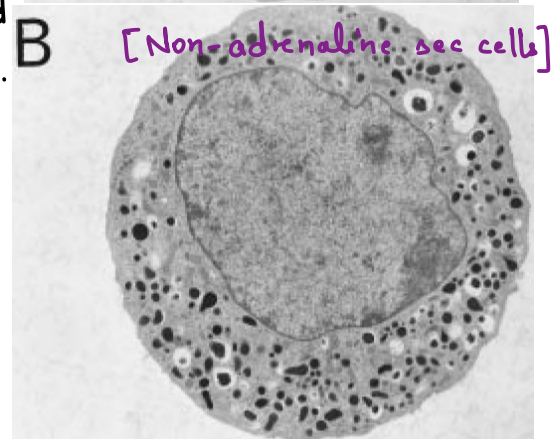


Adrenal Medulla

Introduction :

- It is the inner part of adrenal gland and it forms 20% of the mass of gland.
- Made up of interlacing cords of cells known as Chromaffin cells.
- Chromaffin cells are also called Pheochrome cells or Chromophil cells.
- Two types of Chromaffin cells :
 - (a) Adrenaline-secreting cells (90%)
 - (b) Nonadrenaline-secreting cells (10%)



Hormones of Adrenal Medulla :

- They are amines derived from catechol and so these hormones are called catecholamines.

- Catecholamines :

- (a) Adrenaline / Epinephrine
- (b) Noradrenaline / Norepinephrine
- (c) Dopamine.

- Plasma level of Catecholamines :

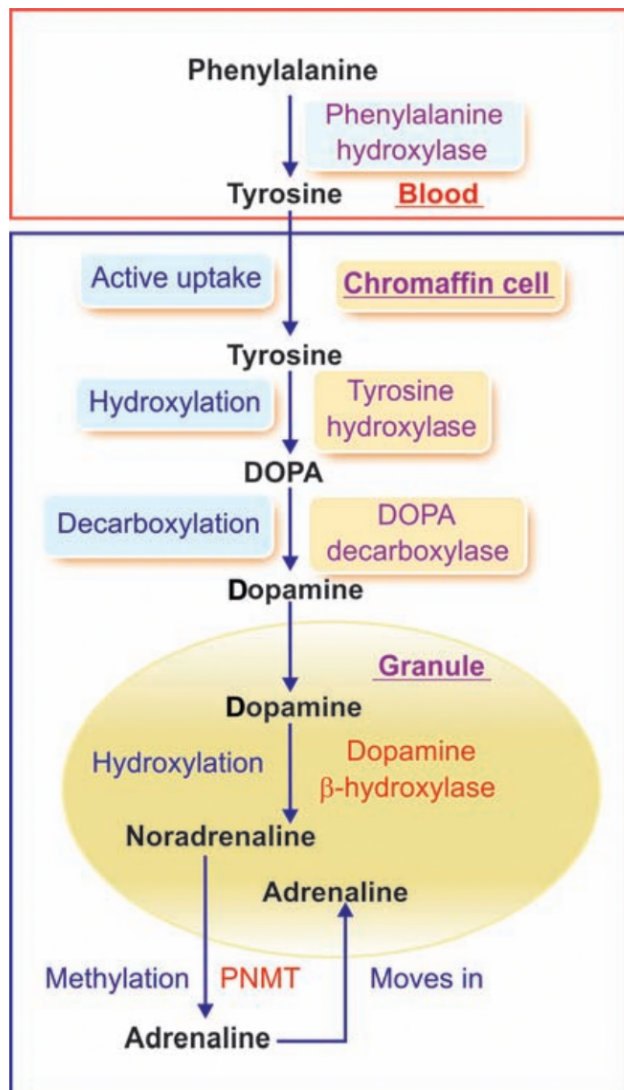
- (a) Adrenaline : 3 µg/dL
- (b) Noradrenaline : 30 µg/dL
- (c) Dopamine : 3.5 µg/dL

- Half-life = 2 minutes.

Synthesis of Catecholamines :

- From amino acid tyrosine in chromaffin cells of adrenal medulla.
- These hormones are formed from phenylalanine also.
- But phenylalanine has to be converted into tyrosine.

Stages :



Synthesis of catecholamines. DOPA = Dihydroxyphenylalanine, PNMT = Phenylethanolamine-N-methyltransferase.

Metabolism :

- 85% of Noradrenaline is taken up by Sympathetic adrenergic Neurons.
- Remaining 15% of Noradrenaline and adrenaline are degraded.
- Catecholamines are removed from body through Urine in 3 forms:
 - 15% as free adrenaline & free Nor-A
 - 50% as free / conjugated meta-adrenaline and meta-noradrenaline.
 - 35% as vanillylmandelic acid (VMA)

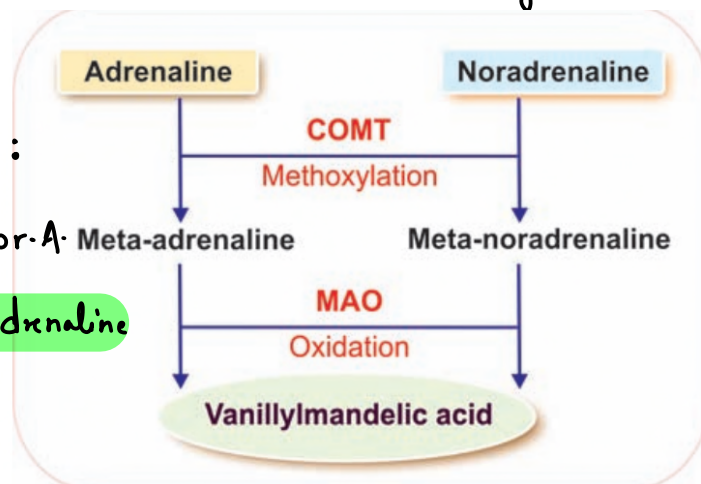


FIGURE 71.2: Metabolism of catecholamines. COMT = Catechol-O-methyltransferase, MAO = Monoamine oxidase.

