Q.1 Objective Type Questions:
(i) Addison  (ii) Gene  (iii) Hypothyroidism  (iv) Calcitonin  (v) Adrenal  (vi) Corpus Luteum
(vii) Acrosome (viii) 100  (ix) 16  (x) Melanin

Section- A

Q.2 Short Answer Type Questions:
Q.2  Describe the history of Endocrinology.
- **Endocrinology**: It is the study of ductless glands which secrete hormones directly into the venous blood or lymph through tissue fluid.
- **Neuroendocrinology**: It is the study of hormones released from nerve cells.
- **Neurohormone**: These are secreted by neurons. eg. Releasing/Inhibiting hormones of hypothalamus, adrenalin and nor-adrenalin from adrenal medulla, etc.
- **Releasing/Inhibiting Hormones**: These hormones are released from hypothalamus which control the secretion of pituitary gland.
- **Berthold (1849)**: He is the founder of endocrinology. He performed castration and grafting of testes in roosters and cockerels and observed the changes in the body systems.
- **Schiff (1854)**: He performed thyroidectomy and found that animals were dead.
- **Thomas Addison (1855)**: He is the father of Endocrinology. He removed the cortical part of adrenal gland of the animals which caused Addison’s disease.
- **Claude Bernard (1855)**: He observed that nervous system controls the functions of endocrine glands. He also coined the term internal secretion.
- **Huxley (1935)**: Hormones are highly active organic compounds and act as chemical messengers.
- **Baylis and Starling (1903)**: They discovered first hormone- Secretin. It stimulated pancreas to secrete pancreatic juice hence named secretin.
- **Starling (1905)**: He coined the term Hormone.
- **Guillemin (1977)**: He observed axoplasmic flow of hormones.

Q.3  Write about hormones secreted from GI-track.
- **GI- track is the largest endocrine organ system. It secretes proteinoid hormones.**
- **Gastrin**: It is secreted by G-cells of pyloric stomach and by y-cells of pancreas in presence of food in stomach. It is secreted as progastrin which is converted into gastrin by HCl. It induces mucosa to secrete digestive juice and HCl. It relaxes pyloric sphinctor and promotes churning movement in stomach. Its hypersecretion produces gastric ulcers and other gastric problems.
- **Secretin**: It is secreted from small intestine to entry of HCl in duodenum. It stimulates pancreas to secrete watery pancreatic juice which mainly contains bicarbonates.
- **Pancreozymin (PZ)**: It stimulates pancreas to secrete pancreatic juice which is rich in digestive enzymes.
- **Cholycystokinin (CCK)**: It is secreted from entire small intestine in the presence of food. It excites gall bladder to contract and release the bile juice.
- **Enterogastrone/Gastric Inhibitory Peptide (GIP)**: It is secreted in response to fatty acids. It stops the secretion of gastrin resulting in inhibiting of stomach movements and secretion of gastric juice.
- **Vasoactive Intestinal Peptide (VIP)**: It is secreted by small intestine and colon. It acts as vasodilator.
- **Enterocrinin**: It stimulates small intestine to secrete intestinal juice.
- **Hepaticin**: It stimulates liver for bile production.
- **Duocrinin**: It stimulates secretion of alkaline mucous from Brunner’s glands of duodenum.
- **Villikinin**: It stimulates movement of intestinal microvilli to increase absorption of digested food.
Q.4 Draw a labeled diagram of T.S. of Testis.

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Q.5 Describe spermatogenesis.

- Formation of sperms by seminiferous tubules in the testis is called spermatogenesis. In man, it takes about 64-74 days. It is regulated by FSH, testosterone, Vit. A & E, scrotal temperature, etc. Developing sperms feed on glycogen.
- Spermatogenesis is completed into three phases:
  (1) **Multiplication phase:** One cell of germinal epithelium is differentiated into primordial germ cell (2n). This cell divide mitotically several times resulting a number of spermatogonia (2n).
  (2) **Growth phase:** One spermatogonium gets nutrition and grows in size which is now called as primary spermatocyte (2n).
  (3) **Maturation phase:** Primary spermatocyte divides meiotically (Meiotic- I) resulting in two secondary spermatocytes (n). Now these cells divide mitotically (Meiotic-II) and four spermatids are produced (n).
- By the process of spermiogenesis or spermateleosis, the spermatids are transformed into mature sperms (04).
Q.6 Write an account on parthenogenesis.

