B. THE AUTONOMIC NERVOUS SYSTEM (ANS)

The innervation of all tissues other than skeletal muscle is by way of the ANS.

It is also called *vegetative or involuntary nervous system*. It is organised into two distinct regions along the CNS forming the *sympathetic* and *parasympathetic* systems. The

sympathetic division consists of the thoracic and lumbar ganglia, therefore, also called *thoraco-lumbar division;* and ***parasympathetic division*** consists of the cranial ganglia (III, VII, IX and X cranial nerves) and sacral ganglia (2nd, 3rd and 4th sacral segments of the spinal nerves), therefore, also called *craniosacral division*

Organs Receiving Sympathetic Nerves

The sympathetic nervous system supplies nerves to the following organs:

1. Eye: Vessels of eye ball, retina, ciliary body, eye muscles.

2. Skin: Sweat glands, plain muscles of hair, those around the orifices of the body (anal sphincters and vagina), retractor penis, blood vessels, etc.

3. **Glands:** Buccal, parotic, sublingual, submaxillary, lacrymal, thyroid and adrenal medulla.
4. **Blood Vessels:** Internal carotid, vertebral arteries, coronary vessels.
5. **Heart**
6. **Limbs**
7. **Stomach** and **Intestine**
8. **Urinary bladder**
9. **Spleen** and **Gall bladder**
10. **Ureters**
11. **Kidney**
12. **Uterus, Fallopian tubes** and **Vas deferens**
13. **Liver**

Secretion

The sympathetic nervous system brings about its action on the organs by secreting a chemical substance at the nerve endings. This chemical is called ***norepinephrine*** or ***epinephrine***. The nerve fibres which produce norepinephrine are called ***adrenergic.*** The norepinephrine corresponds to ***sympathin.***

Effect of Sympathetic Nervous System

The sympathetic nervous system brings about the following actions:

1. The action of sympathetic nervous system is antagonistic to parasympathetic nervous system.
2. The pupils are dilated.
3. The bronchi are dilated.
4. The heart beat is increased.
5. The secretions of saliva and digestive juices are decreased.
6. It reduces peristalsis.
7. It contracts hair muscles causing the hairs to stand up.
8. It stimulates sweat glands to secrete.
9. It causes expenditure of energy.
10. In general, sympathetic system has stimulatory and acceleratory influence on target organs.
11. The sympathetic system is strongly activated in many emotional states. In the state of rage (furious anger), the following reactions occur:
    - *a. Increased arterial pressure.*
    - *b. Increased blood flow to active muscles.*
    - *c. Increased metabolism.*
    - *d. Increased blood glucose concentration.*
    - *e. Increased glycolysis in muscles.*
    - *f. Increased muscle strength.*
    - *g. Increased mental activity.*
    - *h. Increased rate of coagulation.*

    All these reactions together constitute sympathetic ***alarm reaction*** or ***fight*** or ***flight reaction*** or ***sympathetic stress reaction.***

Organs Receiving Parasympathetic Nerves

The parasympathetic fibres supply the following organs:

Eye muscles	*Lacrymal glands*	*Nose*
Salivary glands	*Heart*	*Larynx*
Trachea	*Bronchi*	*Lungs*
Alimentary canal	*Liver*	*Pancreas*
Adrenal gland	*Kidney*	*Bladder*
Gonads	*Colon*	

Secretion

The parasympathetic fibres bring out their actions on the organs by secreting chemical substance at the nerve endings. This chemical is ***acetylcholine.*** The nerve fibres secreting acetylcholine are called ***cholinergic.*** Thus all the parasympathetic fibres are cholinergic.

The parasympathetic fibres cause ***excitation*** in some organs but inhibition in others.

