Signal Transduction

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Introduction to Physiology

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Chemical classes of hormones

- Lipid-soluble hormones- use transport proteins in the **plasma**
  - Steroid: Lipids derived from cholesterol.
    - Are lipophilic hormones.
      - Testosterone.
      - Estradiol.
      - Cortisol.
      - Progesterone.
  - Thyroid (amine but lipid soluble)
  - Nitric oxide (NO)

Chemical classes of hormones

- Water-soluble – circulate in "free" form in the plasma
  - Amines:
    - Hormones derived from tyrosine and tryptophan.
  - Polypeptides and proteins:
    - Polypeptides:
      - Chains of < 100 amino acids in length.
        - ADH.
    - Protein hormones:
      - Polypeptide chains with > 100 amino acids.
      - Growth hormone.
  - Eicosanoid (prostaglandins) derived from arachidonic acid (20 carbon 4 double bonds)

Chemical Classification of Hormones

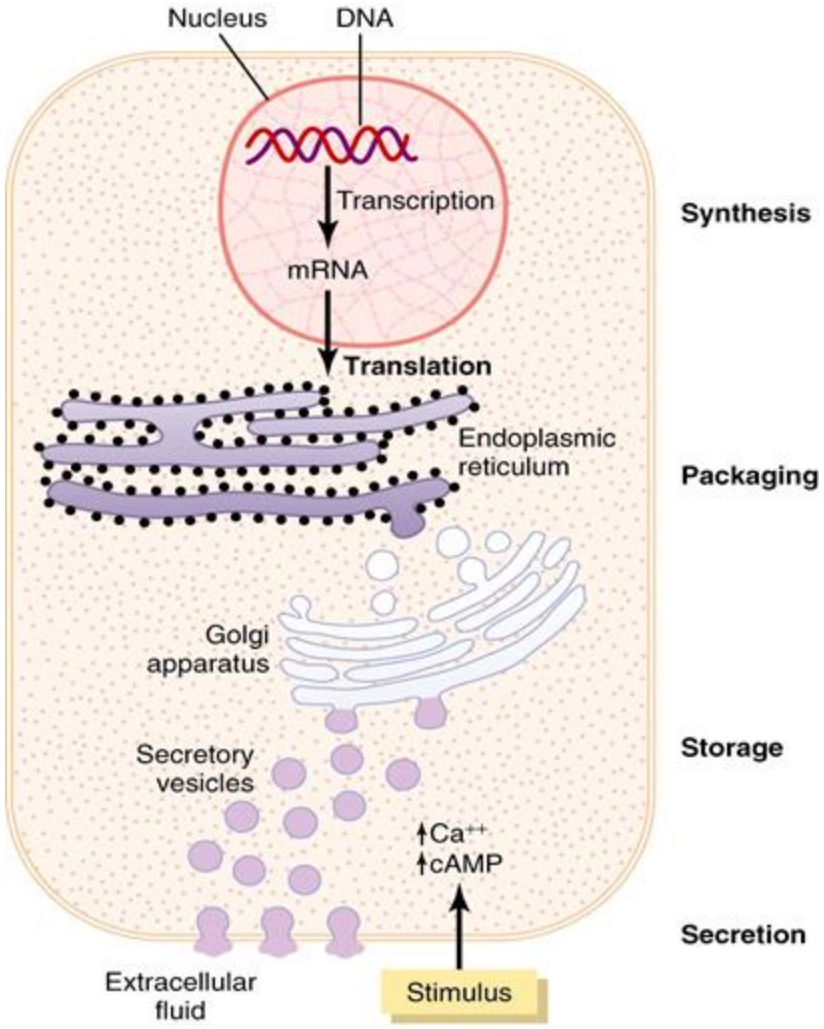
- Glycoproteins:
  - Long polypeptides (>100) bound to 1 or more carbohydrate (CHO) groups.
    - FSH and LH, TSH and hCG (human chorionic gonadotropin)

