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Medical Curriculum Objectives Project
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Endocrinology and Metabolism
(revised 2011)

General Principles

EN 1. Explain the principle of negative feedback control of hormone secretion.

EN 2. Explain the principles of positive feedback and feed forward control of hormone secretion.

EN 3. Explain the bases of hormone measurements and assessment of biological activity.

EN 4. Contrast the terms endocrine, paracrine, and autocrine based on the site of hormone release and the pathway to the target tissue. Provide an example of each, and describe major differences in mechanisms of action of peptides and steroids working through membrane receptors and steroids, vitamin D, and thyroid hormones working through nuclear receptors.

EN 5. Contrast the location and signaling pathways of membrane bound and intracellular hormone receptors. For membrane bound hormone receptors, describe the process of activation, inactivation, up-regulation, down-regulation, sensitization, and desensitization.

EN 6. Define and describe the interactions between hormones, target cells, and receptors.

EN 7. Compare and contrast hormone actions that are exerted through changes in gene expression with those exerted through changes in protein activity, such as through phosphorylation.

EN 8. Contrast the signal transduction pathways involved in G-protein coupled receptors, receptor enzymes (i.e., tyrosine kinase), and ligand-gated ion channels.

EN 9. Understand the effects of plasma hormone binding proteins on access of thyroid hormones and steroid hormones to their sites of action and degradation and on the regulation of hormone secretion.

EN 10. Explain the effects of secretion, excretion, degradation, and volume of distribution on the concentration of a hormone in blood plasma.

EN 11. Explain the importance of patterns of hormone secretion, such as pulsatile, diurnal, and menstrual.

Pituitary Gland - Posterior

EN 12. Describe the posterior pituitary lobes with respect to cell types, vascular supply, development, and anatomical function relative to the hypothalamus.

EN 13. List the target organs and functional effects of oxytocin.

EN 14. Name the stimuli for oxytocin release in relation to its reproductive and lactation functions.

EN 15. List the target cells for vasopressin and explain why vasopressin is also known as antidiuretic hormone.

EN 16. Describe the stimuli and mechanisms that control vasopressin secretion.

EN 17. Identify disease states caused by a) over-secretion, and b) under-secretion of vasopressin and list the principle symptoms of each.

Pituitary Gland – Anterior

EN 18. Describe the anterior pituitary lobe with respect to cell types, vascular supply, development, and anatomical function relative to the hypothalamus.

EN 19. Describe the 3 major families of the anterior pituitary hormones and their biosynthetic and structural relationships.

EN 20. Identify appropriate hypothalamic factors that control the secretion of each of the anterior pituitary hormones, and describe their route of transport from the hypothalamus to the anterior pituitary.

EN 21. Understand negative feedback control of anterior pituitary hormone secretion at multiple levels.

Growth Hormone

EN 22. Describe the relationship between growth hormone and the insulin-like growth factors and their binding proteins in the regulation of growth.

EN 23. Understand the regulation of growth hormone secretion. Identify the roles of hypothalamic factors, glucose and IGF-I.

EN 24. Identify the target organs or cell types for insulin-like growth factors that account for longitudinal growth.

EN 25. Describe the metabolic and growth promoting actions of growth hormone.

Thyroid Gland

EN 26. Identify the steps in the biosynthesis, storage, and secretion of tri-iodothyronine (T_3) and thyroxine (T_4) and their regulation.

EN 27. Describe the absorption, uptake, distribution, and excretion of iodide.

EN 28. Explain the importance of thyroid hormone binding in blood on free and total thyroid hormone levels.

EN 29. Understand the significance of the conversion of T_4 to T_3 and reverse T_3 (rT_3) in extra-thyroidal tissues.

EN 30. Describe the physiologic effects and mechanisms of action of thyroid hormones.

EN 31. Understand the causes and consequences of a) over-secretion and b) under-secretion of thyroid hormones. Explain what conditions can cause an enlargement of the thyroid gland.

Hormonal Regulation of Calcium and Phosphate

EN 32. Identify the normal range of dietary calcium intake, calcium distribution in the body, and routes of calcium excretion.

EN 33. Identify the normal range of dietary phosphate intake, phosphate distribution in the body, and routes of phosphate excretion.

EN 34. Know the cells of origin for parathyroid hormone, its biosynthesis and degradation.

EN 35. List the target organs and cell types for parathyroid hormone and describe its effects on each.

EN 36. Describe the functions of the osteoblasts and the osteoclasts in bone remodeling and the factors that regulate their activities.

