REPRODUCTIVE HORMONE IN CRUSTACEANS

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Introduction:

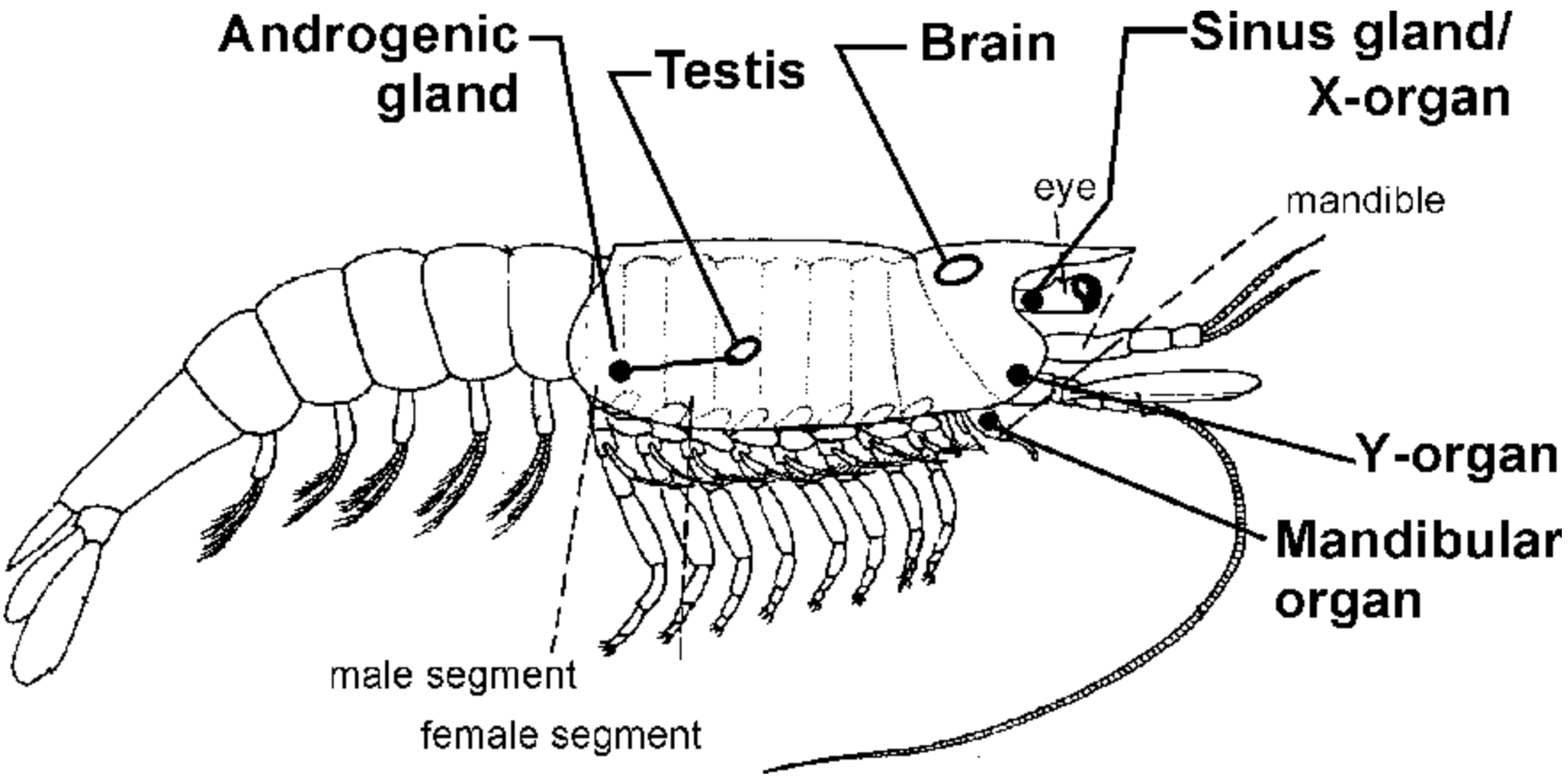
- One of the major problems preventing optimization of commercial culture of crustaceans – control of female reproduction (highly complex in penaeid shrimp).
- A no. of environmental signals can influence different hormonal factors which in turn regulate reproduction.
- Each species uses distinct environmental signals for timing it's reproduction, has a full range of neuronal structures for perception of signals, & uses a complex neuroendocrine system for transduction of messages to the endocrine organs, which themselves produce factors regulating the activity of the organs involved in reproduction.
- Reproduction in decapod crustacean is under the control of hormonal factors ie. GIH & GSH produced from various endocrine centres.
- However, the actual mechanism & hormones' working behind reproduction has not been properly revealed in any crustacean but eyestalk factors have been held responsible in controlling this process.