      They have α and β subunits (α is common and β is specific)
- Hormones can also be divided into:
  - Polar:
    - H_20 soluble.
  - Nonpolar (lipophilic):
    - H_20 insoluble.
      - Can gain entry into target cells.
      - Steroid hormones and T_4 (thyrxine –tetraiodothyronine))

Prohormones and Prehormones

- Prohormone:
  - Precursor is a longer chained polypeptide that is cut and spliced together to make the hormone.
    - Proinsulin – gives insulin
- Preprohormone:
  - Prohormone derived from larger precursor molecule.
    - Preproinsulin.
- Prehormone:
  - Molecules secreted by endocrine glands that are inactive until changed into hormones by target cells.
    - T_4 converted to T_3 (tri-iodothyronin).

Synthesis and secretion of peptide hormones



Chemical classification of hormones

Table 10-4 Chemical Classification and Function of Hormones

Chemical Classification	Examples	Regulated Function
Endocrine Hormones		
Amino acid derivatives	Epinephrine (adrenaline) and norepinephrine (both derived from tyrosine)	Stress responses: regulation of heart rate and blood pressure; release of glucose and fatty acids from storage sites
	Thyroxine (derived from tyrosine)	Regulation of metabolic rate
Peptides	Antidiuretic hormone (vasopressin)	Regulation of body water and blood pressure
	Hypothalamic hormones (releasing factors)	Regulation of tropic hormone release from pituitary gland
Proteins	Anterior pituitary hormones	Regulation of other endocrine systems
Steroids	Sex hormones (androgens and estrogens)	Development and control of reproductive capacity
	Corticosteroids	Stress responses; control of blood electrolytes
Paracrine Hormones		
Amino acid derivative	Histamine	Local responses to stress and injury
Arachidonic acid derivatives	Prostaglandins	Local responses to stress and injury

Peptide & Protein Hormones

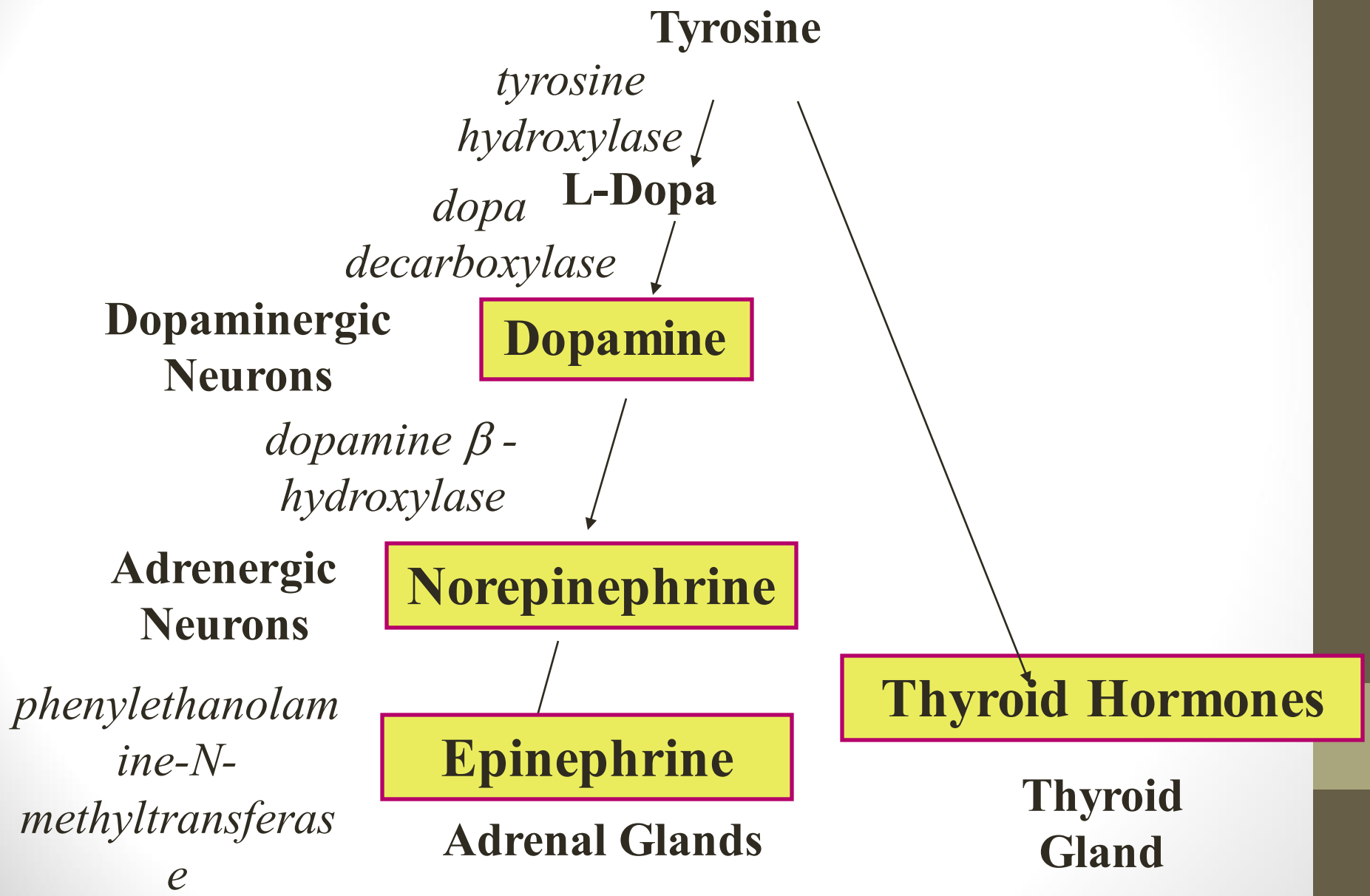
Gland/Tissue	Hormones
Hypothalamus	TRH, GnRH, CRH GHRH, Somatostatin,
Anterior pituitary	ACTH, TSH, FSH, LH, PRL, GH
Posterior pituitary	Oxytocin, ADH
Thyroid	Calcitonin
Pancreas	Insulin,Glucagon, Somatostatin
Liver	Somatomedin C (IGF-1)
Parathyroid	PTH