Development of an individual from unfertilized egg is called parthenogenesis.

Richard Owen (1848): He first of all studied parthenogenesis in unfertilized egg.

Charls Bonnet: He observed natural parthenogenesis and coined the term Parthenogenesis.

Jacques Loeb: He observed artificial parthenogenesis.

Androgenesis: Male parthenogenesis. eg. Drones

Gynogenesis: Female parthenogenesis. eg. Lacerta

Parthenogenesis may be haploid or diploid:
(a) Arrhenotoky (Haploid parthenogenesis): Haploid eggs grow to haploid males. eg Arachnids, some insects (Drones).

(b) Thelotoky (Diploid parthenogenesis): Diploid eggs grow into individuals, generally females eg. Gall fly

Types of Parthenogenesis: Two types

A. Natural Parthenogenesis: It is of three types:
1. Complete/Obligatory parthenogenesis: Only females are produced. eg. Rotifers, Indian small snake (Typhlina brahmina), Caucasian rock lizard (Lacerta sexicola americana), etc.

2. Incomplete/Cyclic parthenogenesis: Both sexual and parthenogenetic individuals are produced.

- In Aphids: Several generations of parthenogenetic females are developed followed by formation of both males and females to perform sexual reproduction.

- In Turkeys: 40% males are produced by parthenogenesis and 60% males and all females from fertilized eggs.

- In Honey bee: Only males are produced eg. Drones.

- Paedogenetic parthenogenesis: Larvae lay eggs which develop parthenogenetically into new generation of larvae. eg. Gall fly.

B. Artificial parthenogenesis: Parthenogenesis by artificial stimuli eg. Eggs of annelids, molluscs, echinodermates, frog, rabbit, hen, etc.

- Being haploid, they generally do not survive.

(a) Physical stimuli: Unfertilized eggs are stimulated by needle pricking, electric shock, change in temperature (Heat and Cold), etc.

(b) Chemical stimuli: Urea, fatty acids, eather, chloroform, sugar, salts, alkaloids, change in pH, etc. are used to stimulate the eggs for division.
Q.7 Describe the mechanism of fertilization.

-Fusion of pronuclei of ovum and sperms is called fertilization. It may be external or internal.
-It occurs at the junction of ampulla and isthmus resulting in diploid zygote.
-On the basis of mode of reproduction, animals are of three types:
1. **Oviparous animals**: Fertilization external /internal, development external. *eg.* Egg laying animals and prototherians
2. **Ovo-viviparous animals**: Fertilization and development internal *eg.* Dog fish.
3. **Viviparous animals**: Fertilization and development internal, placenta is formed *eg.* Mammals.

-Ovum rests for some time in ampulla. Sperms are deposited in vagina.
-Mechanism of fertilization includes following processes:

1. **Approximation of sperms and ova**:
   - Ovum is collected by infundibulum with the help of fimbriae and it reaches to ampulla.
   - Sperms reach up to ampulla partly by swimming and partly by contraction of fallopian tube and uterus.
   - Sperm releases anti-fertilizin while ovum releases fertilizin, hence sperm is attracted towards ovum due to fertilizin and anti-fertilizin compatibility reaction.

2. **Capacitation**: It is preparation of sperm to fertilize the ovum.

3. **Acrosome reaction**: As sperm comes in the contact with corona radiate of ovum, the acrosome covering lyses to release hyaluronidase enzyme. It dissolves the coverings of ovum.

4. **Egg reaction**: Now egg develops a **fertilization cone or cone of reception**.

5. **Penetration of sperms**: -Now a sperm head enters into ovum through fertilization cone.
   - Depolarisation of egg membrane kills other sperms and plasma membrane is converted into fertilization membrane with the help of cortical granules (mucopolysaccharides) which prevents the entry of other sperms.

6. **Activation of ovum**:
   - Now secondary oocyte is transformed into ootid then into ovum and a second polocyte is released.

7. **Fusion of egg and sperm nuclei**:
   - Synkaryon is formed by karyogamy/syngamy. Proximal centriole of sperm helps to form spindle for the cell division.
Long Answer Type Questions:

Q.8 Describe in detail the structure and functions of pituitary gland.