GLAND

- Group of cells that produces or secretes some chemicals
- 2 TYPES
- 1) Exocrine : release their secretion through ducts ,basically not utilizing the blood to deliver the product
- Eg. Liver, pancreas etc

2) Endocrine gland

- Ductless glands
- release their secretion directly into the blood stream where they can be further transported to cells in other parts of body.
- Endocrine system acts with nervous system to coordinate the body's activities



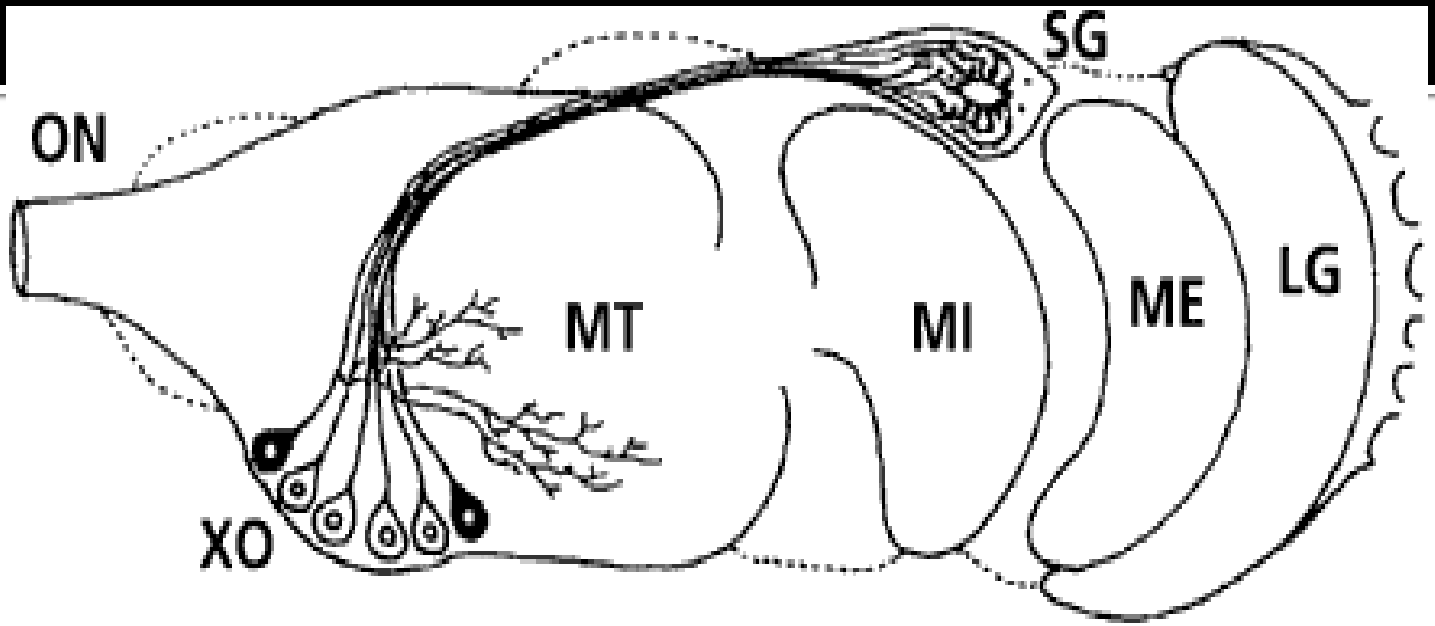
Endocrine glands in shrimp

X-Organ

- This is a specialised neurosecretory organ located in both the eye stalks.
- Optic peduncle has 3 ganglionic (A **ganglion** is a nerve cell cluster or a group of nerve cell bodies located in the autonomic nervous system and sensory system.) formations such as medulla externa, medulla interna & medulla terminalis
- X-organ are located in the medulla terminalis.

