Local anesthesia

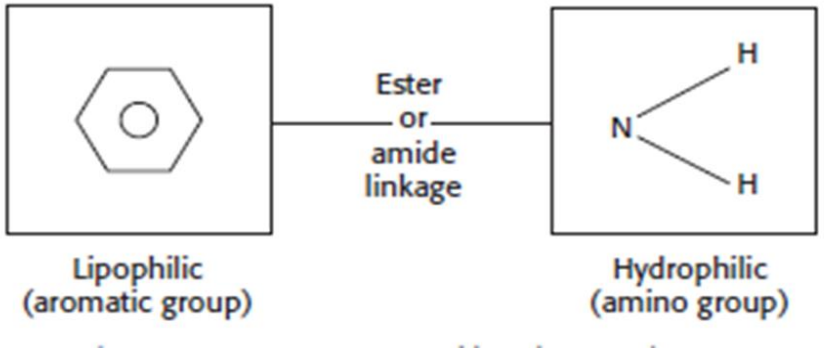
Asmaa A

Anesthesia literally means “no sensation”

Derived from the Greek verb for “to perceive”

Local anaesthetics (LAs) are the drugs that, when applied topically or injected locally, block nerve conduction and cause reversible loss of all sensation in the part supplied by the nerve.

The order of blockade of nerve function proceeds in the following manner—pain, temperature, touch, pressure and finally skeletal muscle power.



Classification of local anesthetics:

1.According to clinical use

a.*Surface anaesthetics*

Cocaine, lignocaine, tetracaine, benzocaine, oxethazaine, benoxinate, butylaminobenzoate, dyclonine.

b.Injectable anaesthetics

i.Short acting with low potency: Procaine, chloroprocaine.

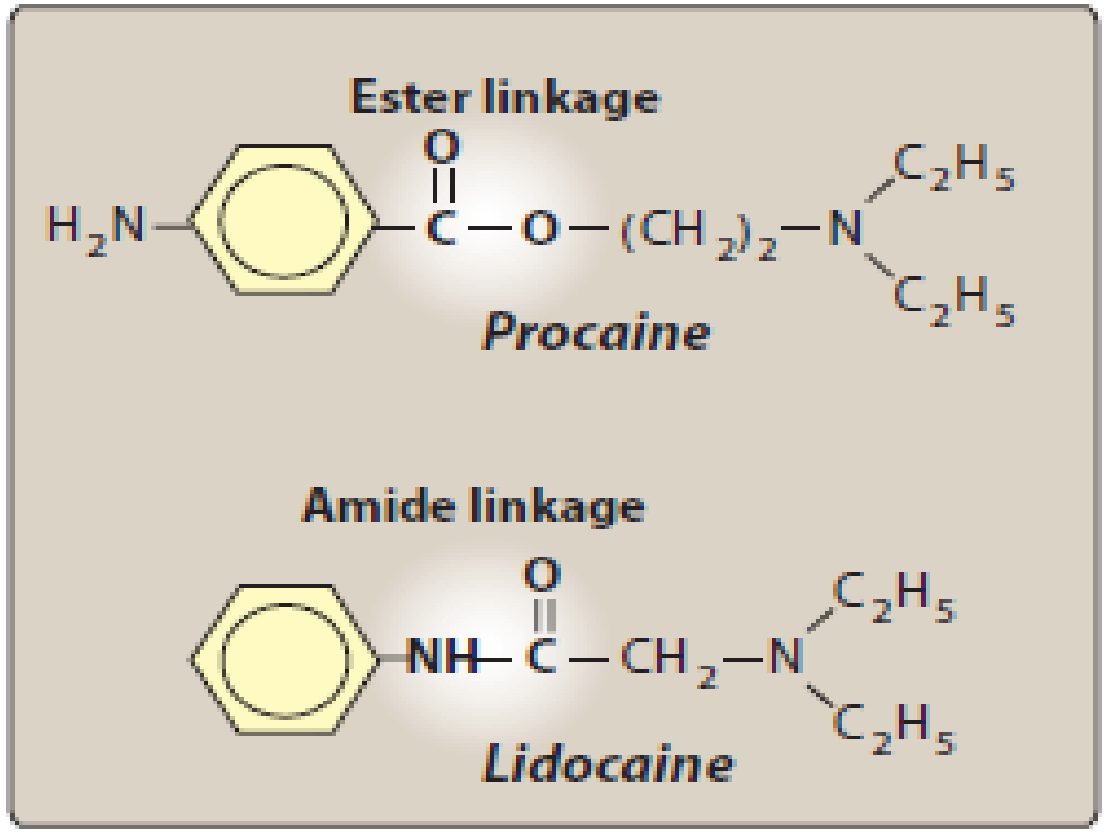
ii.Intermediate acting with intermediate potency: Lignocaine, mepivacaine, prilocaine.