- Pituitary gland + infundibulam is called pituitary body.
- Vesalius coined the term Pituitary but later on called as Hypophysis.
- Master gland: It is called master gland because it regulates metabolism and growth by controlling other endocrine glands.
- Shape and Size: Pea seed sized, 1.2-1.5 cm in diameter and ovoid
- Colour: Redish-grey in colour.
- Weight: 0.5 to 1.0 gm in weight in male and more in female depending on activity, sex and age.
- Location: It is attached to ventral wall of diencephalon (Hypothalamus) and lodged in the cavity of basisphenoid bone of skull (Sella turcica).
- Origin: It is neuro-ectodermal in origin.
- Down growth of diencephalone forms infundibulum which gives rise Neurohypophysis while Rathke’s pouch forms adenohypophysis and joins neurohypophysis forming pituitary gland complex.
- The anterior and posterior lobes are connected with the hypothalamus by hypothalamo-hypophysial portal system and by axons of hypothalamic neurons respectively.
- Structure:
  (1) Adenohypophysis: Consists of (a) Anterior lobe (Pars distalis) and (b) Intermediate lobe (Pars intermedia). Both are ectodermal in origin. (2) Neurohypophysis/posterior lobe: Neuroectodermal in origin
  (1) Adenohypophysis:
  - It comprises 75% of total pituitary. It contains pituicytes which comprise of (a) Chromophobes and (b) Chromophil cells. Pituitary gets blood supply through Circle of Willis.
  Hormones and Functions: Adenohypophysis secretes 07 hormones. All are proteinoids and are under the control of releasing and inhibitory factors secreted by hypothalamus (RH/IH).
  (1) Growth hormone (GH): Its secretion is stimulated by GH-RH and inhibited by GH-IH. It acts as an anabolic growth factor.
  (2) Prolactin (PRL): Secreted by PRL-RH and inhibited by PRL-IH. It is Hormone of Maternity which activates growth of breasts and mammary glands during pregnancy and secretion of milk.
  (3) Follicle stimulating hormone (FSH): It is secreted by FSH-RH.
  - It stimulates gonads for gametogenesis and stimulates ovarian follicles to secrete estrogens.
  (4) Luteinizing hormone (LH):
  - In male, it is secreted by ICSH-RH. ICSH stimulates interstitial or Leydig’s cells secrete testosterone for the development of secondary sexual characters.

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- In female, secreted by LH-RH. LH stimulates ovulation and development of corpus luteum in the ovaries which secrete progesterone. It helps in maintaining pregnancy.

(5) **Adrenocorticotropic hormone (ACTH):** It is secreted by ACTH-RH. It stimulates adrenal cortex to secrete group of hormones like glucocorticoids, mineralocorticoids and gonadocorticoids. Over secretion of ACTH causes **Cushing’s disease,** virilism, obesity, hyperglycemia, hypertension and glucosuria.

(6) **Thyroid Stimulating hormone (TSH):** It is secreted by the action of TSH-RH. It promotes growth and functions of thyroid gland.

(7) **Melanocyte Stimulating hormone (MSH):** Secreted from intermediate lobe under the control of MSH-RH and MSH-IH. It affects the functioning of melanocytes.

**Adenohypophysis irregularities and diseases**

(A) Hyposecretion:

(a) **Pituitary Nanism/Dwarfism:** Caused due to under secretion of GH childhood which retards body growth. Dwarfs who work in circus are called midgets which are usually sterile, intelligent and alertness are normal.

(b) **Acromicria:** The condition of normal body and intelligence but smaller hands, feet and face due to deficiency of growth hormone in later stage of development.

(b) **Pituitary myxoedema:** Caused due to under secretion of GH in adult. Body becomes fluffy due to subcutaneous deposition of mucous.

(B) Hypersecretion:

(a) **Gigantism:** Height is about 2.15 m, more often in man. Due to over secretion of GH in childhood which causes high growth rate. Limbs extraordinary long, due to abnormal elongation of long bones before fusion of epiphyseal plates.

(b) **Acromegaly:** Due to over secretion of GH in adult, causes unproportionate gigantism. Also causes hunchback condition (**Kyphosis**). Abnormal growth of hands, legs and face (especially lower jaw) but normal sized individual. Gorilla like appearance.

(2) **Neurohypophysis:** Comprises 25 % of total pituitary, neurosecretory in nature, contains neuroglial cells, stores ADH and oxytocin in Herring’s body which are synthesized in supraoptic and paraventricular nuclei of hypothalamus.