Effects of Parasympathetic System

The parasympathetic system brings about the following actions:

1. It works antagonistically to sympathetic system.
2. The pupil is caused to ***constrict.***
3. The ciliary muscles are caused to ***contract.***
4. It stimulates the nasal, lacrymal, parotid, submaxillary, gastric and pancreatic glands to secrete the enzymes and secretions.
5. The rate of heart beat is decreased.
6. The bronchi are constricted.
7. Gall bladder and bile ducts are contracted.
8. The penis is erected.
9. It conserves energy.
10. In general, parasympathetic system has inhibitory and retarding action on target organs.

TABLE 164.1: Actions of sympathetic and parasympathetic divisions of autonomic nervous system

Effector organ		Sympathetic division	Parasympathetic division
1. Eye	Ciliary muscle	Relaxation	Contraction
	Pupil	Dilatation	Constriction
2. Lacrimal glands		Decrease in secretion	Increase in secretion
3. Salivary glands		Decrease in secretion and vasoconstriction	Increase in secretion and vasodilatation
4. Gastrointestinal tract	Motility	Inhibition	Acceleration
	Secretion	Decrease	Increase
	Sphincters	Constriction	Relaxation
	Smooth muscles	Relaxation	Contraction
5. Gallbladder		Relaxation	Contraction
6. Urinary bladder	Detrusor muscle	Relaxation	Contraction
	Internal sphincter	Constriction	Relaxation
7. Sweat glands		Increase in secretion	–
8. Heart – rate and force		Increase	Decrease
9. Blood vessels		Constriction of all blood vessels, except those in heart and skeletal muscle	Dilatation
10. Bronchioles		Dilatation	Constriction

