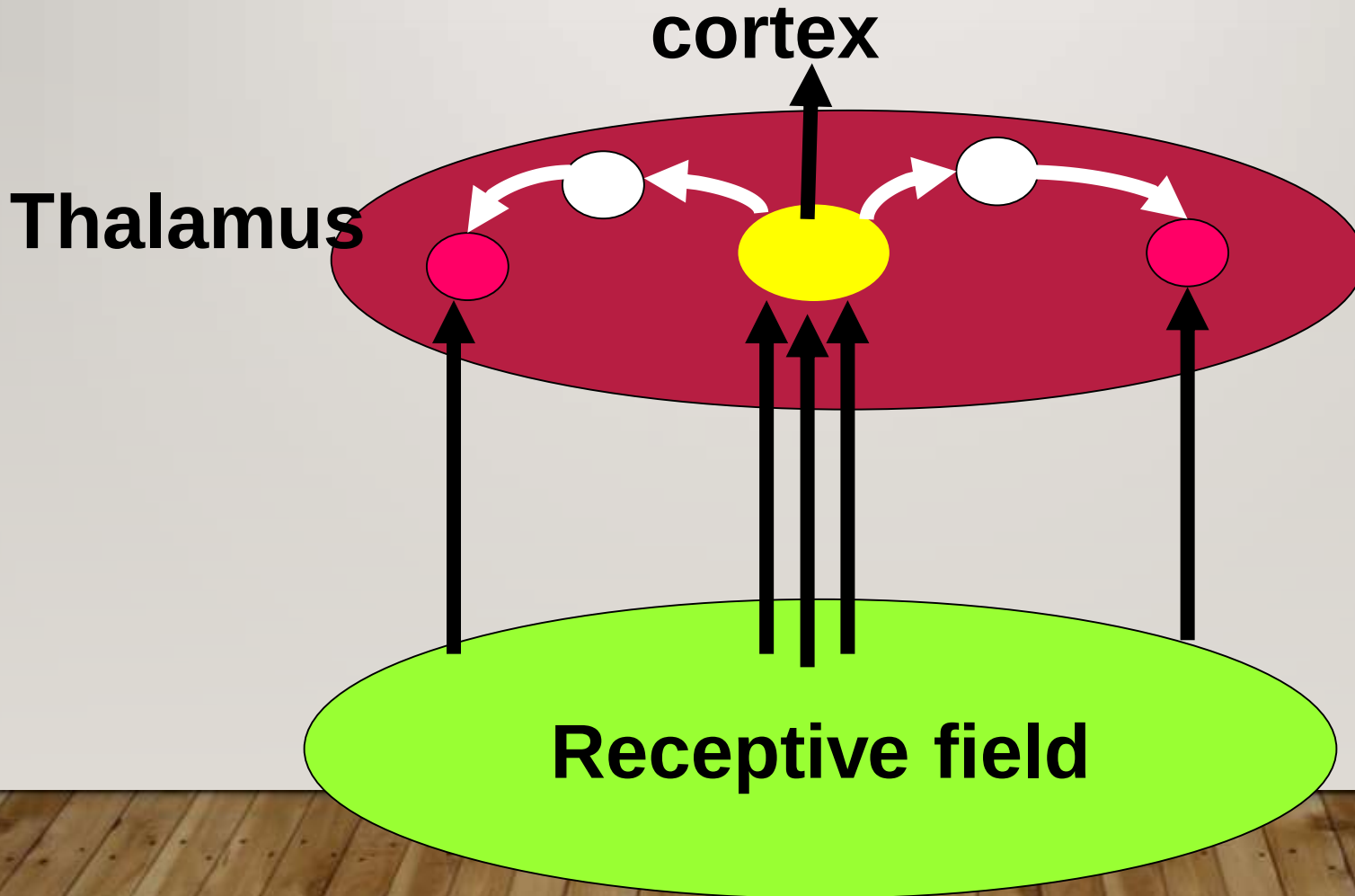
retina



SELECTION STRONGER INFORMATION

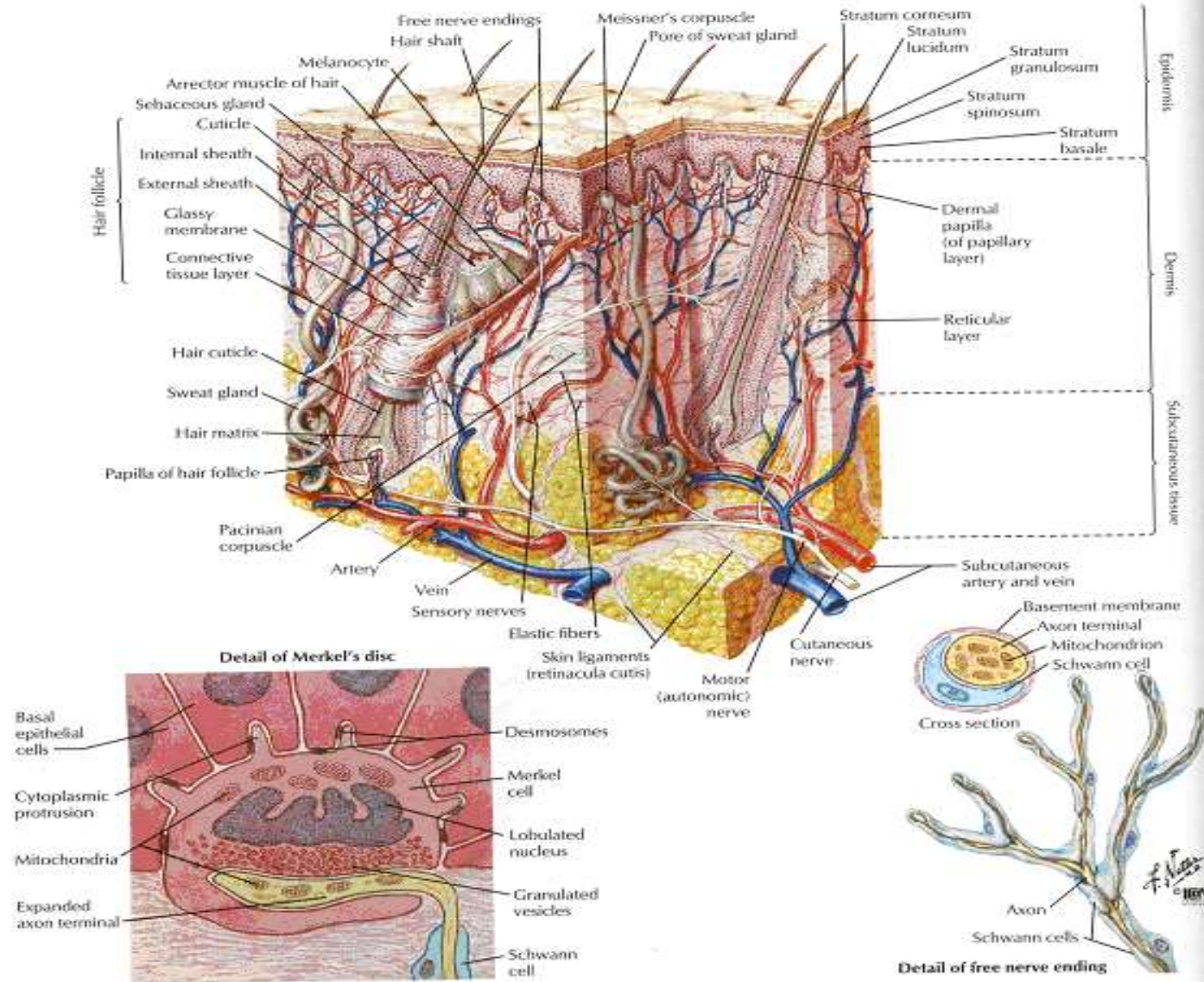
- By means of recurrent and lateral inhibition at the level of thalamic nuclei with the use of Golgi cells
- Aberration (dispersion) is removed

