FISHERIES SCIENCE I

Endocrine physiology

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# Endocrine glands

* Endocrine system act as along with Nervous system
* Secrete hormones to regulate physiological and metabolic processes

- 3 types

\* steroid- testosterone, \*peptides- insulin, \*catecholaminesepinephrine

* Hormones is secreted in to blood, distributed all over the body and the action is only on the target organ
* It is a heterogeneous collection of organs
1. Pituitary gland
2. Thyroid gland
3. Adrenal gland
4. Corpuscles of stannius
5. Ultimobranchial gland
6. Urohypophysis
7. Pancreatic islets
8. Pineal organ
9. Sex organ
10. Intestinal mucosa



# 1.Pituitary gland or hypophysis

* Location- ventral surface of brain, below optic chiasma
* Derived from 2 different components
* Neurohypophysis- from the floor of the embryonic diencephalon
* Adenohypophysis- from the dorsal evagination of the ectodermal part of the buccal cavity- Rathke’spouch
* This pouch later loses its connection from the buccal cavity and remains permenantly connected to the neurohypophysis- infundibular stalk or neurohypophysial stalk- connection to the diencephalon
* Stella tunica – shallow depression in the sphenoidal area which protect ventral side of hypophysis



# structure

* Adenohypophysis- glandular part
* Neurohypophysis- neural part

AHP further divided into

1. Rostral pars distalis (RPD) or pro adenohypophysis- dorsal
2. Proximal pars distalis (PPD) or meso adenohypophysis – in between
3. Pars intermedia (PI) or meta adenohypophysis – distal end

NHP further divided into

1.Median eminence

2. Posterior pars nervosa



# Rostral pars distalis

* Anterior , smallest part of the AHP
* Made up of acidophilic cells- chromophils and cyanophils
* Some cells with non-granular cytoplasm which do not take any stain – chromophobes
* Most of them show follicular arrangement around the blood capillaries
* Functionally 2 type cells – corticotrophs (ACTH) and lactotrophs (prolactin)

# Proximal pars distalis

* Middle region , largest part
* Consist of acidophilic , cyanophilic and chromophobic cells
* No. of acidophilic cells reduce significantly during the spawning phase
* 2 type cyanophilic –small and large
* Functionally 3 type cells- thyrotrophs- thyrotrophins, gonadotrophsgonadotrophins, somatotrophs- growth hormones

# Pars intermedia

* Posterior end
* Composed of acidophilic , cyanophilic and chromophobic cells
* Cyanophils become degranulated during post spawning phase
* Amphibili cells- in some fishes- absorb both strains
* Produce melanophore dispersing (MSH) and contracting hormone (MCH)

# Neurohypophysis

* Composed of non- myelinated nerve fibres, originating from neural cell bodies in the hypothalamus
* Pituicytes – scattered ependymal and glial cells present
* Ultra structurally 2 type fibres- stainable and non- stainable
* Herring bodies- accumulated mass of neurosecretory materials present in the fibres
* Produce polypeptide hormones- vasopressin and oxytoxin
* Regulate osmoregulation , mating and egg laying

# Pituitary hormones are broadly 2 types

1. Control hormones – control the formation of other endocrine glands

• Eg:- thyrotrophins, adrenocorticotrophic hormones

2. Direct hormones- regulate specific enzymatic reactions in various body cells or tissue

Eg:- MSH or intermedin

• Gonadotropins use to stimulate spawning in economically important fishes

# Pituitary broadly classified into

* Platybasic – flat NHP & disc shaped AHP eg: Eel
* Lepto basic – round NHP & oval AHP eg:- trout

# 2.Thyroid gland

* Arises as a median evagination from the floor of the pharynx
* Connection to pharynx become disappears during development
* In Chlamydoselachii fishes, connection persist
* LOCATION varies considerably
* In cyclostomes- thyroid cells dispersed around ventral aorta, do not form any compact encapsulated structure
* In elasmobranchs- located ventrally at the bifurcation of ventral aorta
* In bony fishes- Under the first branchial arch of each side along the branchial arteries of the gills
* Thyroid cells migrate to liver, heart, kidneys, brain. Eye, gut,spleen and gonad - In dipnoi- above hyoid apparatus

# SHAPE

* Cyclostomes – follicular
* Elasmobranchs- compact structures
* Bony fishes- diffused small masses of follicles
* Dipnoi -pair of interconnected lobes
* Ophiocephaliforms – compact and encapsulated