Receptors :

Receptor	Mode of action	Response
Alpha-1 receptor	Activates IP_3 through phospholipase C	Mediates more of noradrenaline actions than adrenaline actions
Alpha-2 receptor	Inhibits adenylyl cyclase and cAMP	
Beta-1 receptor	Activates adenylyl cyclase and cAMP	Mediates actions of adrenaline and noradrenaline equally
Beta-2 receptor	Activates adenylyl cyclase and cAMP	Mediates more of adrenaline actions than noradrenaline actions

Actions :

- Adrenaline & Non-adrenaline have similar effect of sympathetic stimulation but with 10x prolongation, as action of hormones is slow.

(1) On metabolism (via α & β receptors)

- On general metabolism, it increases O_2 consumption & CO_2 removal.
 - It increases BMR, so it is called Calorigenic hormone.
- Carbohydrate metabolism : It increases glucose level.
- Fat metabolism : Causes mobilization of FFA from adipose tissues.

(2) On blood (via β receptors)

- It decreases blood coagulation time.
- It increases RBC count in blood by contracting smooth muscle of splenic capsule and releasing RBCs from spleen into circulation.

(3) On heart (via β receptors)

- Adrenaline has stronger effects on heart than nor-adrenaline.
- It increases overall activity of heart i.e. :
 - (i) Heart Rate (chronotropic effect)
 - (ii) Force of contraction (inotropic effect)

- (iii) Excitability of heart muscle (bathmotropic effect)
- (iv) Conductivity in heart muscle (dromotropic effect)

(4) On blood vessels (via α & β -2 Receptors)

- Nonadrenaline has strong effects on blood vessels.
- It causes constriction of vessels via α -Receptors.
- Adrenaline also causes vasoconstriction.
- But also causes dilation of blood vessels in skeletal muscle, liver, and heart through β -2-Receptors.
- Catecholamines need the presence of glucocorticoids, for these vascular effects.

(5) On Blood Pressure (via α & β -Receptors)

- Adrenaline increases systolic blood pressure by increasing the force of contraction of heart and cardiac output.
- But it decreases diastolic blood pressure by reducing the total peripheral resistance.
- Noradrenaline increases diastolic pressure due to general vasoconstriction.
- It also increases the systolic blood pressure to a slight extent by its actions on heart.

(6) On Respiration (via β -2 Receptors)

- It increases Rate & Force.
- Causes bronchodilation.

(7) On skin (via α & β -2 Receptors)

- It causes contraction of Arrector pili. It also increases the secretion of sweat.

(8) On skeletal Muscle (via α & β -2 Receptors)

- It causes severe contraction and quick fatigue.
- It causes glycogenolysis and causes vasodilation.

(9) On smooth Muscle (via α & β Receptors)

- Causes contraction of smooth muscles in following organs:
 - (i) Splenic capsule
 - (ii) Sphincters of GI tract.
 - (iii) Arrector pili
 - (iv) Gall bladder
 - (v) Uterus
 - (vi) Dilator pupillae of Iris
 - (vii) Nictitating membrane of cat.
- Causes Relaxation of:
 - (i) Non-sphincteric part of GI tract. [Esophagus, stomach, Intestine]
 - (ii) Bronchioles
 - (iii) Urinary Bladder.

(10) On CNS (via β Receptors)

- It increases the activity of Brain.
- It enhances the cortical arousal and other facilitatory functions.

(11) Other Effects :

- (a) On salivary gland (via α & β -2 receptors) $\rightarrow$ Mild increase in secretion
- (b) On sweat gland (via β -2) : Secretion $\uparrow$
- (c) On lacrimal gland (via α) : Secretion $\uparrow$
- (d) On ACTH (via α) : ACTH sec $\uparrow$
- (e) On Nerve fibers (via α) : Latency $\downarrow$, Activity $\uparrow$
- (f) On Renin secretion (via β) : Renin secretion $\uparrow$

Applied :

[Pheochromocytoma]

- Condition characterised by **Hypersecretion of catecholamines.**

Cause :

- It is caused by tumor of chromophil cells in adrenal medulla. It is also caused rarely by tumor of sympathetic ganglia.

Extra-adrenal pheochromocytoma.

Signs & Symptoms:

- Hypertension
- Anxiety
- Chest Pain
- Fever
- Headache
- Hyperglycemia
- Metabolic disorders.
- Nausea & Vomiting
- Palpitation
- Polyuria & glucosuria
- Sweating & Flushing
- Tachycardia
- Wt. loss.

Tests :

- It is detected by measuring metanephrines and Vanillylmandelic acid in urine and catecholamines in plasma.

