BMSN1601– Anatomy – Part III (L18-L22)

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| Introduction to The Endocrine System |

*# Gland: any specialized group of cells, makes and secretes a hormone*

◉ Hormones regulate the following body functions:

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| Mood | Sleep Cycle | Growth and Development |
| Metabolism and Energy Balance | Body Defense | Reproductive Process |

◉ Location of Major Endocrine Glands

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| Common Major Endocrine Glands | Pituitary gland |
| Pineal gland |
| Thyroid gland |
| Parathyroid gland |
| Hypothalamus |
| Thymus |
| Pancreas |
| Adrenal glands |
| Female Only: Major Endocrine Gland | Ovary |
| During Pregnancy Only: Major Endocrine Gland | Placenta |
| Male Only: Major Endocrine Gland | Testicle |

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| Secretion of Hormone – Mode of Action |

◉ Endocrine Glands has 3 Mode of Action to secret the hormone

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| Endocrine Signaling | Paracrine Signaling | Autocrine Signaling |
| ◉ Act on distant cells | ◉ Act on cells next to secreting cell | ◉ Act on cell that secreted them |
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| Exocrine Gland versus Endocrine Gland |

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| Endocrine | Exocrine |
| Do not have ducts (Ductless) | Do have ducts |
| Secret Hormone | Secret Sweat, Enzymes, Mucus, Sebum (皮脂) |
| Finally Carry to the ICF | Finally Carry to the outside of the body or into a body cavity |

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| Classification of Hormone – Structural Difference |

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| Amino acid derivatives (Amines) | Peptide and Proteins Hormone | Steroid (類固醇) |

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| Introduction to Amine Hormone (Amino acid derivatives) |

◉ Amine Hormones are **derivatives of the amino acid tyrosine**.

◉ Half-Life: minutes to few days

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| Amine Hormone | Thyroid Hormone | From **Thyroid Gland** |
| Epinephrine | From **Adrenal Medulla** |
| Norepinephrine |
| Dopamine | From **Hypothalamus** |

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| Introduction to Peptide Hormone |

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◉ There is a signal peptide in the polypeptide to tell the cell whether the Hormones:

▨ Should be encapsulated in cell

▨ directly release to the blood vessel

◉ The cell may secrete **multiple peptide hormones**—*derived from the same prohormone*—each of which differs in its

effects on target cells.

◉ Release the contents of the secretory vesicles by **exocytosis**

◉ Relative Half Life in Blood: minutes

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| Introduction to Steroid Hormone |

◉ Steroid Hormone are **derived from cholesterol (e.g.: cortisol)** and primarily produced by the:

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| Adrenal Cortex | Gonads (Testes / Ovaries) | Placenta (During pregnancy) |

◉ Vitamin D can be converted into active steroid hormone @ Liver / Kidney

◉ Steroid hormones **diffuse across the plasma membrane** into the circulation

▨ Reversibly **bound to carrier proteins such as albumin** in plasma

◉ **Synthesized in sER on demand** because of **longer half-life**

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| Summary of Amine Hormone, Peptide Hormone, Steroid Hormone |

◉ Do notice that: catecholamines and thyroid hormone are Amine Hormone

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|  | Major Form in Plasma | Location of Receptors | Rate |
| Peptides and catecholamines | Free | Plasma Membrane | Fast (minutes) |
| Steroids and thyroid hormone | Protein-bound | Intracellular | Slow (hours to day) |

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| Introduction to Some Important Hormone – Part I |

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| Introduction to Some Important Hormone – Part II |

表格

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| Clinical Problem Related to Endocrine Disorders |

◉ Problems in the secreting gland, e.g. tumors, infection

◉ Problems in the **endocrine feedback system**, mostly **hypothalamic-pituitary axis**

◉ **Auto-immune disorders** (e.g. Type 1 diabetes mellitus)

◉ **Genetic disorders**

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| Case Study Related to Endocrine System – Menstrual Cycle |

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| In the proliferative phase (follicular phase), follicle-stimulating hormone (FSH) induces estrogen production by the ovary |
| Rising estrogen levels stimulate luteinizing hormone (LH) production, leading to ovulation |
| After ovulation, the corpus luteum produces estrogen and progesterone |
| In the absence of fertilization, corpus luteum decays. Estrogen and progesterone levels drop, which leads to uterus lining shedding and the onset of menses |

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| Introduction to Mechanism of Hormone Action |

◉ A hormone **can only trigger A SINGLE REACTION** in **SEPECIFIC CELLS**

*Hormone Receptors can also be triggered by the hormones which have high structural similarity hormone.*

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| Water-Soluble Hormone  (Peptides & Catecholamines Hormone) | Lipid-Soluble Hormone  (Steroid & Thyroid Hormone) |
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| ◉ Attach to the Membrane Protein and trigger series  Responses through Signal transduction.  ◉ Responses including:  ▨ Cytoplasmic Responses  ▨ Nuclear Responses | ◉ The Receptors are inside the Nucleus  ◉ Responses including:  ▨ Nuclear Responses [Controlling Gene Expression] |

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| 💦 | Supplementary Note:  ◉ Cytoplasmic Responses: Transport specific/some substance from intracellular vesicle release to the extracellular  fluid.  ◉ Nuclear Responses: Induce Gene Expression or Silencing Gene Expression. |

