Lipid-soluble hormones

Steroid hormones	aldosterone, cortisol, testosterone, oestrogen
Tyroid hormones	T3 & T4
Gases	nitric oxide (hormone & neurotransmiter)

1. lipid-soluble hormone **diffuses** into cell
2. **activated receptor-hormone complex** alters **gene expression**
3. newly formed **mRNA** directs synthesis of **specific proteins** on **ribosomes**

- increase **solubility** in blood
- **slow rate of hormone loss** in urine
- provide a ready **reserve** of hormone

Hypothalamus & pituitary gland

the hypothalamus is the major link between nervous & endocrine systems, & it **regulates**the pituitary gland.
the pituitary gland is pea-shaped & secretes **7** hormones, it had two anatomically/functionally distinct portions, the **anterior pituitary** is **stimulated** by **releasing** hormones from **hypothalamus** & is **suppressed** by inhibiting them.

Pineal gland

small endocrine gland attached to roof of third ventricle, secretes **melatonin** which contributes to maintaining **biological clock** & more is secreted in **darkness** - gland is very developed in nocturnal animals.

Parathyroid glands

Hormone + source	control	Action
PTH from chief cells	low blood Ca2+ levels stimulate secretion (& vice versa)	increases blood Ca2+ & Mg2+ levels & decreases blood $HPO4^{2-}$ level, increases bone resorption by osteoclasts, increases Ca2+ reabsorption * $HPO4^{2-}$ excretion by kidneys, promotes formation of calcitriol (vit D active form) which increases rate of dietary Ca2+ & Mg2+ absorption.

two [airs of small, round masses of tissue attached to posterior surface of lateral lobes of thyroid gland

Adrenal glands

Hormone + source	control	Action
a) *cortex hormones*		
1. mineralocorticoids from zona glomerulosa cells	increased blood K+ level & angiotensin II stimulate secretion	increase blood levels of Na+ & water, decrease blood level of K+
2. glucocorticoids from zona fasiculata cells	ACTH stimulates release; corticotropin-releasing hormone promotes ACTH secretion in response to stress & low blood levels of glucocorticoids	increase protein breakdown (except in liver), stimulate gluconeogenesis & lipolysis, provide resistance to stress, dampen inflammation, depress immune responses
3. androgens from zona reticularis cells	ACTH stimulates secretion	assist in early growth of axillary & pubic hair in both sexes, in females - contribute to libido & are source of oestrogen after menopause
b) *medulla hormones*		
1. adrenaline/noradrenaline from chromaffin cells	sympathetic preganglionic neurons release ACh which stimulates secretion	enhances effects of sympathetic division of autonomic nervous system during stress

two (one superior to each kidney - suprarenal glands) with two structurally/functionally distinct regions - medulla & cortex.

Water-soluble hormones

Amine hormones	adrenaline, noradrenaline, dopamine	(tyrosine)
	histamine	(histidine)
	serotonin & melatonin	(tryptophan)
Peptide/Protein hormones	amino acid polymers 3-49aa/50-200aa	
	(peptide) oxytocin, ADH	
	(protein) human growth, insulin	
eicosanoid hormones	derived from arachidonic acid/membrane lipids. Prostaglandins & leukotrienes. Local hormones secreted by all cells (except RBCs).	

1. hormone binding to receptor **activates** G protein, activating **adenylate cyclase**
2. activated **adenylate cyclase** converts **ATP --> cAMP**
3. **cAMP** activates protein **kinases**
4. activated protein **kinases phosphorylate cellular proteins**
5. millions of **phosphorylated proteins** cause reactions that produce physiological responses

Anterior pituitary

Hormone	Target tissues	Action
hGH	liver	stimulates liver, muscle, cartilage & bone to synthesise & secrete insulin-like growth factos (IGFs) which promote growth of body cells, protein synthesis, tissue repair, lipolysis & elevates blood [glucose].
TSH	thyroid gland	stimulates synthesis & secretion of thyroid hormones
FSH	ovaries & testes	initiates development of oocytes & induces ovarian secretion of estrogens/ stimulates testes to produce sperm
LH	ovaries & testes	stimulates secretion of oestrogen & progesterone, ovulation & formation of corpus luteum/ stimulates testes to produce testosterone
prolactin (PRL)	mammary glands	promotes milk production
ACTH	adrenal cortex	stimulates secretion of glucocorticoids
MSH	brain	exact role unknown, may influence brain activity, excess can cause skin darkening