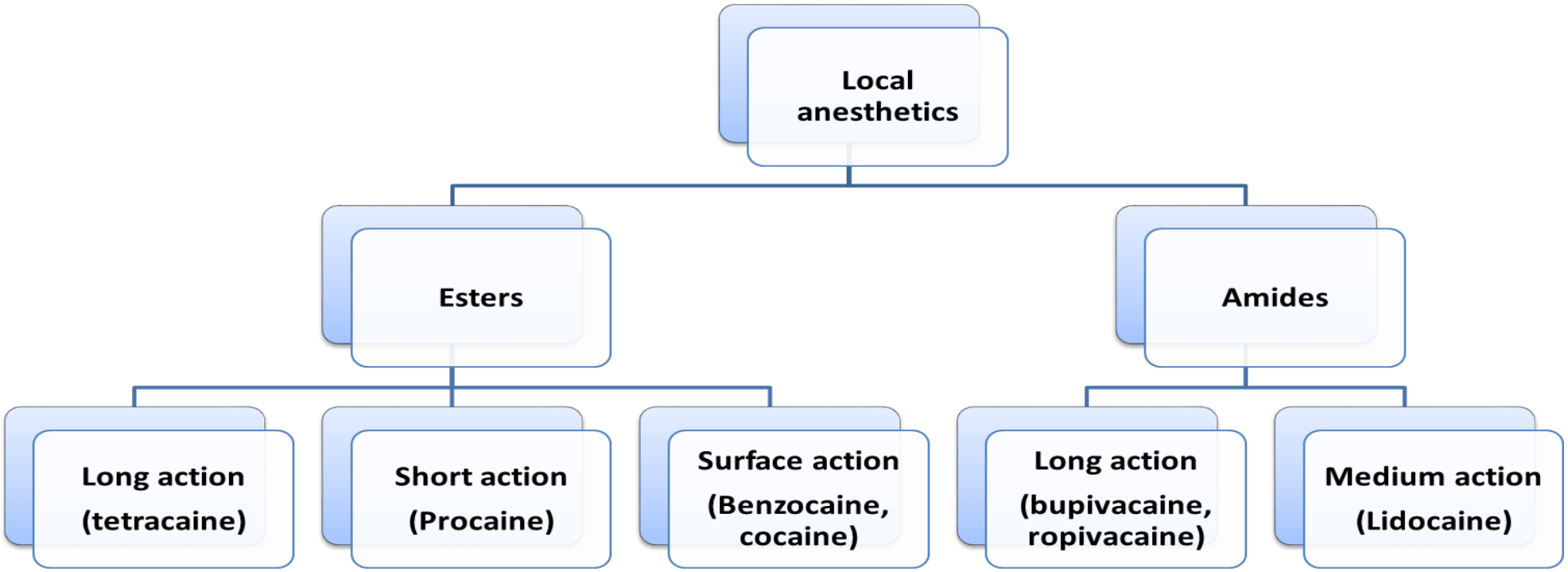
iii. Long acting with high potency: Tetracaine, bupivacaine, dibucaine, ropivacaine.

2.**According to structure**

a. *Esters**: Cocaine, procaine, chloroprocaine, benzocaine, tetracaine.

b. *Amides**: Lignocaine, mepivacaine, bupivacaine, prilocaine, articaine, ropivacaine.