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| Hormone Interaction at Whole Body Level – Redundant Effect |

◉ **Safe-guard mechanism for very important metabolism**

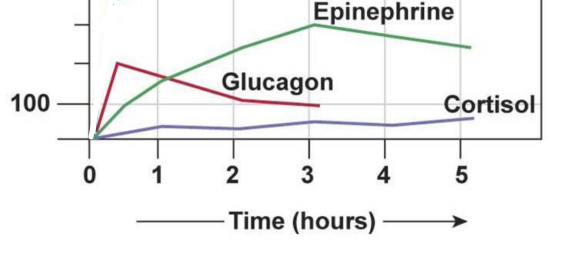
◉ **Produce synergistic outcome:**

combine action of redundant hormones to produce effects greater than the sum of their individual effects

◉ Definition: *Different hormones produce same effect*

◉ Case Study: Epinephrine, glucagon, and cortisol can all act on liver to increase blood glucose level. Although the result is

the same, the **mechanisms and time constant are different**.



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| Epinephrine (Adrenaline) | Glucagon | Cortisol |
| Amino Acid Derivative Hormone | Peptide Hormone | Steroid |
| ◉ Via Sympathetic Nerve System  🡪 Take times for Sympathetic Nerve  System to work. | ◉ Faster as 2 Responses are induced  (Cytoplasmic & Nuclear Response) | ◉ Only 1 Response is induced  (Controlling Gene Expression - Slow) |

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| Hormone Interaction at Whole Body Level – Reinforcement effects |

◉ Definition:

**Acts in different tissues to induce different responses which reinforce each other from perspective of body.**

◉ Case Study: Effect of Cortisol in Our Body

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| Pancreas | Adipose Tissue | Skeletal Muscle |
| Decrease Insulin Secretion | Increase break down of lipid | Increase break down of protein |
| * Maintain Blood Glucose Level | * Converting fatty acid into glucose in Liver | * Converting amino acid into glucose in Liver |
| **Blood Glucose Level is Increased** | | |

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| Hormone Interaction at Whole Body Level – Antagonistic effects |

◉ Definition:

**Hormones that act to return body conditions to within acceptable limits from opposite extremes**

◉ Case Study: Regulating Blood Glucose Level

▨ **Insulin decreases blood glucose level** whereas **glucagon increases blood glucose level**

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| Hormone Interaction at Whole Body Level – Permissive effects |

◉ Definition:

A Second Hormone can only affect the target cell   
if the **presence of primary (another) hormone is at certain concentration.**

◉ Case Study:

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| Estrogen induces the expression of progesterone receptor in uterus during proliferative phase.  ◉ Estrogen induces the **proliferation of uterine endometrium**  →Increase the thickness of the uterine wall  ◉ Progesterone induces the development of uterine endometrium, including blood vessels formation  →Prepare for implantation |

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| Summary of Hormone Interaction at Whole Body Level |

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| Type of Interaction | Definition | Example |
| Redundant effects | Combine action of redundant hormones to produce same effects which is greater than the sum of their individual effects | Effect of Epinephrine, glucagon, and cortisol on regulating (increasing uptake of) blood glucose level |
| Reinforcement effects | Acts in different tissues to induce different responses which reinforce each other from perspective of body. | Effect of Cortisol on Pancreas, Adipose and Skeletal Muscle. |
| Antagonistic effects | One hormone opposes the action of another in which case Hormones can act to return body conditions to within acceptable limits from opposite extremes | Interaction between Insulin and Glucagon to regulate blood glucose level to maintain homeostasis. |
| Permissive effects | The Concentration of one hormone controls the expression of receptor of another hormone. | Effect of Estrogen on the Receptor of Progesterone during development of uterine endometrium. |

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| Summary of Rhythms of Hormone Secretion |

◉ Hormone concentrations in blood plasma **fluctuate (波動) from minute to minute.**

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| Secretion | Definition | Example |
| Pulsatile secretion | Hormones **released in short bursts**, which is regulated by **physiological stimuli** (**In** **Most of Cases**) | Nutritional factors, Insulin |
| Diurnal secretion | Concentration of hormone fluctuate because of Circadian variation (昼夜节律). | Cortisol peaking shortly after waking, whereas melatonin peaking at night → Tell the cells what time it is |
| Cyclic secretion | Some hormones are secreted in complicated cycles with respect to some bodily events.   → Cyclic changes in hormonal levels control and orchestrate (編排) the events of the complicated cycle. | Secretion of Hormone during menstrual cycle. |

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| Summary of Regulation of Hormone Activity |

◉ Concentration of the hormone in the blood must be **returned to normal** after hormone has acted on target cells  
→ Prevent prolonged exposure of target cells to hormones.

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| Secretion | Definition | Example |
| Regulation of hormone receptors | **Internalization of receptor-hormone complex** can be used to reduce the number of receptors | **Growth hormone** downregulates receptors by targeting the receptor to degradation via internalization |
| Feedback Control - Negative Feedback | A negative way on the secretory cell to inhibit further hormone secretion | **Glucagon secretion** and blood glucose level |
| Feedback Control  - Positive Feedback | Broken of Positive Feedback Cycle | **Oxytocin** secretion during childbirth to cause contraction of uterine muscle |