Gland/Tissue	Hormones
Placenta	HCG, HCS or HPL
Kidney	Renin
Heart	ANP
G.I. tract	Gastrin, CCK, Secretin, GIP, Somatostatin
Adipocyte	Leptin

Amine Hormones

Gland/Tissue	Hormones
Hypothalamus	▪ Dopamine
Thyroid	▪ T_3, T_4
Adrenal medulla	▪ Epinephrine and Norepinephrine (NE, EPI)

Synthesis of Amine Hormones



Steroid Hormones

Gland/Tissue	Hormones
Adrenal Cortex	▪ Cortisol, Aldosterone, Androgens
Testes	▪ Testosterone
Ovaries	▪ Estrogens, Progesterone
Corpus Luteum	▪ Estrogens, Progesterone
Placenta	▪ Estrogens, Progesterone
Kidney	▪ 1,25-Dihydroxycholecalciferol (calcitriol)

Hormone Activity

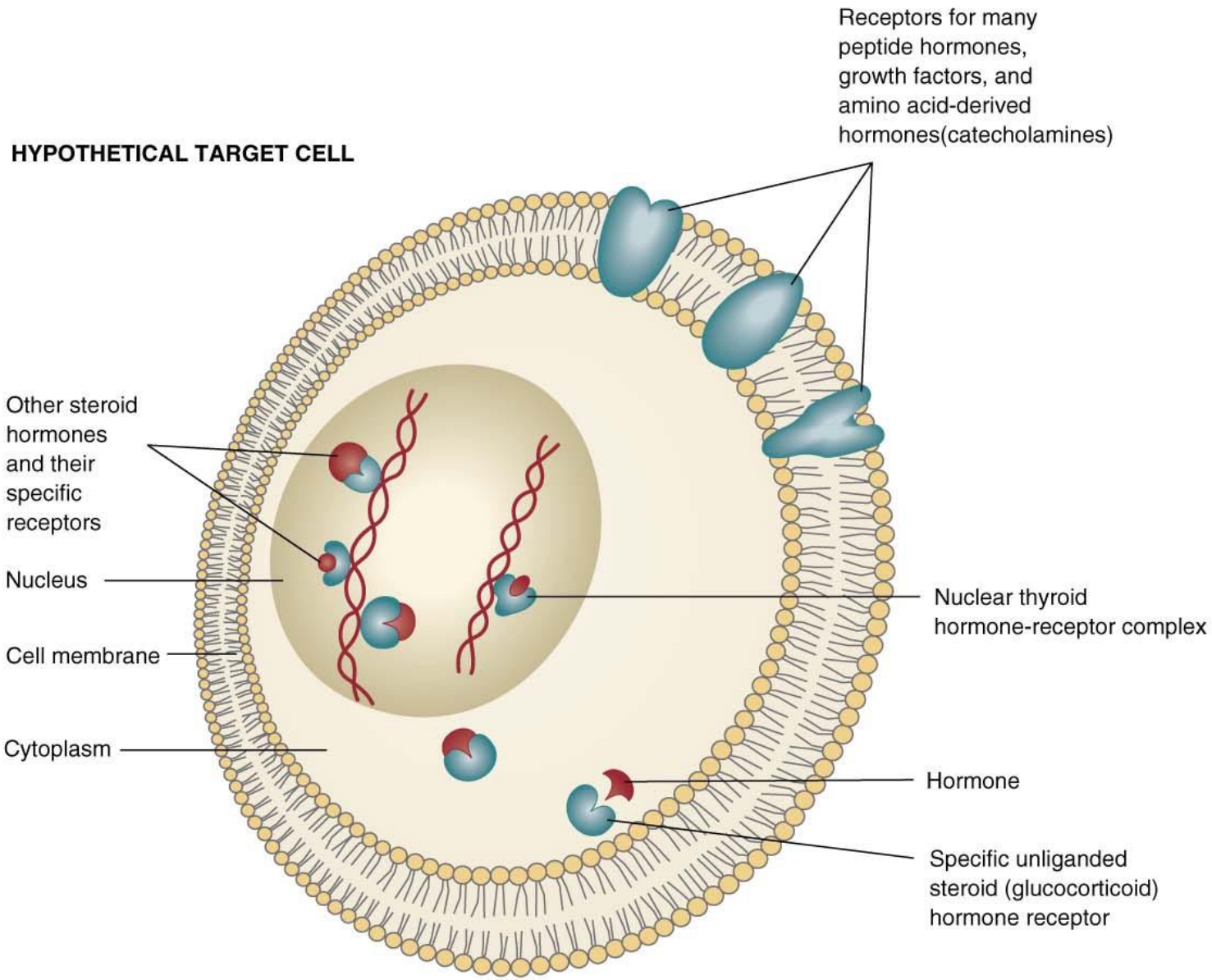
- Hormones affect only specific target tissues with specific receptors
- Receptors are dynamic and constantly synthesized and broken down
  - Down-regulation- decrease in receptor number or esponse
  - Up-regulation- increase in receptor number or activity