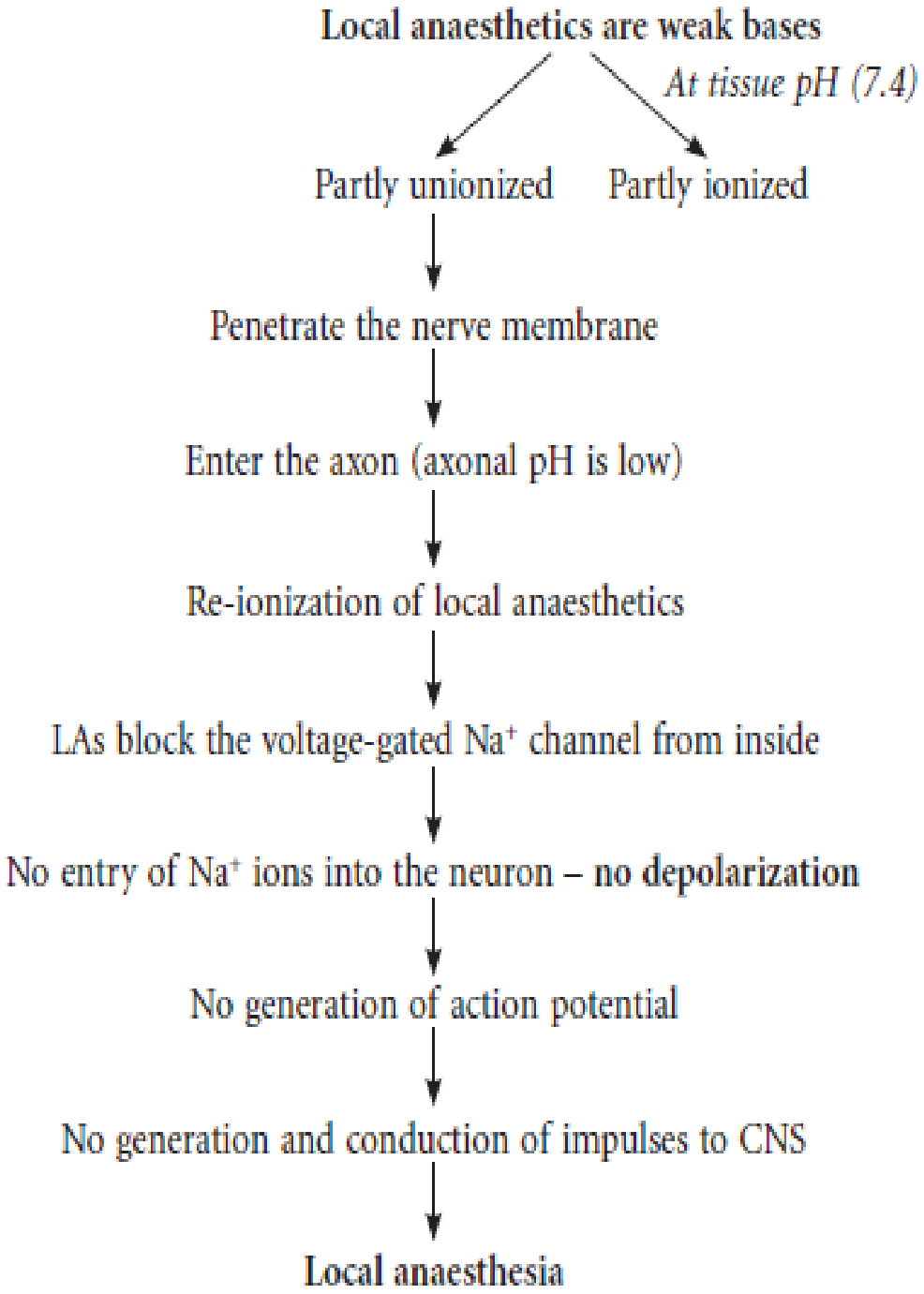




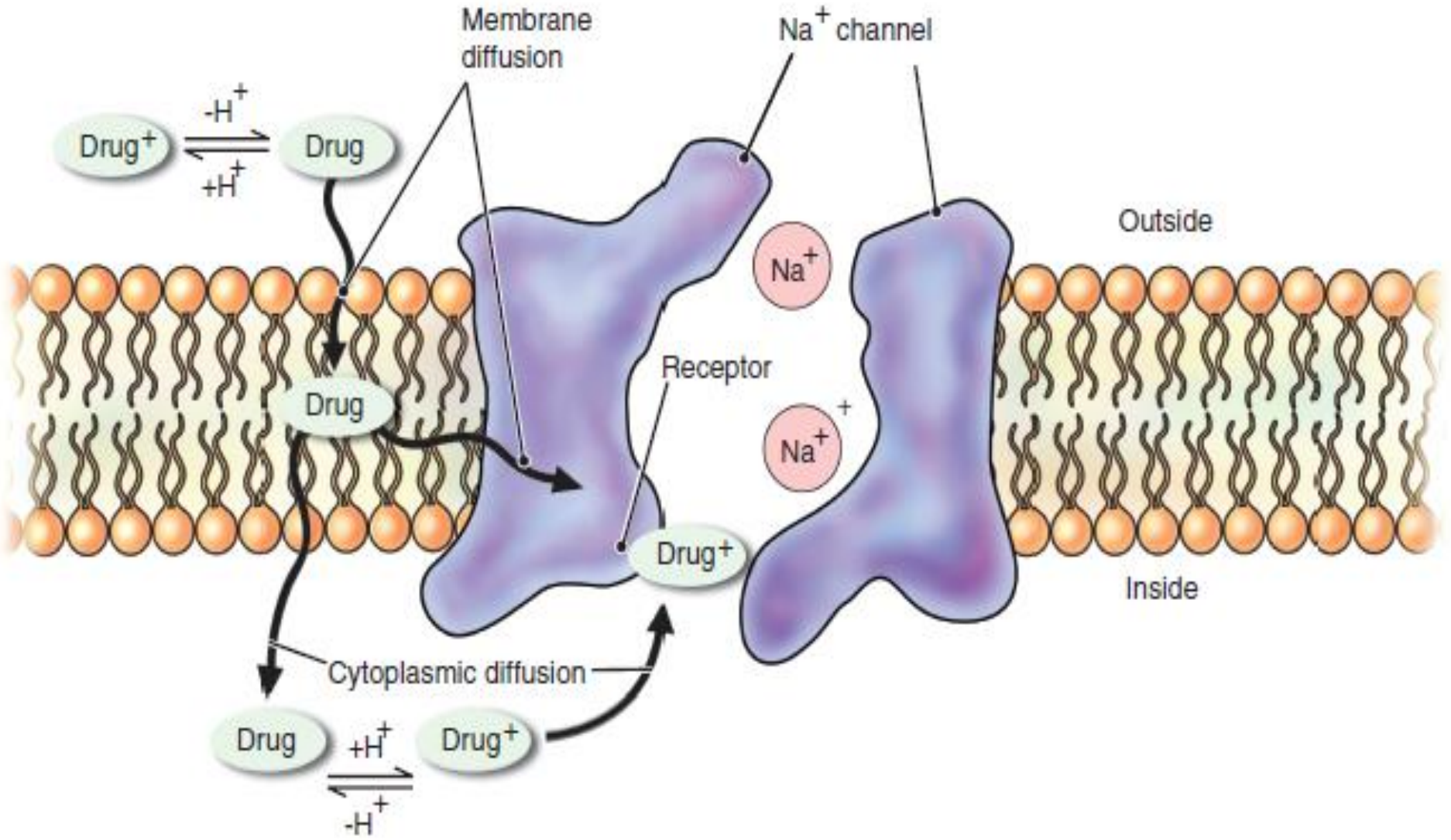
Note: The choice of “which” LA to use clinically is often based upon its duration of action

CHARACTERISTIC	ESTERS • *Procaine* • *Chloroprocaine* • *Tetracaine* • *Cocaine*	AMIDES • *Lidocaine* • *Bupivacaine* • *Ropivacaine* • *Mepivacaine* • *Prilocaine*
Metabolism	Rapid by plasma cholinesterase	Slow, hepatic
Systemic toxicity	Less likely	More likely
Allergic reaction	Possible- PABA derivatives form	Very rare
Stability in solution	Breaks down in ampules (heat, sun)	Very stable chemically
Onset of action	Slow as a general rule	Moderate to fast
pK_a's	Higher than physiologic pH (8.5–8.9)	Close to physiologic pH (7.6–8.1)

DRUG	POTENCY	ONSET	DURATION
Procaine	Low	Rapid	Short
Chloroprocaine	Low	Rapid	Short
Tetracaine	High	Slow	Long (spinal)
Lidocaine	Low	Rapid	Intermediate
Mepivacaine	Low	Moderate	Intermediate
Bupivacaine	High	Slow	Long
Ropivacaine	High	Moderate	Long



Mechanism of action


Membrane diffusion
Na+ channel
Drug+
-H+
+H+
Drug
Outside
Na+
Receptor
Drug
Na+
Drug+
Inside
Cytoplasmic diffusion
Drug
+H+
Drug+
-H+