SELECTION STRONGER INFORMATION

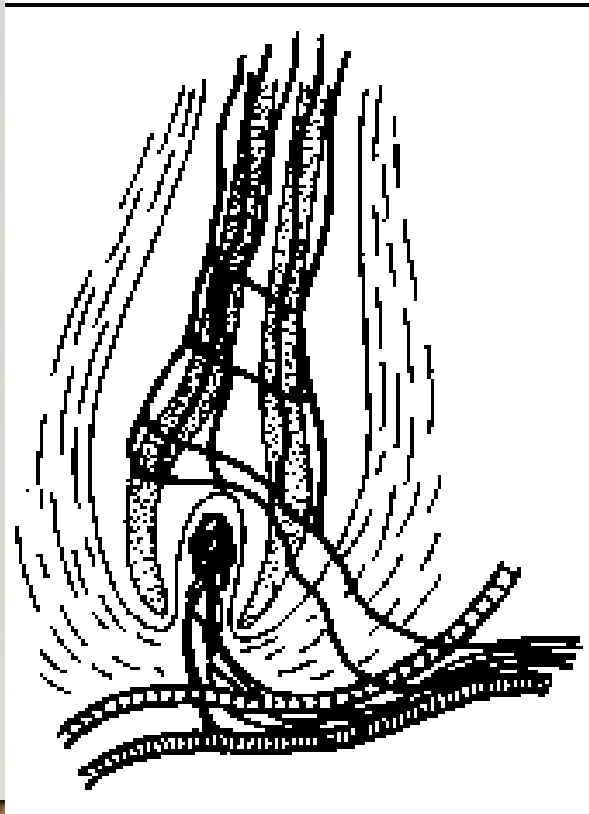


SOMATO-SENSORY SYSTEM

SKIN

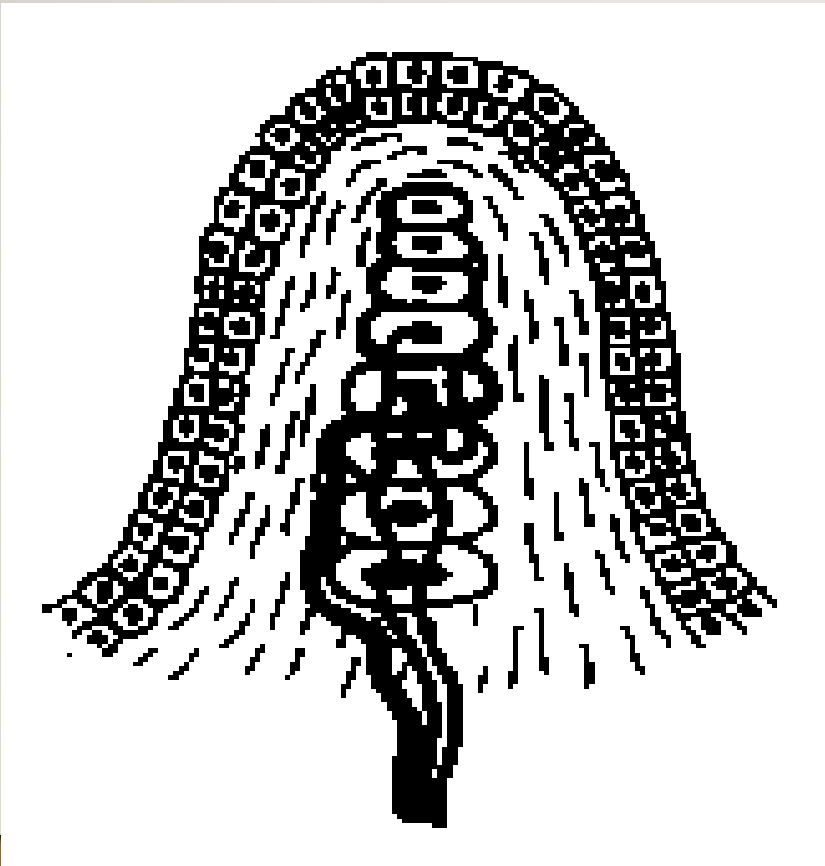


TOUCH RECEPTORS - HAIR FOLLICLE ENDING



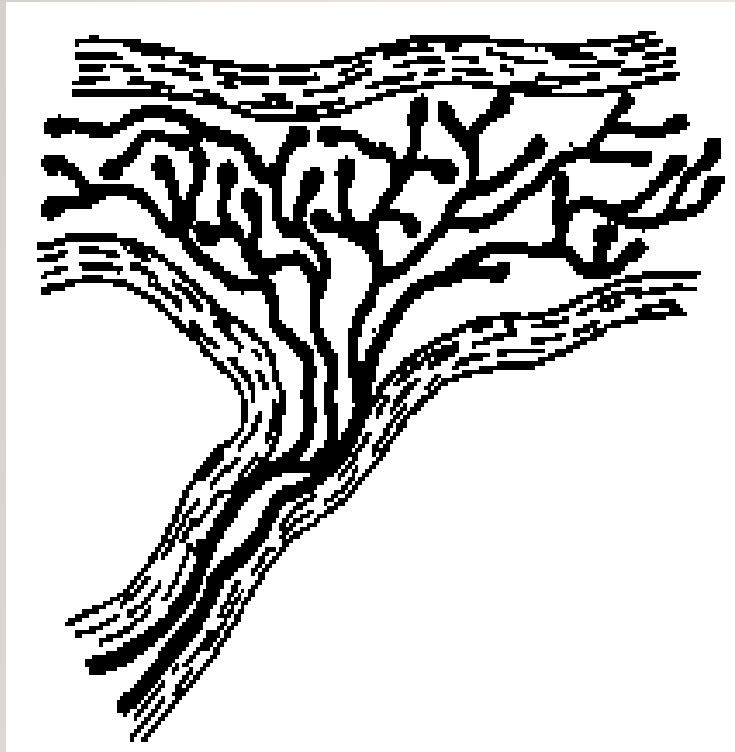