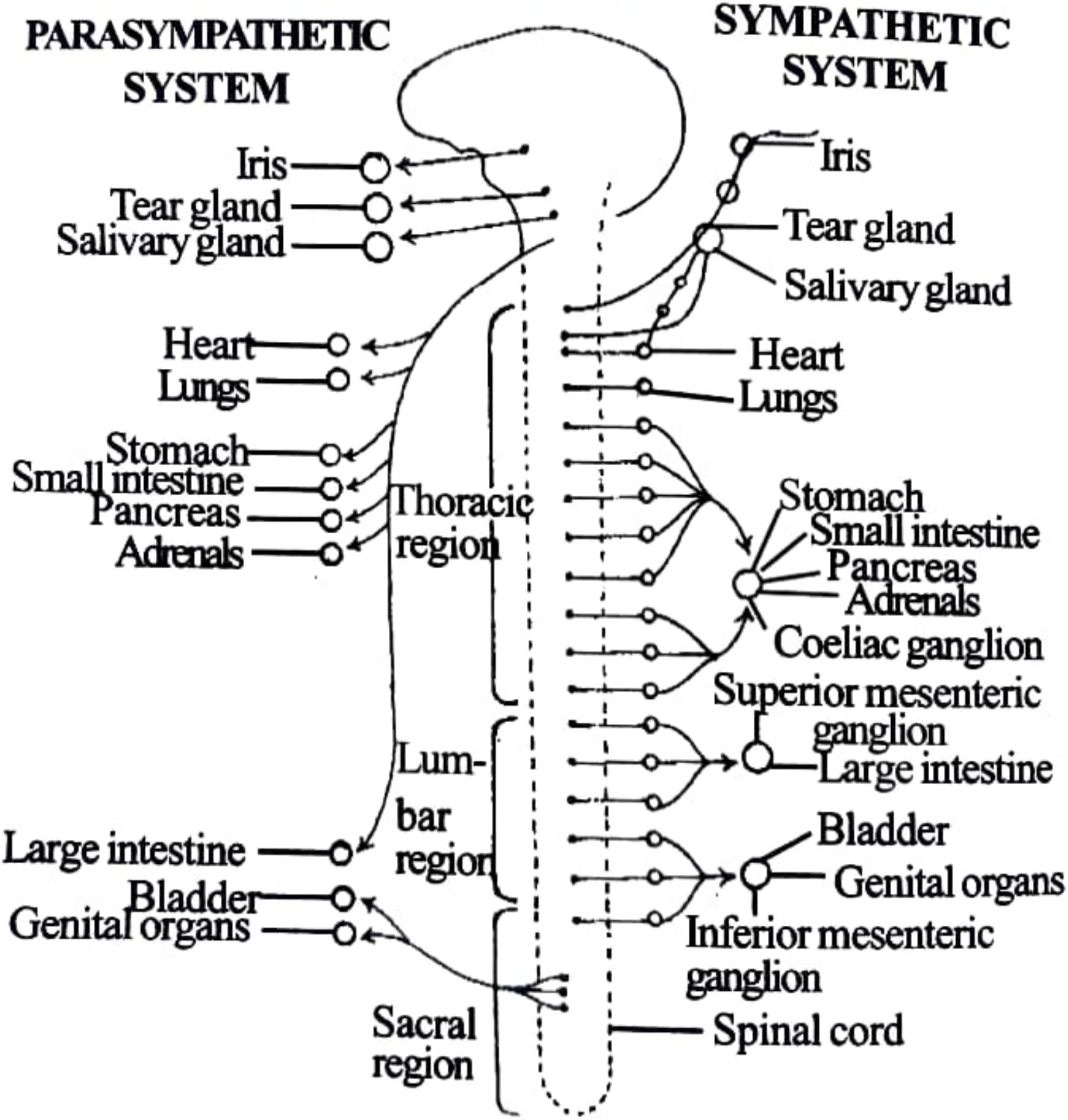

Fig. 7.97: Sympathetic and para sympathetic nervous system.

Receptors

■ DEFINITION

Receptors are sensory (afferent) nerve endings that terminate in periphery as bare **unmyelinated endings** or in the form of specialized **capsulated structures**. Receptors give response to the stimulus. When stimulated, receptors produce a series of impulses, which are transmitted through the afferent nerves.

Biological Transducers

Actually receptors function like a transducer. Transducer is a device, which converts one form of energy into another. So, receptors are often defined as the biological transducers, which convert (transducer) various forms of **energy** (stimuli) in the environment into **action potentials** in nerve fiber.