**Hormones and functions:**

(1) **ADH:** It controls the water absorption in nephrones.

- Low secretion of ADH causes Diabetes insipidus/Drinker’s disease (Polyurea- high amount of urine, hypotonic sugar free urine, several times a day (5l/day) accompanied with excessive thirst (Polydipsia) and dehydration.

(2) **Oxytocin:** It is known as birth hormone because causes labour pain and also called milk ejection hormone.

Q.9 Describe in detail the pancreas.

- It is known as sweet bread because spongy in nature and sweet in taste. It is an heterocrine or mixed gland because 98-99 % part is exocrine and 1-2 % part is endocrine.

- **Location:** It is located in the loop of duodenum.

- **Shape:** It is leaf like in structure.

- **Size:** It is 12-15 cm long.
**Weight:** It is about 60-90 gm.

**Colour:** Orange in colour.

**Origin:** It is endodermal in origin.

**Structure:** It is composed of pancreatic acini which secrete digestive enzymes and Islets of Langerhans which secrete hormones.

**Islets of Langerhans:** One million in number, each with 3000 cells, comprise about 1.5% of pancreatic mass, contains:

- **α- cells:** Secretes glucagon which helps in glycogenolysis.
- **β- cells:** Secretes insulin which helps in lipogenesis and glycogenesis.
- **γ-Cells:** Secretes gastrin which is similar to that of pyloric gastrin.
- **D- cells:** Secretes somatostatin. It retards secretion of insulin, glucagon and PP.
- **F- Cells:** Secretes pancreatic polypeptide (PP). It retards the secretion of SS.

**Alloxan:** Present in the roots of some plants, when taken with food destroys β-cells.

**Diazoxide and Phenytoin:** Compounds that destroy α-cells.

**Insulin**

- It is proteinaceous hormone. Secreted as pro-insulin by β-cells. It converts glucose into glycogen and lipids.

- **Schaefer (1912):** Coined the term insulin.
- **Banting (1923) and Best and Collip (1922):** Extracted pure insulin from the pancreas of newly born calf (Bovine insulin).
- **Tsan (1965):** Synthesized human insulin. Insulin is the first protein synthesized by a scientist in laboratory.

**A) Hypoinsulinism and Diabetes mellitus:**

- Causes Diabetes mellitus while experimented in dogs.

- **Hyperglycemia:** Sugar level in blood is elevated up to 300-1200 mg/100 ml of blood, and started to pass in urine.

- **Glycosuria:** With too much loss of sugars in urine, the required quota of carbohydrates is synthesized from the proteins and fats. Certain products of fat catabolism such as ketone bodies accumulated in the blood (causes acidity), all leading to a state of unconsciousness (Diabetic coma). Death follows in 2-3 weeks.

- 3-4% people inherit genetic trait for it.

- Diabetes causes Polydipsia, Diuresis, Dehydration, Polyphagia, Ketonemia, Ketonuria, etc.

- World Diabetes day; 14th November or 27th June

- Insulin injections are given to chronic diabetics (insulin dependent- insufficient insulin production) and to hypoglycemic (insulin independent-person's inability to use insulin)

- **Insulin shock syndrome:** Over secretion of pancreatic insulin or excessive intake of insulin by a diabetic patient causes hyper-insulinism leading to marked decrease in blood sugar as a result of which glucose and oxygen shortage occur in brain cells causes reduced nervous activity, such as weakness, sweating, anxiety, unconsciousness, and tremors, etc.

- Today human insulin as Humulin and Humalog are synthesized from bacteria (E. coli) using genetic engineering.

- Oral and pure insulin- Insugen is expected shortly by the use of genetic engineering and biotechnology

- Injury may result in gangrene (Dead tissues) - Blurred vision

**B) Hyperinsulism:** May be genetic defect - Hypoglycemia

- **Insulin shock:** Continuous excess of glucose in blood causes coma and then death. Injections of glucose, cortisol and adrenaline are given

**Glucagon**

- Discovered by Kimball and Murlin (1923)

- Secreted by α- cells, proteinoid in nature.

- Increases the level of glucose in blood during deficiency - Promotes deamination of amino acids and gluconeogenesis

- Hypersecretion may cause glycosuria - Promotes glycogenolysis in liver and passage of glucose into blood

- Glucagon has no effect upon muscle glycogen.
Q.10 Describe in detail the role of hormones in menstrual cycle.