Responds to hair displacement. Wraps around hair follicle in hairy skin.

TOUCH RECEPTORS - MEISSNER CORPUSCLE



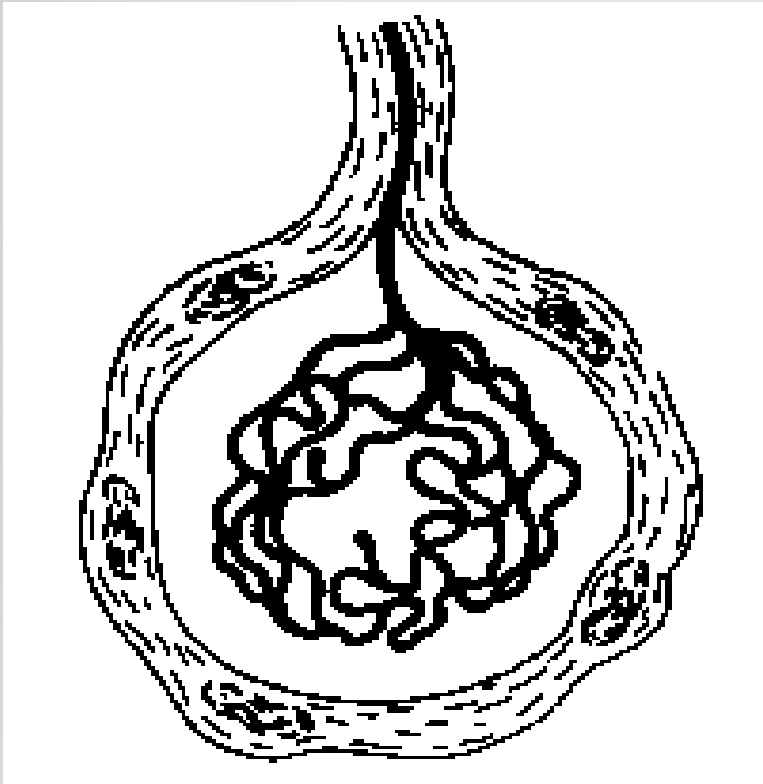
Responds to vibration.
Most sensitive in 20-40
Hz range
Dermis of
glabrous skin.