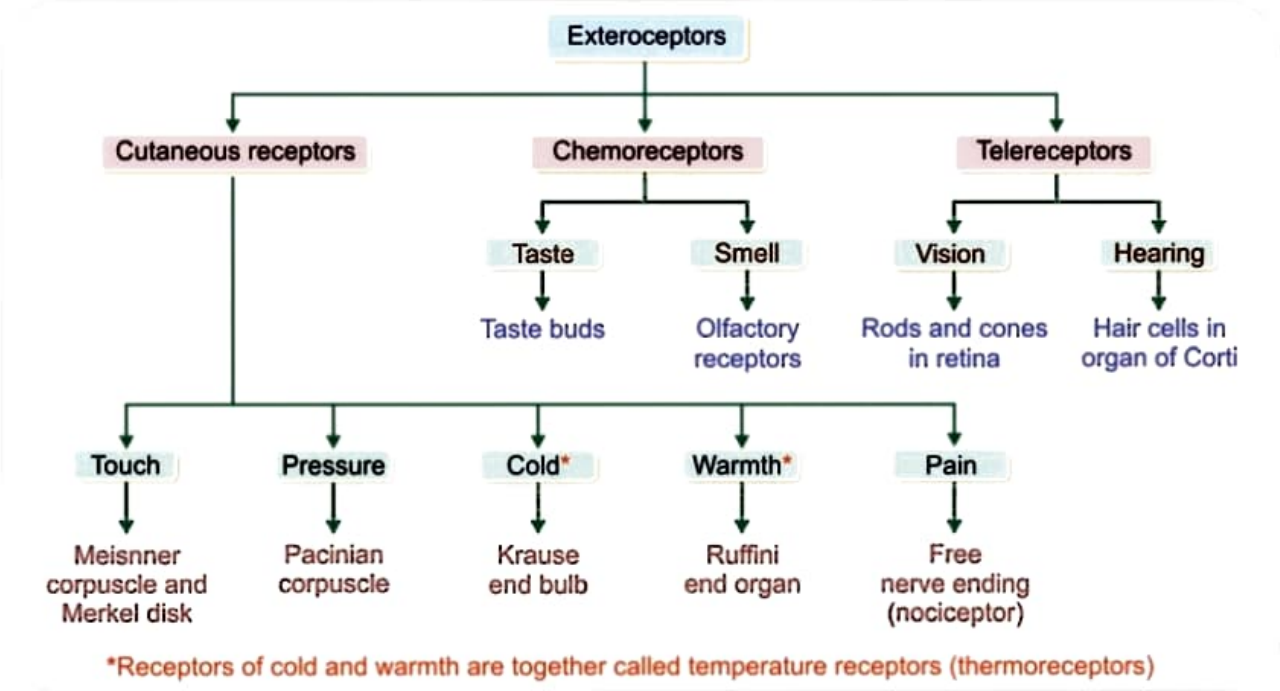

FIGURE 139.2: Exteroceptors

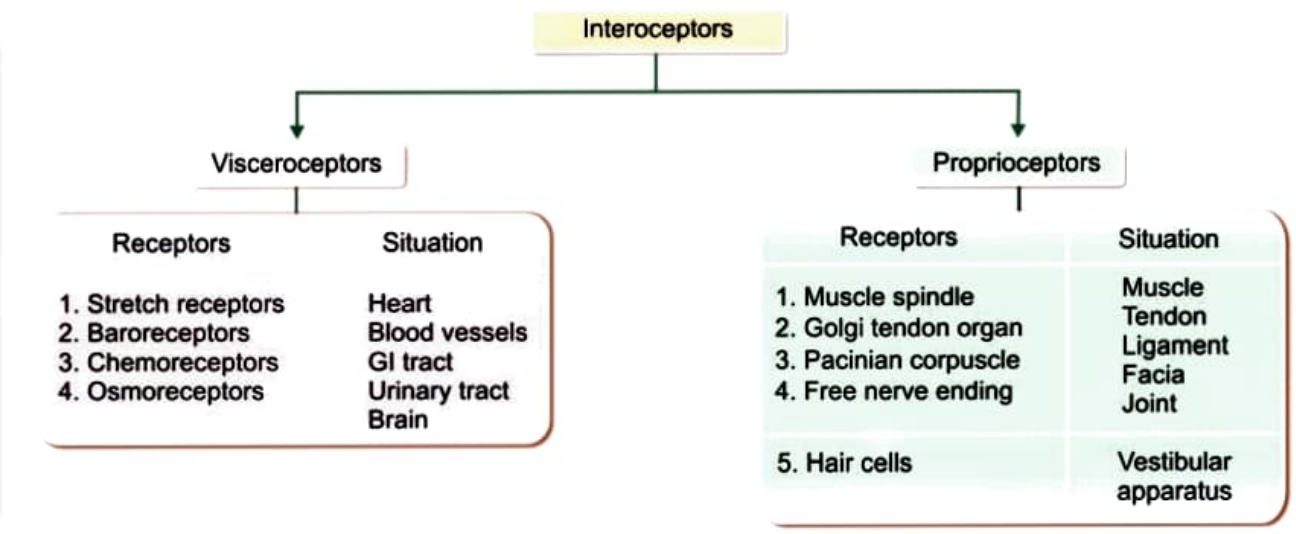

FIGURE 139.3: Interoceptors

■ 4. SENSORY TRANSDUCTION

Sensory transduction in a receptor is a process by which the energy (stimulus) in the environment is converted into electrical impulses (action potentials) in nerve fiber (transduction = conversion of one form of energy into another).

When a receptor is stimulated, it gives response by sending information about the stimulus to CNS. Series of events occur to carry out this function such as the development of receptor potential in the receptor cell and development of action potential in the sensory nerve.

Sensory transduction varies depending upon the type of receptor. For example, the chemoreceptor converts chemical energy into action potential in the sensory nerve fiber. Touch receptor converts mechanical energy into action potential in the sensory nerve fiber.