- The axons (the long thread-like part of a nerve cell along which impulses are conducted from the cell body to other cells.) of these secretory neurons and neurohaemal organ are together called sinus gland, which serves as a storage – release centre for these hormones.
- As the sinus gland serves for the storage and release of neurohormones secreted by secretary neurons of x-organ it is called "X- organ-sinus-gland complex

EYESTALK



Diagrammatic representation of the ganglia and the X-organ/sinus gland complex in eyestalks of decapod crustaceans (dorsal view). LG, lamina ganglionaris; ME, medulla externa; MI, medulla interna; MT, medulla terminalis; ON, optic nerve; SG, sinus gland; XO, X-organ.

Functions of X organ

- The X-organ secretes several neurohormones such as
- Ovary (gonad) Inhibiting Hormones (OIH/GIH)
- Moult Inhibiting Hormone (MIH)
- Light adapting hormone or distal retinal pigment hormone
- Hyper Glycemic Factor (CHH- Crustacean Hyperglycaemic Hormone)
- Erythrophore concentrating hormone &
- Neuro depressing hormone.

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- Out of these, OIH and MIH are directly involved in reproduction
- GSH : neuropeptide
- Growth Stimulating Hormone(GSH) is also known as Moult or Gonad Stimulating Hormone. It is secreted by the Thoracic ganglia.

Functions of GSH

- Stimualting the development of gonads, gametogenesis, energy conservation for spawning and prepartion of the animal for breeding.
- This hormone is believed to be a complex with more fractions responsible for the ion regulation and physiological control of the animal for breeding.

Y-Organ

- Located in the antennary / maxillary segment of the body anteriorly.
- It secretes a moulting hormone (ecdysone) which is a steroid hormone.
- The secretary activity of this gland is controlled by moult inhibiting hormone secreted by X-organ and secretion of mandibular organ.
- MIH inhibits Y-organ whereas secretion of mandibular organ will stimulate the gland.

- Molting: Regular phenomenon in crustaceans as it grows.
- Molt cycle: Divided into 4 phases-
- Premolt: Inorganic constituents of old exoskeleton reabsorbed & stored in gastroliths (constrictions in the stomach wall) or hepatopancrease + glycogen deposited in hypodermis + increased oxygen concentration indicating accelerated metabolic activity.
- Molt: Old cuticle sloughed off + increase in size of body due to rapid absorption of water /hydration.
- Postmolt: New exoskeleton formed due to redeposition of chitin and inorganic salts.

- Premolt & molt stages: Molting hormone (ecdysone) secreted by Y-organ.
- Post molt & intermolt stages: Ecdysone secretion stopped by molt inhibiting hormone of X-organ.
- During anecdysis (A prolonged period without ecdysis)(period between molts) Y-organ is greatly reduced (indicating dysfunction) resulting in lack of molting.