RECEPTORS OF PRESSURE -RUFFINI ENDINGS



Dermis of both
hairy and glabrous
skin

RECEPTORS OF PRESSURE -KRAUSE CORPUSCLE



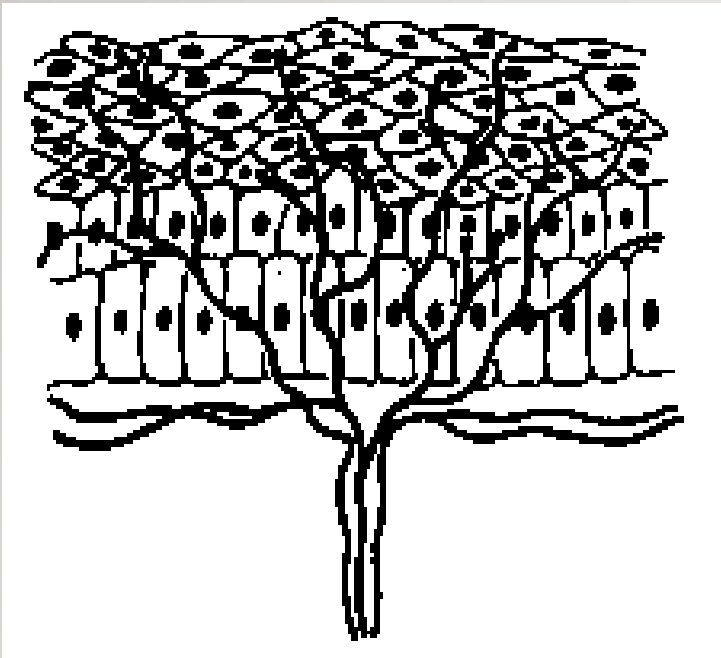
Lips, tongue, and
genitals.

VIBRATION RECEPTORS -PACINIAN CORPUSCLE



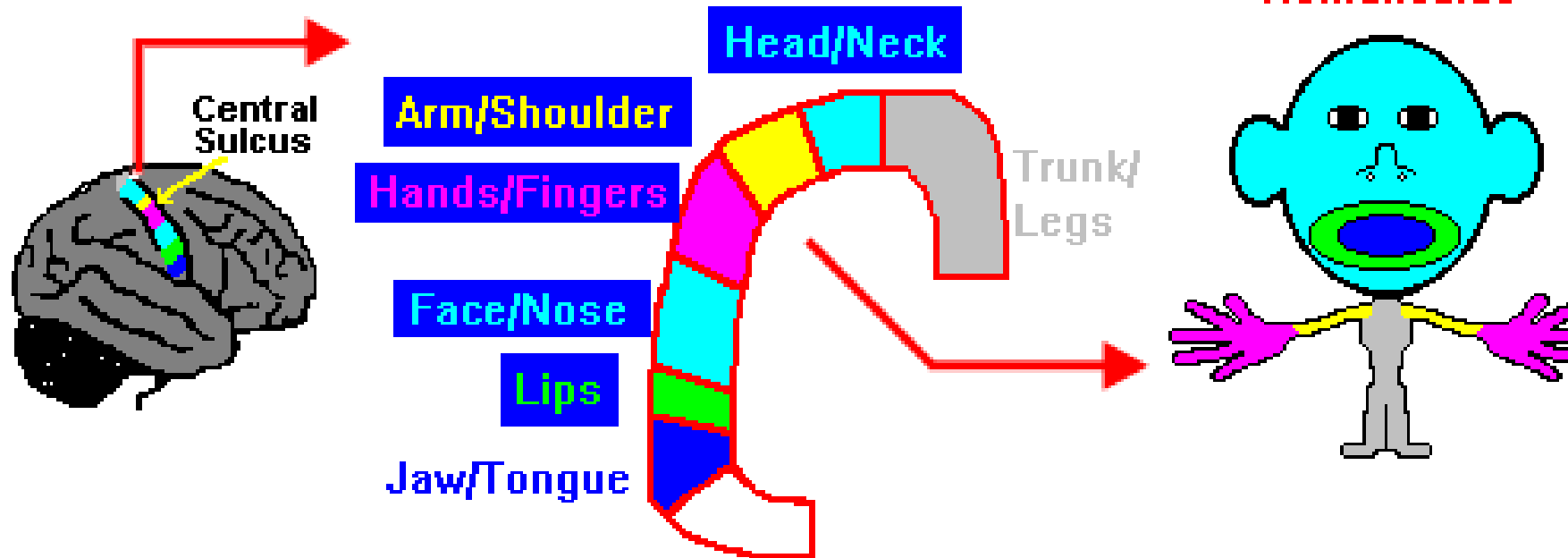
Responds to vibration.
Most sensitive in 150-300
Hz range Deep layers of
dermis in both hairy and
glabrous skin. Deep layers
of dermis in both hairy
and glabrous skin.