# Histology

* Composed of a large number of follicles
* Each in the form of a hollow ball- consisting of a single layer of epithelial cells enclosing a fluid filled spaces
* Follicles vary in shape and size- bound together by connective tissue
* Highly vascular and surrounded by epithelial cells
* Height of the epithelial cells depends on secretory activity

# 2 type of epithelial cells

* Chief cells- columnar in shape
* Benstay’s cell or colloid cels – contain droplets of secretions
* Lumen of each follicle contain acidophilic or basophilic colloiddepends on secretory activity

# Thyroxine

* Iodinated derivative of tyrosine
* Production is under the control of thyrotropin from AHP
* Osmoregulation, nitrogen metabolism, migration carbohydrate metabolism, scale and bone formation, growth and feeding
* Thyroid hormone acting up on cerebral centers- increases sensitivity of olfactory centre- evoke normal feeding in fishes

# 3. Adrenal gland

* Adrenal cortex and adrenal medulla separately found in fishes
* In cyclostomes, adrenal cortex occur in the wall of cardinal veins
* In elasmobranchs, located between posterior lobe of kidney
* In bony fishes, in the cardinal veins
* In dipnoi, ventral surface of kidney
* Adrenal cortex or Interrenal tissue produces adrenocorticosteroid hormones
* Mineral corticoids- control osmoregulation
* Glucocorticoids- control metabolism of proteins and carbohydrates, antiinflammatoryreaction
1. aldosterone- regulate Na level
2. Cortisol
3. Cortisone
4. Corticosterone- protein and carbohydrate metaboilsm

-unde the control of ACTH of hypophysis

* Adrenal medulla or chromaffin tissue or suprarenal bodies
* In lampreys- in the form of strand along dorsal aorta
* In shark- associated with nerve ganglia
* In elasmobranchs- true adrenal position
* Produce adrenaline and noradrenaline
* Increase blood sugar content in times of sudden demands

# 4. Corpuscles of stannius

* Small nodular bodies attached with kidney
* Oval or round in shape – 0.15-6 mm in size
* In shark , flat white structure on the peritoneal surface of kidney
* Pink or white in colour , 1-10 in number
* Originated as outgrowth from the pronephric or mesonephric region
* Histologically an outer capsule of firous tissue and inner mass of columnar cells
* Renin regulate bp, osmoregulation, control electrolyte homeostasis by regulating kidney



# 5. Ultimobranchial gland

* Exciting invention in fish endocrinology
* Absent in cyclostomes
* Described by Van Bemmelen (1886)as suprapericardial bodies
* Also known as post- branchial bodies
* Modern term by greli (1905)
* Originated from epithelium of last gill pouch
* In Elasmobranch, located in the left side of pericardium
* In Teleosts, bilateral and located in the transverse septum between abdominal cavity and sinus venosus



* Composed of highly vascularised follicles, lined with columnar epithelium
* Some granular materials present in the follicle
* Covered by 2 type epithelial cells – dark nucleus, numerous mc and pale nucleus, less mc
* Calcitonin – regulate plasma Ca level by bone Ca resorption
* Under the control of pituitary

# 6. Urohypophysis

* Urohypophysis or caudal neurosecretory organ
* Present only in Elasmobranchs and teleosts
* Is in the form of a swelling at the posterior end or caudal end of spinal cord or in the wall
* Contain neurosecretory cells
* Large sized cells with enlarged axons
* Cells bodies- Dahlgren cells – located in the grey matter
* In Teleosts, axon terminate into small bulb – which store and release secretion
* In Elasmobranchs, no bulb
* Urotensin complex contains 4 components
1. Urotensin I – decrease bp
2. Urotensin II – increase bp
3. Urotensin III – enhance Na uptake
4. Urotensin IV – increase water transfer and contract smooth muscle of urinogenital system

# 7. Pancreatic Islets

* Composed both exocrine and endocrine parts
* Endocrinal part represented by Islets of Langerhans – separate from the pancreas – located near gall bladder or spleen or intestine – principle Islets
* Arise from the endodermal lining of embryonic foregut
1. Alpha or A cells – secrete glucagon
2. Beta or B cells - secrete insulin
3. D cells – function is not clear

# 8.Pineal Organ

* Situated nearby pituitary
* Consist of pineal sac, pineal thalamus ande pineal stalk
* Both photosensory and secretory in function
* Pineal sac- photoreceptive organ in fishes but also considered as an endocrine gland
* Gonadotropins – influence maturation of gonads
* Pinealectomy results in reduce growth rate and abnormalities in skeleton