Pancreas

Hormone + source	control	Action
glucagon from alpha cells of pancreatic islets	decreased blood level of glucose, exercise, & mainly protein meals stimulate secretion, somatostatin (growth hormone) & insulin inhibits.	raises blood glucose by accelerating glycogen breakdown into glucose in liver (glycogenolysis), converting other nutrients into glucose in liver (gluconeogenesis) & releasing glucose in blood
insulin from beta cells of pancreatic islets	increased blood level of glucose, ACh, arginine & leucine, glucagon GIP, hGH, & ACTH stimulate, somatostatin inhibits	lowers blood glucose by accelerating transport of glucose into cells, converting glucose into glycogen & decreasing glycogenolysis & gluconeogenesis, increases lipogenesis & stimulates protein synthesis

Pancreas (cont)

somato-statin from delta cells of pancreatic islets	pancreatic polypeptide inhibits	inhibits secretion of insulin & glucagon, slows absorption of nutrients from GI tract
pancreatic polype-ptide from F cells of pancreatic islets	meals with protein, fasting, exercise & acute hypogl-ycemia stimulate, somatostatin & elevated blood glucose inhibit	inhibits somatostatin secretion, gallbladder contraction & secretion of pancreatic digestive enzymes

located posterior & inferior to stomach, both endocrine & exocrine gland.

Hormone interactions

permissive effect

> requires recent/simultaneous exposure to 2nd hormone

synergistic effect

> two hormones have greater impact than individually

antagonistic effect

> two hormones have opposing actions

cell target responsiveness is dependent on the [hormone] in blood, number of receptors on target cell, & the influences of other hormones.

Thyroid gland

Hormone + source	control	Action
T3 & T4 from follicular cells	secretion increased by TRH which stimulates release of TSH in response to low thyroid hormone levels, low metabolic rate, cold, pregnancy & high altitudes. TRH/TSH secretions inhibited by high thyroid hormone levels & high iodine level	increase basal metabolic rate, stimulate protein synthesis, increase glucose & fatty acid use for ATP production, increase lipolysis, enhance cholesterol excretion, accelerate body growth, contribute to nervous system development
calcitonin (CT) from parafolli-cular cells	high blood Ca2+ levels stimulate secretion (& vice versa)	lowers blood levels of Ca2+ & $HPO4^{2-}$ by inhibiting bone resorption by osteoclasts & by accele-rating calciu-m/phosphate uptake into bone extrac-ellular matrix

butterfly-shaped, located inferior to larynx & anterior to trachea. together with hGH & insulin, thyroid hormones accelerate growth (particularly in nervous/skeletal systems)

Thymus

- located superiorly to heart
- secretes **thymosin**
- promotes proliferation & maturation of T cells (lymphocyte that destroys microorga-nisms & foreign substances)

Testes

testos terone	stimulates descent of testes before birth, regulates spermatog-enesis, promotes development & maintenance of male secondary sex characteristics
inhibin	inhibits secretion of FSH from anterior pituitary

- oval glands in scrotum
- main hormone produced & secreted is testosterone

Posterior pituitary

Hormone	Target tissues	control	action
oxytocin	uterus, mammary glands	neuros-ecretory cells of hypoth-alamus secrete OT in response to uterine distention & stimul-ation of nipples	stimulate contra-ction of smooth muscle cells of uterus during childbirth stimulate contra-ction of myoepi-thelial cells in mamma glands to cause milk ejection

Posterior pituitary (cont)

ADH	kidneys, arterioles, sudoriferous (sweat) glands	neurosecretory cells of hypothalamus secrete ADH in response to elevated blood osmotic pressure, dehydration, loss of blood volume, pain or stress; inhibitors of ADH are low blood osmotic pressure, high blood volume & alcohol	conserves water by decreasing urine volume, decreases water loss through perspiration, raises BP by constricting arterioles

does not synthesise hormones, stores & releases oxytocin & ADH

Ovaries

Hormone	action
estrogens & progesterone	together with gonadotropic hormones of anterior pituitary, regulate female reproductive cycle & oogenesis, maintain pregnancy, prepare mammary glands for lactation & promote development & maintenance of female secondary sex characteristics

Ovaries (cont)

relaxin	increases flexibility of pubic symphysis during pregnancy, helps dilate uterine cervix during labour & delivery.
inhibin	inhibits secretion of FSH from anterior pituitary

- paired oval bodies in the female pelvic cavity
- produce several steroid hormones

Other

skin

> vit D - mineral homeostasis

liver

> angiotensinogen - increases BP

small intestine

> secretin - increases pancreatic juice secretion

heart

> ANP - decreases bp

stomach

> gastrin - increases stomach motility

kidney

> EPO - increases RBC production