FREE NERVE ENDINGS



Different types of free nerve endings that respond to mechanical, thermal or noxious stimulation.

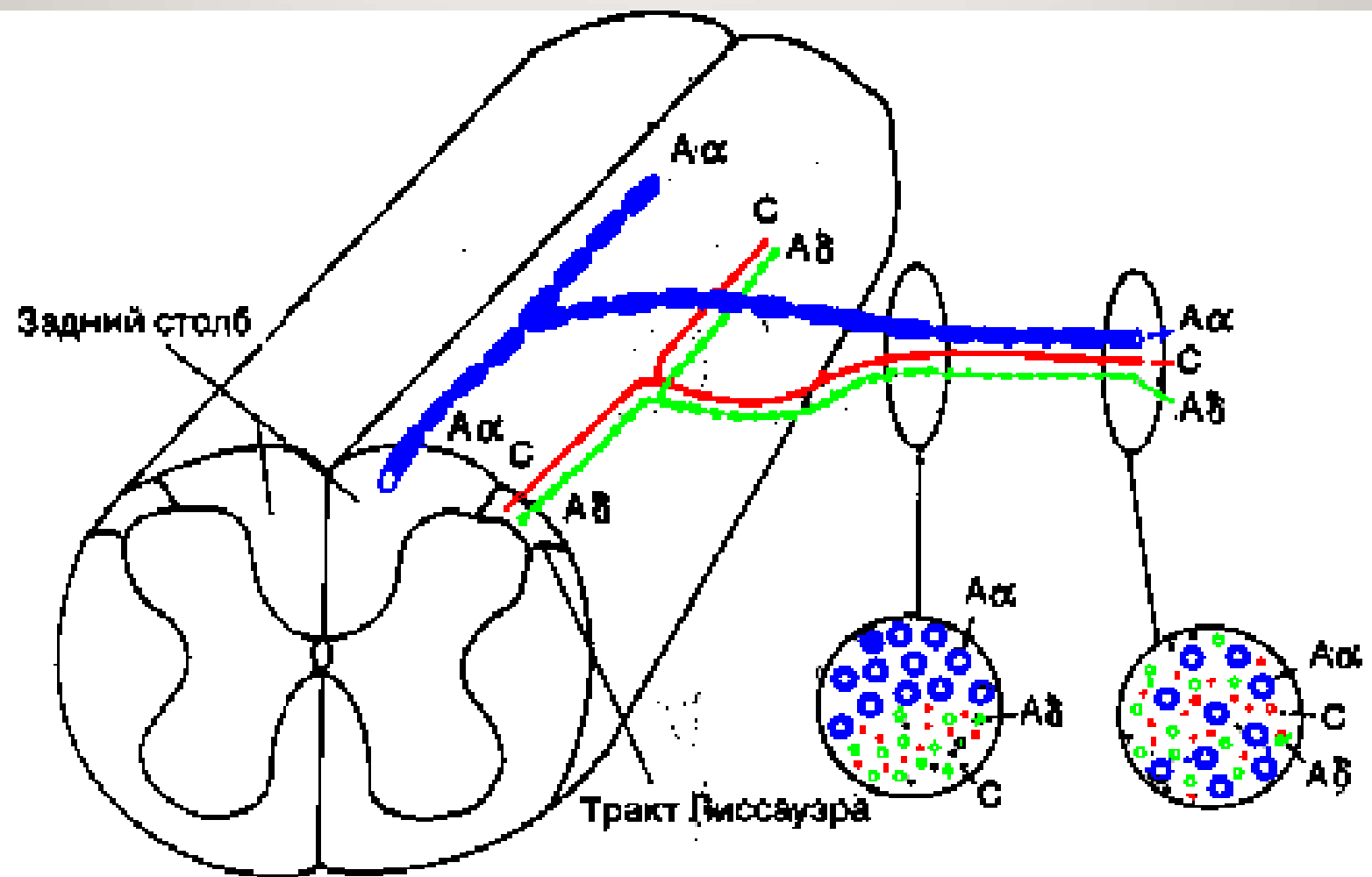
Homunculus



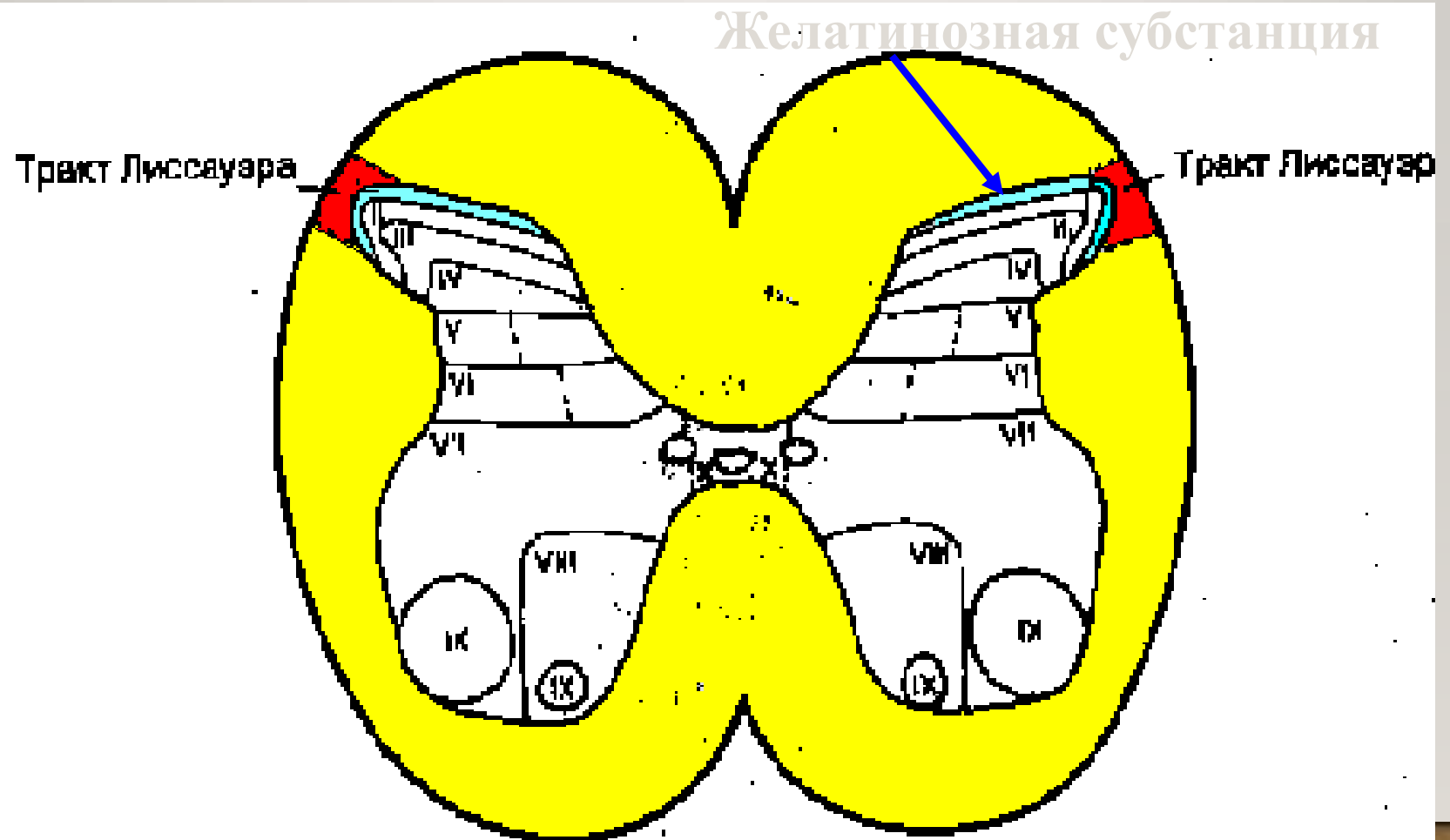
NOCICEPTIVE SYSTEM

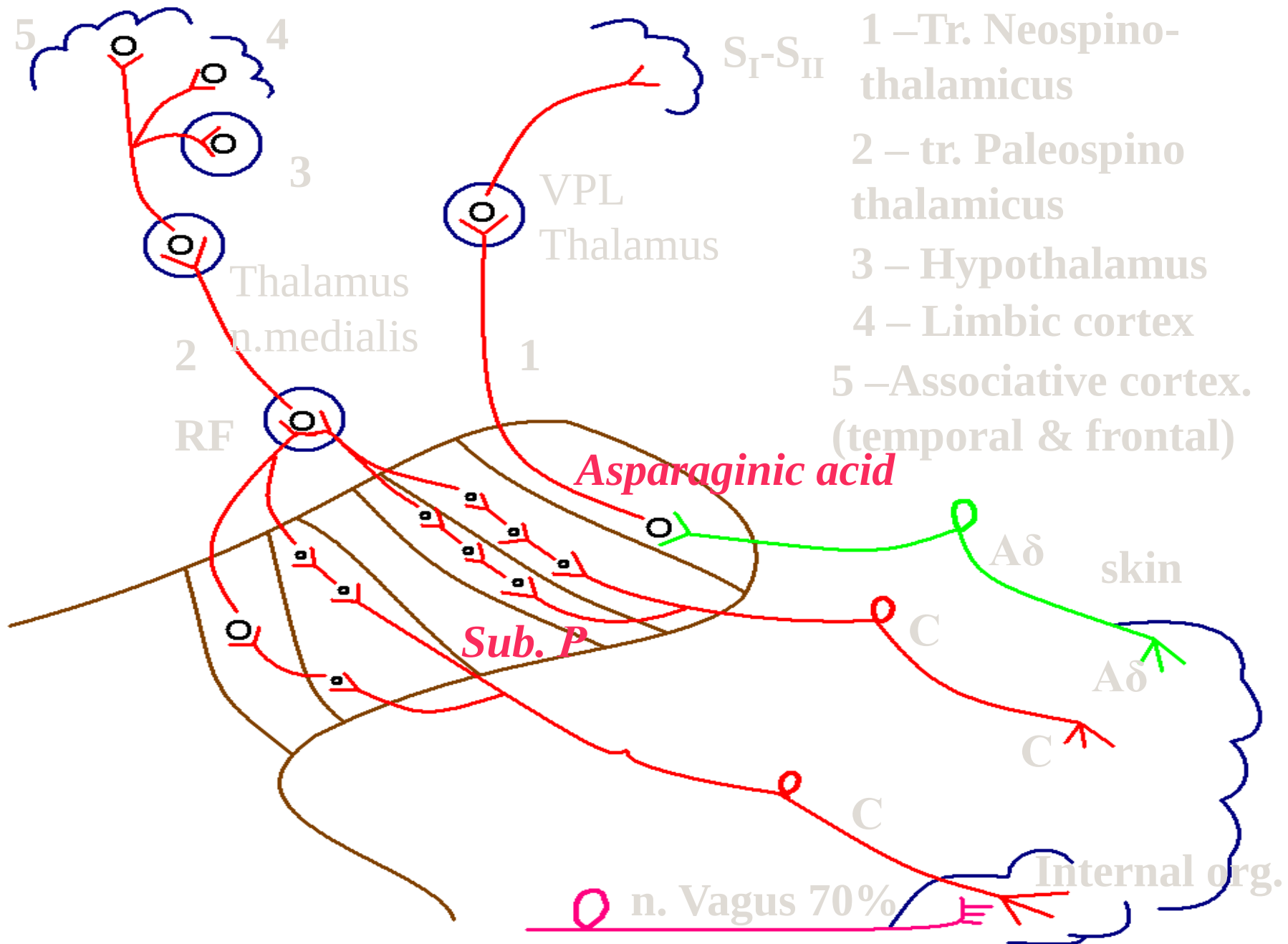


RECEPTIVE FIELDS



SPINAL CORD





CONDUCTING PATHWAYS

- **Tr. Neospino-thalamicus** – in the anterior funiculus, has somatotypical organization. *Enables primary pain conduction.*

- **Tr. paleospinothalamicus** – non-specific system (RF) – has many synapses on one level in the spinal cord, makes diffuse connections in cortex. *Enables emotional component of pain – secondary pain*