# Sex gland

* Secretion by specialized cells of ovaries and testies
* Under the control of pituitary
* Necessary for maturation of gametes & ssc- breeding tubercles and colouration
* Secrete testosterone and estrogen
* Progesterone from corpora lutea control vitellogenesis , egg capsule formation and oviposition
* Oestradiol – development and maintenance of reproductive tract
* Relaxin – egg laying

# 10.Intestinal mucosa

* From anterior part of the small intestine
* Under the control of NS
* Secretin – affects flow of enzyme carrying liquids from pancreas
* Pancreozymin- accelerate flow of digestive enzymes
1. Pituitary gland- ACTH, Prolactin, Thyrotropins, Gonadotropins, Somatotropins, MSH, MCH, Vasopressin, &Oxytocin
2. Thyroid gland – Thyroxine
3. Adrenal gland – Aldosterone, Cortisol, Cortisone, Corticosterone, Adrenaline & Nonadrenaline
4. Corpuscles of Stannius – Renin
5. Ultimobranchial gland – Calcitonin
6. Urohypophysis – Urotensin complex
7. Pancreatic Islets – Glucagon & Insulin
8. Pineal gland – Gonadotropins
9. Sex glands- Testosterone, Estrogen, Progesterone, Oestradiol & Relaxin
10. Intestinal mucosa- Secretin & Pancreozymin

# Crustacean Neurosecretory system

* Nervous system & Endocrine system both work together
* Both synthesize & release special chemical agents
* Juxtacrine , paracrine, endocrine and autocrine
* Nerve cells produce materials – chemical messengers
* Locally acting or at a distance
* Many endocrine glands have a control over NS through their hormones
* Similarly endocrine organs also stimulated or inhibited NS
* Both ES & NS together is known as Neuro – Endocrine system



* Neurosecretory centre is found in association with optic ganglia – lies within the eye stalk

1. X- organs- best known neurosecretory centre

2 kinds – ganglionic & sensory pore

* In brachyurans , 2 X- organs fused to form to form a single structure
* In other crustaceans they are separated as group of neurosecretory cells
* Clusters of secretory neurons are found within the brain- in thoracic ganglia , esophageal connective ganglia & central commissure
* Neurosecretory cells are group of nerve cells capable of functioning as glands
* Granules of secretory nature originate in the nerve cell bodies and are moved along the axons to bulb like terminals
* Axon terminals end near blood vessels – act as storage and release centres – neurohormonal organs
* Eg:- neural lobe of pituitary, insect corpus cardiacum and crustacean sinus gland
* Neurohormones – polypeptides – chemical messengers released by neurosecretory cells
* Neurosecretory cells act as a link between CNS & endocrine organs
* Receive impulse from CNS and respond by releasing neurosecretions which stimulate or inhibit endocrine glands

2. Sinus gland – another best known neurosecretory centre – storage and discharge

* Build up of axonic ends packed in connective tissue & closely associated with rich vascular channels
* Act as reservoir for the storage & discharge of neurohormones
* Post commissural and pericardial organs – neurohaemal centersstore and discharge
* Secretion charged axons from oesophageal connective ganglia terminate in the post commissural organ
* Ventral ganglia liberate hormones to pericardial organs
* 3 Endocrine glands not composed of secretory neurons are found in crustacea
* Y organs – androgenic glands & ovaries
* Y organs – located in the antennary or maxillary segment – regulated by neurosecretion from eye stalk complex
* Androgenic gland located outside the testis , typically found along the vas deferens
* Induce primary & secondary sexual characters in male
* - controlled by neurohormones from the X -organ
* Androgenic gland hormones regulate spermatogenesis in males • Removal of AG delayed spermatogenesis
* If AG grafted into a female , ovaries transforms into testis – also appeared SSC of male
* if ovaries grafted into male without AG, they persist as functional ovaries
* When grafted into male with AG, acquire testicular structure
* In the absence of AG hormones , the gonad can become ovaries, but testicular differentiation requires the presence of this hormone
* Differentiation of germ cells is reversible regardless of their genetic constitution
* In hermaphrodites , AG present only during male phase of life cycle
* Reproduction is under the control of neuroendocrine system
* ovaries &androgenic glands regulate the differentiation of both male & female sexual characters
* Neurosecretion from ganglionic X organ – sinus gland complex inhibit ovarian maturation & secretory activity of androgenic glands
* Moulting hormone from Y organ is essential for normal differentiation of both ovary &testis
* Bilateral removal of ovaries in certain crustaceans result in the loss of SSC
* Removal of androgenic glands induced SSC of the female type in genetic males
* Extract of eye stalk with ganglionic X organ prevent ovarian enlargement