EN 37. Describe the regulation of parathyroid hormone secretion and the role of the calcium-sensing receptor.

EN 38. Understand the causes and consequences of a) over-secretion, and b) under-secretion of parathyroid hormone, as well as its therapeutic use.

EN 39. Describe the normal function of parathyroid hormone related protein (PTHrP) and its role as a marker for some cancers.

EN 40. Identify the sources of vitamin D and diagram the biosynthetic pathway and the organs involved in modifying it to the biologically active $1,25(OH_2)D_3$ (1-25 dihydroxy cholecalciferol).

EN 41. Identify the target organs and cellular mechanisms of action for vitamin D.

EN 42. Describe the negative feedback relationship between parathyroid hormone and the biologically active form of vitamin D [$1,25(OH_2)D_3$].

EN 43. Describe the consequences of vitamin D deficiency and vitamin D excess.

EN 44. Name the stimuli that can promote secretion of calcitonin, its actions, and identify which (if any) are physiologically important.

Adrenal Gland

EN 45. Identify the functional zones (one medullary and three cortical zones), innervation, and blood supply of the adrenal glands and the principal hormones secreted from each zone.

EN 46. Describe the biosynthesis of the adrenal steroid hormones (glucocorticoids, mineralocorticoids, and androgens) and the key structural features that distinguish each class.

EN 47. Understand the cellular mechanism of action of adrenal cortical hormones.

EN 48. Identify the major physiological actions and therapeutic uses of glucocorticoids

EN 59. Describe the components of the neuroendocrine axis that control glucocorticoid secretion.

EN 50. Identify the causes and consequences of a) over-secretion and b) under-secretion of glucocorticoids and adrenal androgens.

EN 51. List the major mineralocorticoids and identify their biological actions and target organs or tissues.

EN 52. Understand the differential regulation of cortisol versus aldosterone release.

EN 53. Describe the principal physiological stimuli that cause increased mineralocorticoid secretion. Relate these stimuli to regulation of sodium and potassium excretion.

EN 54. Identify the causes and consequences of a) over-secretion and b) under-secretion of mineralocorticoids.

EN 55. Identify the chemical nature of catecholamines, their biosynthesis, mechanism of transport within the blood, and how they are degraded and removed from the body.

EN 56. Describe the biological consequences of activation of the adrenal medulla and identify the target organs or tissues for catecholamines along with the receptor subtype that mediates the response. Understand the mechanism by which epinephrine and norepinephrine can produce different effects in the same tissues.

EN 57. Name the key stimuli causing catecholamine secretion. List the factors that can modulate a) the secretory response and b) the responses of target tissues.

EN 58. Describe the interactions of adrenal medullary and cortical hormones in response to stress.

EN 59. Identify disease states caused by an over-secretion of adrenal catecholamines.

Metabolism

EN 60. Identify the normal range of plasma glucose concentrations, and list the chemical forms and anatomical sites of storage pools for glucose and other metabolic substrates.

EN 61. Identify the hormones that promote the influx and efflux of glucose, fat, and protein into and out of energy storage pools and their impact on the uptake of glucose by tissues. Establish specific roles for insulin, glucagon and catecholamines.

EN 62. Describe the changes in metabolic fuel utilization that occur in long- and short-term fasting and in acute and sustained exercise. Understand how increases or decreases in hormone secretion produce these changes.

EN 63. Describe the role of appetite and metabolic rate in the maintenance of long-term energy balance and fat storage. Identify the factors that regulate appetite and fuel oxidation.

Pancreas

EN 64. Identify the major hormones secreted from the endocrine pancreas, their cells of origin, and their chemical nature.

EN 65. List the target organs or cell types for glucagon and describe its principal actions on each.

EN 66. List the major target organs or cell types for insulin, the major effects of insulin on each, and the consequent changes in concentration of blood constituents.

EN 67. Identify the time course for the onset and duration for the biological actions of insulin.

EN 68. Understand the relationship between blood glucose concentrations and insulin secretion.

EN 69. Describe the roles of neural input and gastrointestinal hormones on insulin secretion. List the factors that modulate the secretory response.

EN 70. Describe the control of glucagon secretion.

EN 71. Identify disease states caused by: a) over-secretion, b) under-secretion of insulin, or c) decreased sensitivity to insulin, and describe the principal symptoms of each.

Endocrine Integration of Energy and Electrolyte Balance

EN 72. Explain how thyroid, gonadal, and adrenal hormones modulate growth.

EN 73. Understand the nature and actions of local growth factors: epidermal growth factor, nerve growth factor, platelet-derived growth factor, and angiogenic and antiangiogenic factors.