**First danger (bacterial infection,
inflammation, mechanical influence)**

Algogenic substances formation

Nociceptors

**Transduction &
transformation**

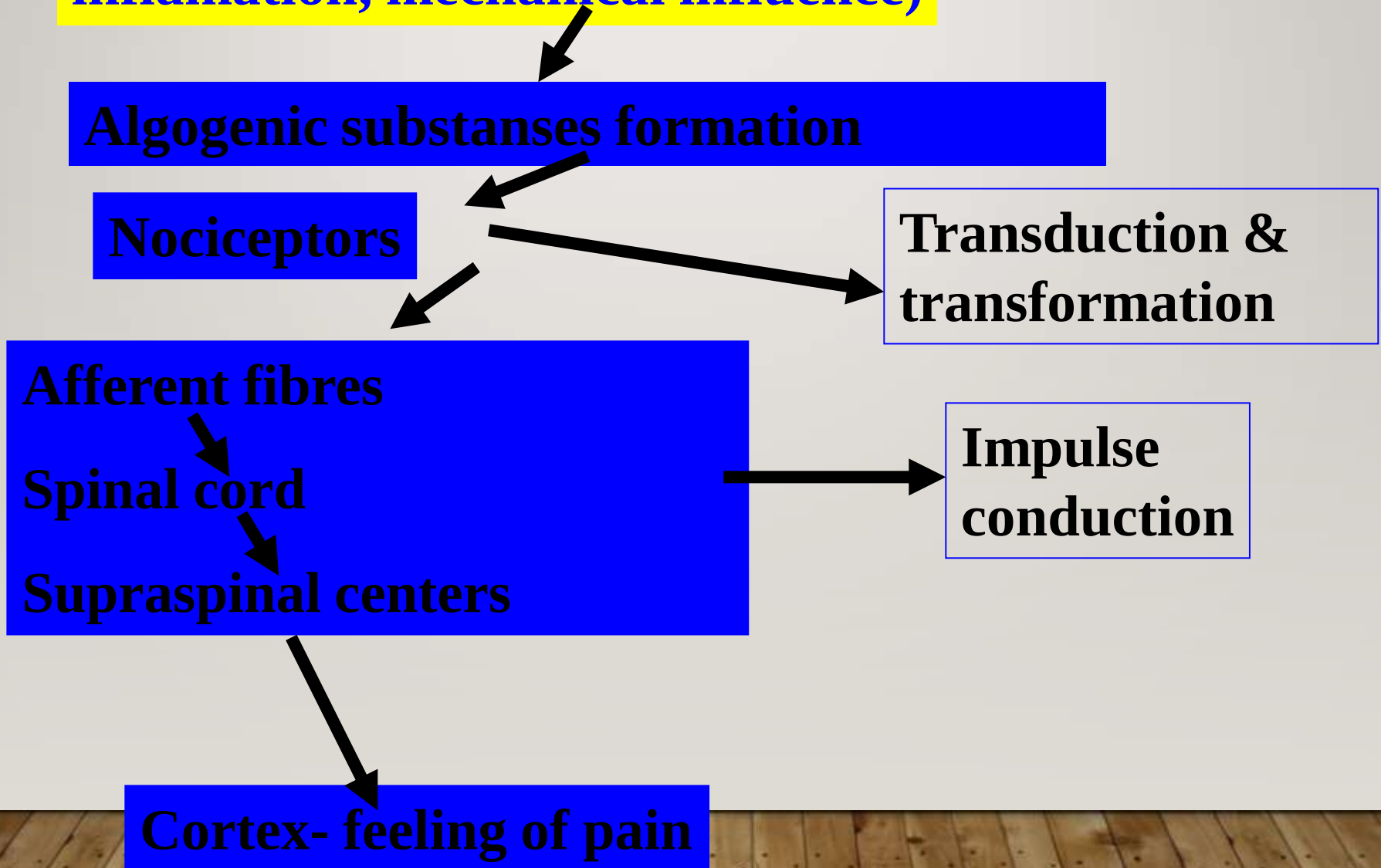
Afferent fibres

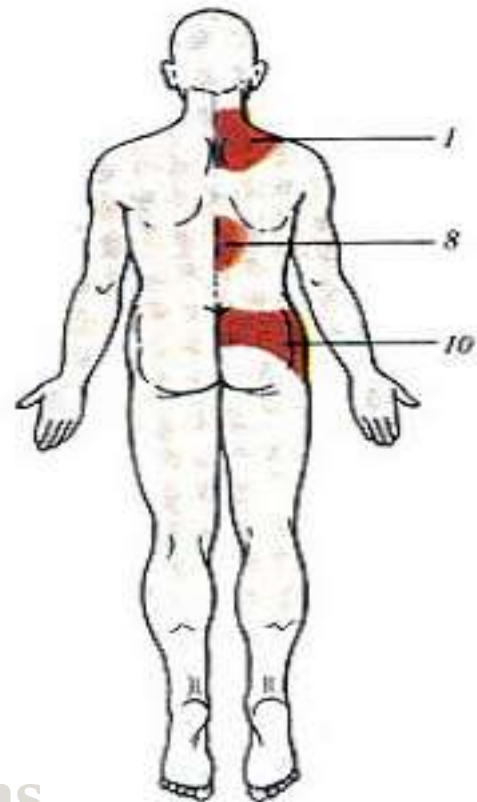
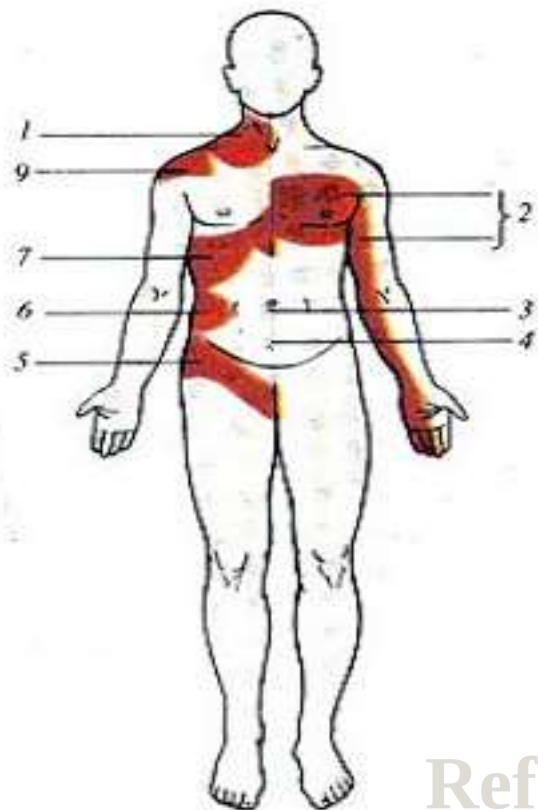
Spinal cord

Supraspinal centers

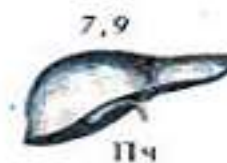
**Impulse
conduction**

Cortex- feeling of pain





Referred pains



ANTINOCICEPTIVE SYSTEM

Gigantic-cell nucleus RF

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graph TD; A[Gigantic-cell nucleus RF] --> B[Spinal cord neurons secreting endorphins]; C[serotonin] --> B; B --> D[Inhibition of afferent nociceptive neurons & neurons of posterior horn II & V plates];
```

serotonin

**Spinal cord neurons
secreting endorphins**

**Inhibition of afferent nociceptive
neurons & neurons of posterior
horn II & V plates**

ANTINOCICEPTIVE SYSTEM

Central grey matter

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graph TD; CGM[Central grey matter] --> RN[Ruph nuclei]; NAR[Noradrenalin, alpha-2 adrenoreceptors] --> RN; RN --> SCN[Spinal cord neurons releasing endoopiates]; S[serotonin] --> SCN;
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The diagram illustrates the antinociceptive system. It begins with the Central grey matter, which has a red horizontal line below it. An arrow points from the Central grey matter to the Ruph nuclei. Another arrow points from a box labeled 'Noradrenalin, alpha-2 adrenoreceptors' to the Ruph nuclei. From the Ruph nuclei, an arrow points down to a yellow box labeled 'Spinal cord neurons releasing endoopiates'. A separate arrow labeled 'serotonin' also points to this yellow box.

*Noradrenalin, alpha-2
adrenoreceptors*

Ruph nuclei

serotonin

Spinal cord neurons
releasing endoopiates