Tetracaine

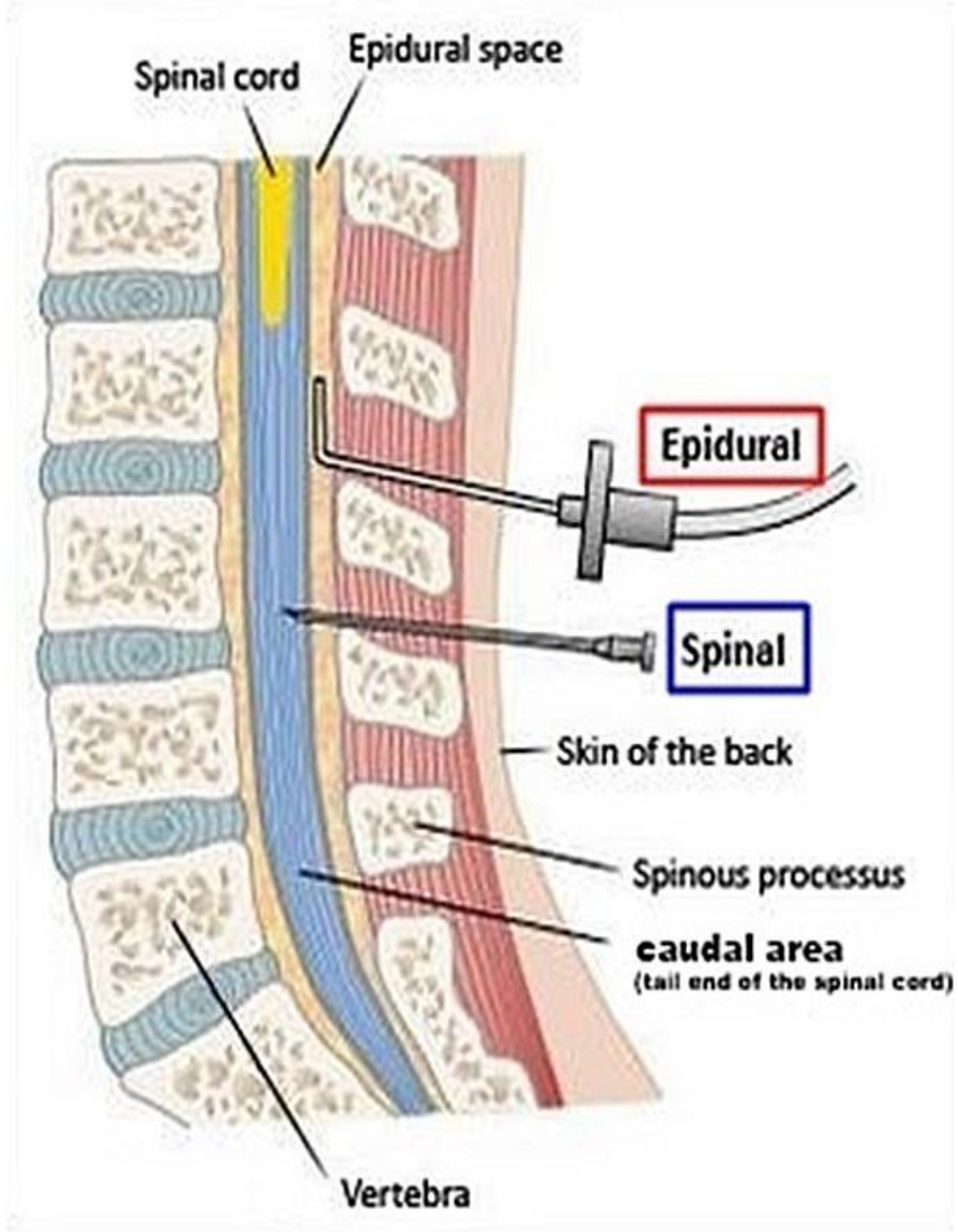
An ester type of LA; has long duration but slow onset of action. It is rarely used for spinal anaesthesia because of its longer duration of action.

Bupivacaine

It is a widely used LA. It is potent and has a long duration of action. It produces more sensory than motor blockade; hence it is very popular for obstetric analgesia. It is highly cardiotoxic and may precipitate ventricular arrhythmias.

Ropivacaine

It is less potent and less cardiotoxic than bupivacaine. Its duration of action is similar to bupivacaine. It is used for both epidural and regional anaesthesia.