Effects of [Hormone] on Tissue Response

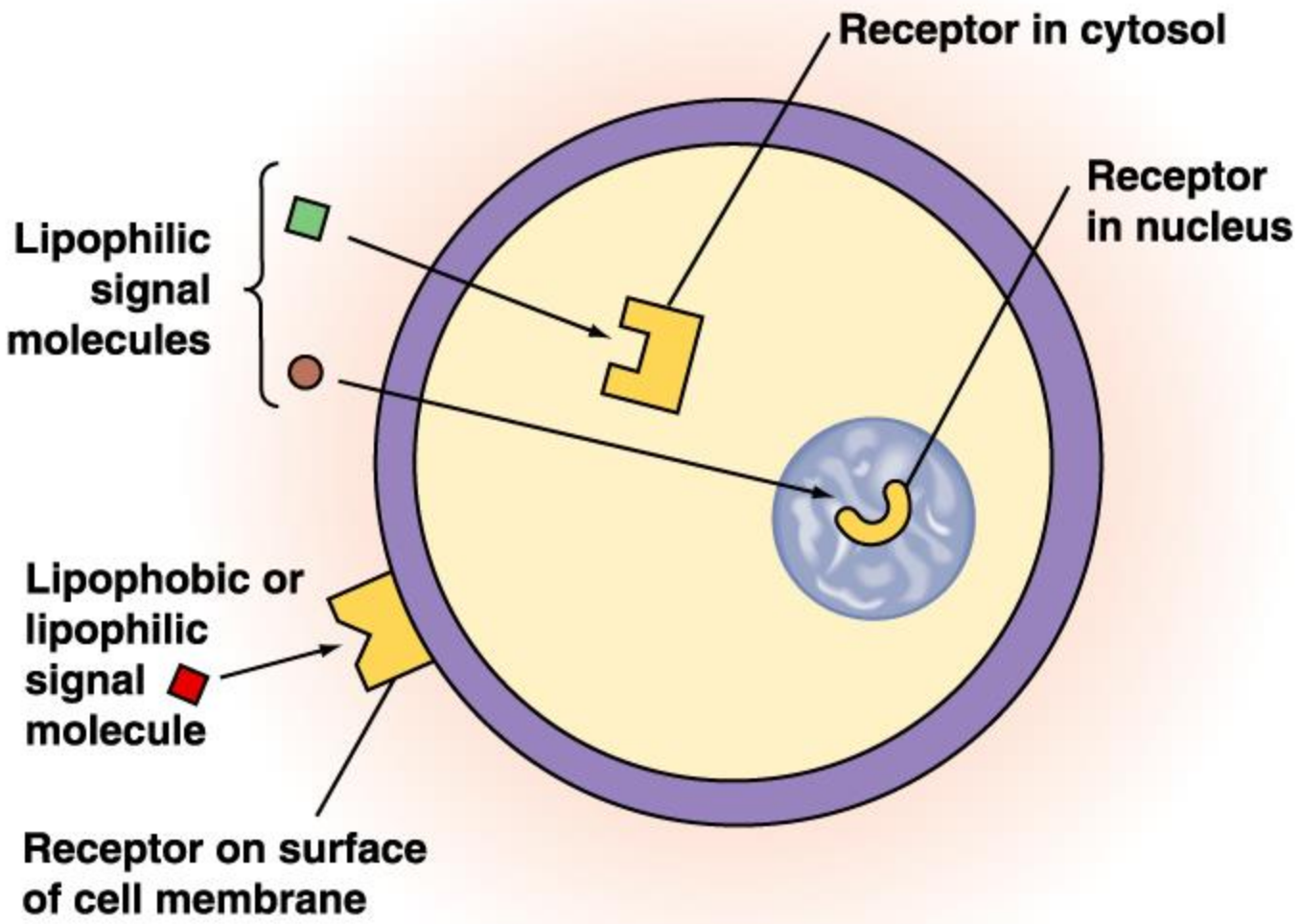
- Priming effect (upregulation):
  - Increase number of receptors formed on target cells in response to particular hormone.
  - Greater response by the target cell.
- Desensitization (downregulation):
  - Prolonged exposure to high [polypeptide hormone].
    - Subsequent exposure to the same [hormone] produces less response.
      - Decrease in number of receptors on target cells.
        - Insulin in adipose cells.
  - Pulsatile secretion may prevent downregulation.

Effects of hormone concentration on Tissue Response

- [Hormone] in blood reflects the rate of secretion.
- Half-life:
  - Time required for the blood [hormone] to be reduced to ½ reference level.
    - Minutes to days.
- Affinity of receptors to ligands, Kd
- Normal tissue responses are produced only when [hormone] are present within physiological range.
- Varying [hormone] within normal, physiological range can affect the responsiveness of target cells.



. Diagram showing the different locations of classes of hormone receptors expressed by a target cell.


Receptor in cytosol
Receptor in nucleus
Lipophilic signal molecules
Lipophobic or lipophilic signal molecule
Receptor on surface of cell membrane