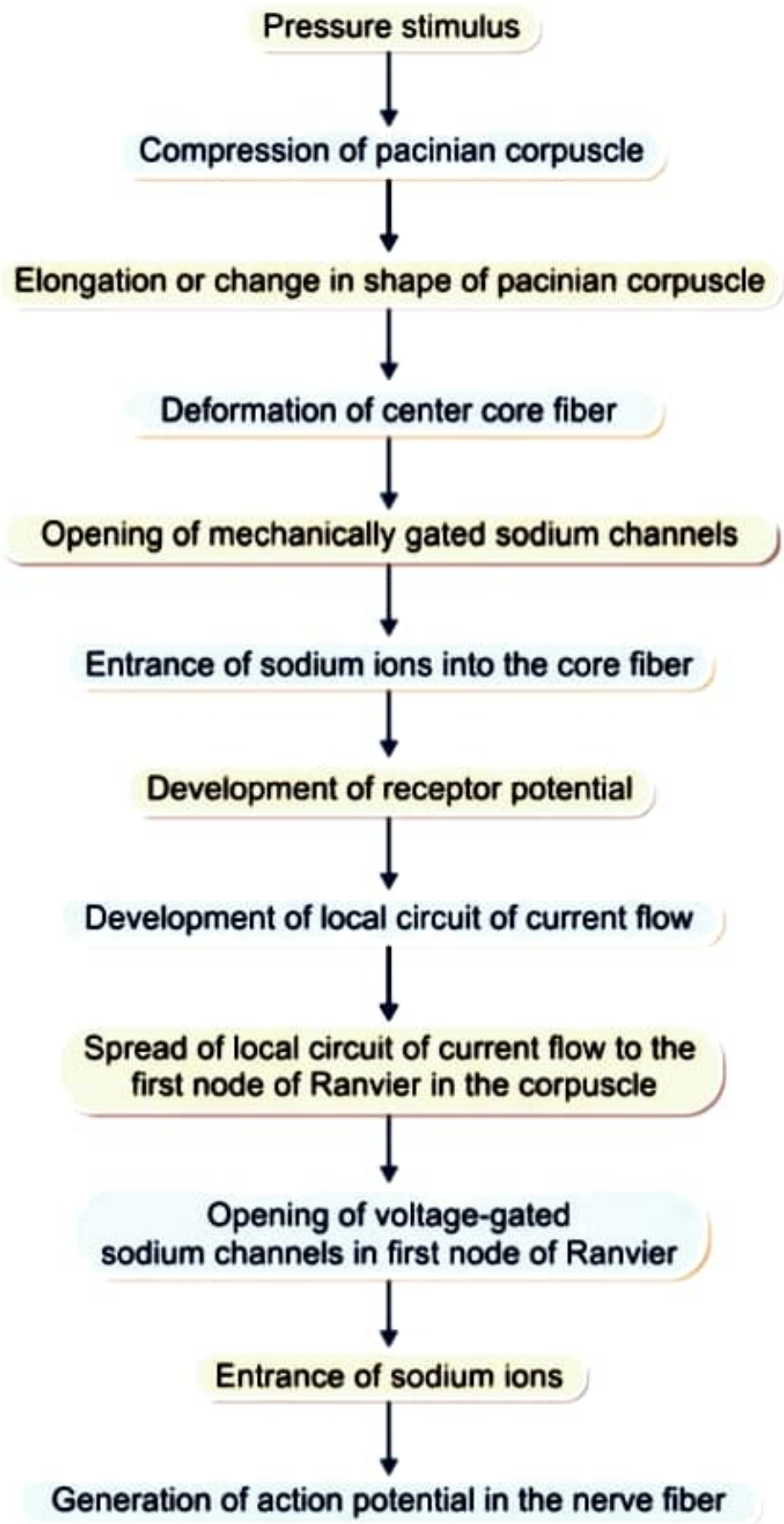

FIGURE 139.5: Schematic diagram showing development of receptor potential and generation of action potential in nerve fiber.