Spinal cord
Epidural space
Epidural
Spinal
Skin of the back
Spinous processus
caudal area
(tail end of the spinal cord)
Vertebra

Factors affecting local anaesthetic action

1.pKa: Higher the pKa, more is the ionized fraction of the drug at physiological pH. Hence, onset of action is slow and vice versa.

For example, the pKa of procaine is 9.1, hence, it has slow onset of action; whereas the pKa of lignocaine is 7.7—it has rapid onset of action.

2.**Degree of plasma protein binding:** Higher the plasma protein binding, longer the duration of action of the drug, e.g. procaine is poorly bound to plasma proteins, hence has a short duration of action; whereas bupivacaine is highly bound and has a longer duration of action.

3. **Rate of diffusion from the site of administration:** It depends on the initial concentration gradient of the drug. Higher the concentration, rapid is the onset of action.

4.**Lipid solubility:** Higher the lipid solubility more is the potency of the drug, e.g. lignocaine is more potent than procaine as it is more lipid soluble.

5.**Presence of vasoconstrictor:** Prolongs the duration of local anaesthetics.

The commonly used vasoconstrictor with local anaesthetics is adrenaline. Others are phenylephrine, felypressin, etc.

Combination of vasoconstrictor with local anaesthetic

The commonly used vasoconstrictor with a local anaesthetic is adrenaline. Addition of a vasoconstrictor (e.g. adrenaline) to the LA has the following advantages:

1.Slow absorption from the local site, which results in prolonged duration of action of local anaesthesia.

2.Decreased bleeding in the surgical field.

3.Slow absorption of LA reduces its systemic toxicity.

Contraindications of combining vasoconstrictor with LA:

1.Intense vasospasm and ischemia in tissues with end arteries may cause gangrene of the part (e.g. fingers, toes, penis, ear lobule, tip of the nose, etc.). Hence, use of vasoconstrictors is contraindicated in these sites.

2.Absorption of adrenaline can cause systemic toxicity—tachycardia, palpitation, rise of BP and precipitation of angina or cardiac arrhythmias. Hence, combined preparation (LA with adrenaline) should be avoided in patients with hypertension, congestive cardiac failure (CCF), arrhythmias, ischaemic heart disease and uncontrolled hyperthyroidism.

3.May delay wound healing by reducing the blood flow to the affected area.

Pharmacological actions

1. **Nervous system**

a. Peripheral nerves: The order of nerve fibres affected is autonomic fibres, pain, temperature, touch, pressure and motor fibres.

b. CNS: Most of the LAs cross the blood–brain barrier (BBB)—initially they cause CNS stimulation and then depression in higher doses. They cause excitement, tremor, twitching, restlessness and convulsions. Large doses can cause respiratory depression, coma and death.

2. Cardiovascular system

a. Heart: LAs, by blocking Na+ channels, decrease abnormal pacemaker activity, contractility, conductivity, excitability, heart rate, cardiac output and increase effective refractory period. At higher concentrations, the intravenous administration of LAs may precipitate cardiac arrhythmias. Bupivacaine is more cardiotoxic than other LAs—may cause cardiovascular collapse and death. Lignocaine decreases automaticity and is useful in ventricular arrhythmias.

b. Blood vessels: Local anesthetics produce hypotension due to vasodilatation and myocardial depression.

Pharmacokinetics

Most of the ester-linked LAs are rapidly metabolized by plasma cholinesterase whereas amide-linked drugs are metabolized mainly in liver. LAs (procaine, lignocaine, etc.) are not effective orally because of high first-pass metabolism. In liver diseases, the metabolism of lignocaine may be impaired; hence dose must be reduced accordingly.

Adverse effects

1.Central Nervous System (CNS): LAs initially cause CNS stimulation followed by depression. They are restlessness, tremor, headache, drowsiness, confusion and convulsions followed by respiratory depression, coma and death.

2.CVS: Bradycardia, hypotension, cardiac arrhythmias, rarely cardiovascular collapse and death. Bupivacaine is highly cardiotoxic.

3.Methylparaben, a preservative in LA solutions, may cause allergic reactions.

4.Allergic reactions: These are skin rashes, itching, erythema, urticaria, wheezing, bronchospasm and rarely anaphylactic reaction. The incidence of allergic reactions is more with ester-linked LAs than with amide-linked LAs.

5.Mucosal irritation (cocaine) and methaemoglobinaemia (prilocaine) may be seen.