-It is counted from beginning of one menstrual bleeding to the beginning of next menstrual bleeding.

-Menstruation: The periodic sloughing of the lining of uterus in the absence of pregnancy. Periodicity is of 28 days (menarche to menopause). It is characteristic of Primates, does not occur in other vertebrates. It is characterized by menses.

-Menses: Loss of blood along with cell debris and unfertilized egg.

-Menarch: On set of menstrual cycle, starts at the age of 13-14 years, Indicates puberty.

-Menopause: Stopping of menstruation at the age of 45-46 years.

-Absent during pregnancy and hyper secretion of prolactin.

Following phases:

1. Menstrual phase:
   -It starts on 28th day and lasts within 4-6 days. Menses takes place. Total blood loss is 50-100 ml.
   -Very low level of estrogen and progesterone stimulates pituitary to secrete FSH.

2. Post-menstrual Phase:
   -It takes place from 6th to 13th day of menstruation. Growth and maturation of Graffian follicles takes place.
   -Regeneration of endometrium, myometrium, blood vessels, glands and other tissues occurs by estrogens secreted by ovary and follicle cells of mature Graffian follicles.
   -Level of FSH is increased which stimulates one or two Graffian follicles to grow. It also stimulates follicle cells to secrete estrogens. Increased estrogens reduce FSH secretion and induce LH secretion.

3. Ovulatory phase:
   -Ovum in the stage of secondary oocyte is released from Graffian follicles into coelom on 14th day under the control of LH. Corpus luteum is developed. Hence best chance of pregnancy is in third week and least chance in first week of menstruation.

   -LH causes ovulation and formation of Corpus luteum (14th day)

4. Post-ovulatory phase:
   -It ranges from 15th to 28th day. Corpus luteum secretes progesterone in large amount to maintain pregnancy.
   -Corpus luteum degenerates, if no fertilization of ovum, into white mass- Corpus albicans.
   -Corpus luteum secretes progesterone (rises up to 22nd day) and declines to a very low level (up to 25th day).

   -Low level of estrogens and progesterone again stimulate FSH and LH secretion to repeat this cycle.

   -Amenorrhea: Absence of menstruation.

   -Dysmenorrhea: Painful menstruation with excessive bleeding.

   -Dormitory effect: Synchronisation of MC of women living together probably due to pheromones.

Q.11 Describe development of frog up to gastrula.

-Frogs are amphibious in nature. They lay eggs as spawn in the water, hence fertilization is external in water.

-Structure of zygote: Vitelline membrane surrounds the cytoplasm and yolk. In perivitelline space, polar bodies are present. In animal pole, cytoplasm and diploid nucleus is present. It is blackish in colour due to melanin. In vegetal pole, yolk is present hence appears whitish in colour. In between animal and vegetal poles, there is a less pigmented area known as grey crescent. It marks the position of dorsal lip of blastopore.

-Embryonic development:

1. Early cleavages: These are holoblastic and unequal. First cleavage is vertical forming two blastomeres. Second cleavage is also vertical but at right angle of first producing four equal blastomeres. Third cleavage is horizontal just above the equator producing eight blastomeres. Upper four cells are small and pigmented known as micromeres while lower four cells are large containing yolk are megameres. Further cleavages become irregular and micromeres divide faster than macromeres.

2. Morula: This stage does not occur in the development of frog.

3. Blastula: After irregular cleavages, a hollow ball like blastula stage is formed. It contains a fluid filled cavity known as blastocoels situated towards the animal pole. Roof contains micromeres and floor megameres.
(4) **Gastrula**: It is formed by the following processes:

(a) **Epiboly**: Micromeres divide rapidly and cover the megameres completely except at the region of blastopore at grey crescent.

(b) **Emboly**: It includes invagination and involution. Micromeres along with megameres invaginate and move inside the blasocoel resulting a new cavity formation known as archenteron which opens out side through blastopore. Archenteron finally replaces the blastocoels. Now roof of archenteron become two layers thick.

(5) **Yolk plug stage**: Floor of archenteron contains a mass of yolk cell visible through blastopore as yolk plug, hence gastrula is called as yolk plug stage. Lateral sides contain mesodermal cells, upper side ectodermal cells and lower side endodermal cells.