EN 74. Identify the normal range of dietary sodium intake, sodium distribution in the body, and routes of sodium excretion. Explain the roles of antidiuretic hormone, aldosterone, angiotensin, and atrial natriuretic hormone in the regulation of sodium balance.

EN 75. Identify the normal range of dietary potassium intake, potassium distribution in the body, and routes of potassium excretion. Explain how acute changes in aldosterone, insulin, and acid/base concentrations affect the plasma potassium concentration and the movement of potassium into and out of the intracellular compartment. Explain the chronic regulation of body potassium balance and plasma potassium levels by aldosterone through its actions on renal excretion, intestinal excretion, and dietary appetite/absorption.

Reproductive Physiology - Male

EN 77. Describe the physiological functions of the major components of the male reproductive tract.

EN 78. Describe spermatogenesis and the role of Sertoli cells, Leydig cells and the basement membrane in this process.

EN 79. Describe the endocrine regulation of testicular function: the role of the GnRH pulse generator, FSH, LH, testosterone, and inhibin.

EN 80. Describe the, biosynthesis, mechanism of transport within the blood, metabolism and elimination of testosterone and related androgens.

EN 81. List the major target organs and cell types for testosterone and other androgens.

EN 82. Describe the actions and cellular mechanisms of testosterone and related androgens.

EN 83. Describe the neural, vascular, and endocrine components of the erection and ejaculation response.

EN 84. Identify the causes and consequences of over-secretion and under-secretion of testosterone for a) prepubertal and b) postpubescent males.

EN 85 Understand aging- related changes in the hypothalamo-pituitary-goandal axis that lead to puberty, reproductive maturity, and reproductive senescence (andropause).

Reproductive Physiology - Female

EN 86. Describe oogenesis and its relationship to changes in the ovarian follicle. Explain the roles of FSH, LH, estradiol, and inhibin in oogenesis and follicular maturation.

EN 87. Describe ovulation and the formation and decline of the corpus luteum and the roles of hormones in each of these processes.

EN 88. Describe the hormonal regulation of estrogen and progesterone biosynthesis and secretion by the ovary. Identify the cells responsible for their biosynthesis, the mechanism of their transport in the blood, and how they are degraded and removed from the body.

EN 89. List the major target organs and cell types for estrogen action and describe its effects on each.

EN 90. Describe the actions and cellular mechanisms of estrogen.

EN 91. List the principal physiological actions of progesterone, its major target organs and cell types, and describe its effects on each and the importance of “estrogen priming.”

EN 92. Describe the actions and cellular mechanisms of progesterone and other progestins.

EN 93. Graphically illustrate the timing of changes in blood levels of FSH, LH, estradiol, progesterone, and inhibin, and correlate these with structural changes in the endometrium and the ovary seen during the menstrual cycle.

EN 94 Describe how the changes in ovarian steroids produce the proliferative and secretory phases of the uterine endometrium and menstruation and the changes in basal body temperature during the menstrual cycle.

EN 95 Understand aging- related changes in the hypothalamo-pituitary-goandal axis that lead to puberty, reproductive maturity, and reproductive senescence (menopause).

Pregnancy and Birth

EN 96. Describe the process of fertilization, including capacitation and the acrosome reaction, and the movement of the blastocyst to the uterus.

EN 97. Describe the process of implantation.

EN 98: Describe the development and the major physiological functions of the placenta.

EN 99. List the protein hormones secreted by the placenta and describe the role of human chorionic gonadotropin (hCG) in the rescue of the corpus luteum in maintaining pregnancy early post-implantation.

EN 100. Describe the interactions between the placenta and the fetus in the pathway for production of estrogens during pregnancy.

EN 101. Discuss the roles of sex steroids, oxytocin, relaxin, and prostaglandins in the initiation and maintenance of parturition.

EN 102. Explain the role of hormones in mammary gland development during puberty, pregnancy, and lactation.

EN 103. Explain the basis for the inhibition of milk secretion during pregnancy and the initiation of lactation after parturition.

EN 104. Describe the neuroendocrine regulation of milk secretion and milk ejection.

EN 105. Explain the physiological basis of steroid hormone contraception.

Sexual Differentiation

EN 106. Compare and contrast the actions of testosterone, dihydrotestosterone, estradiol, and Müllerian inhibitory factor in the development of the male and female reproductive tracts.

EN 107. Describe developmental changes in the male and female reproductive systems, including the mechanisms responsible for these changes, during *in utero* development, and in childhood through puberty.