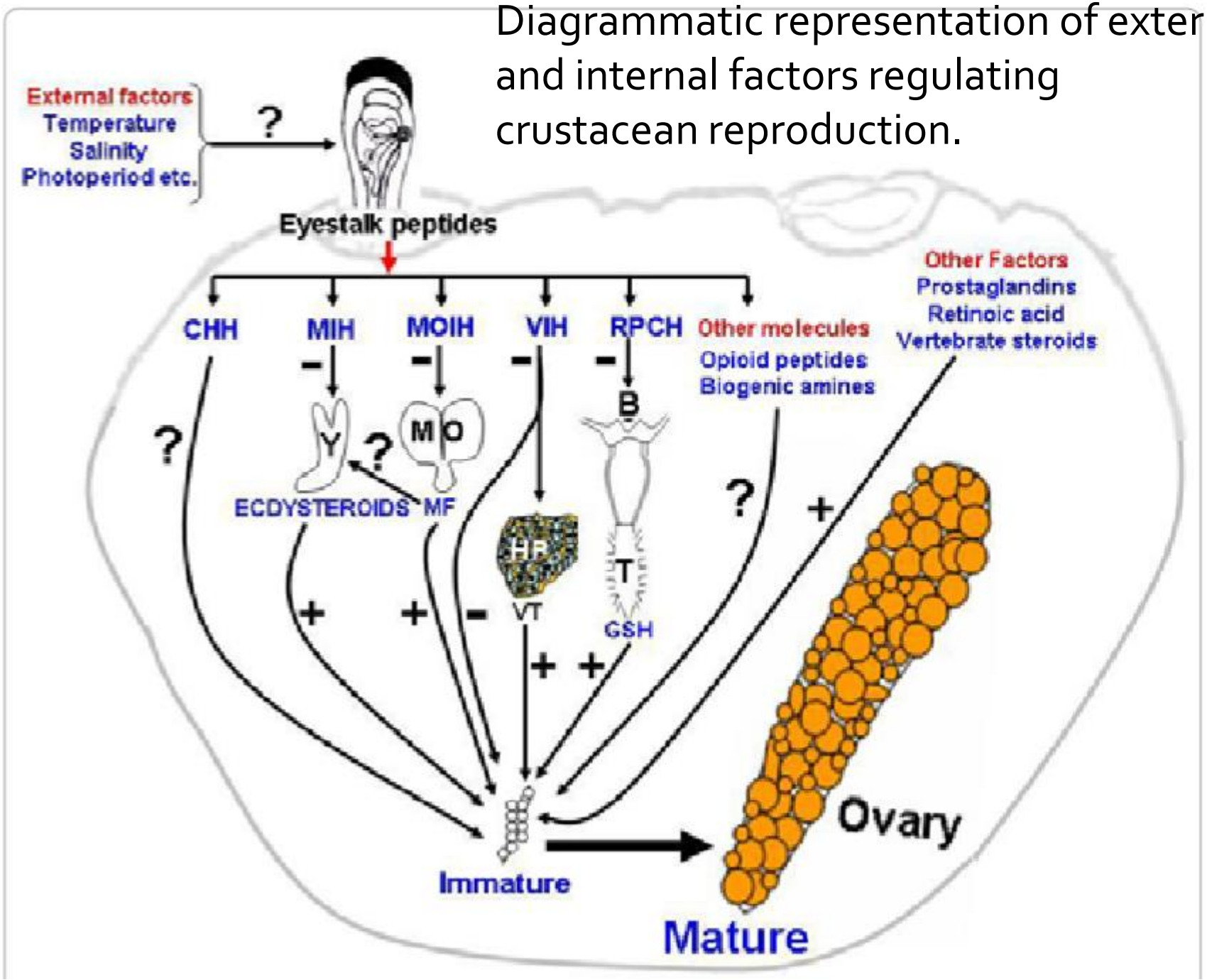
Mandibular Organ

- The mandibular organ in the crustaceans is similar to that of an endocrine gland in higher vertebrates.
- It secretes hormones or hormone like substances, that will have the influence on the reporducitve organs or reproductive process.
- It has been involved in ovarian growth and vitellogenesis.
- Mandibular organ synthesizes a substance called methyl farnesoate (MF) which is responsible for juvenile characteristics.
- MF has been shown to have stimulatory effect on Y-organ to secrete ecdysone.

Androgenic gland

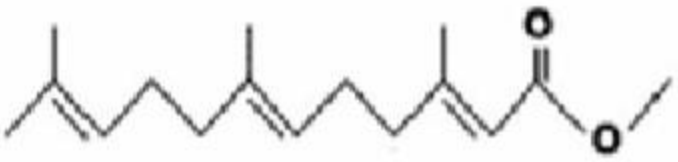
- Testes are said to have no endocrine role whereas the androgenic gland is shown to be endocrine in function.
- It controls male secondary sexual characters and spermatogenesis and responsible for masculine characters
- If androgenic gland is removed from a genetic male, it may develop ovary and change into a female. So, a genetic female can be changed to male by the transplantation of androgenic glands into females.

Diagrammatic representation of external and internal factors regulating crustacean reproduction.

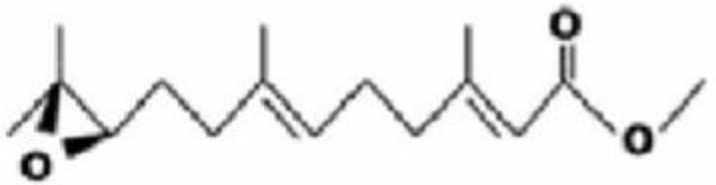


Ctnd from previous fig

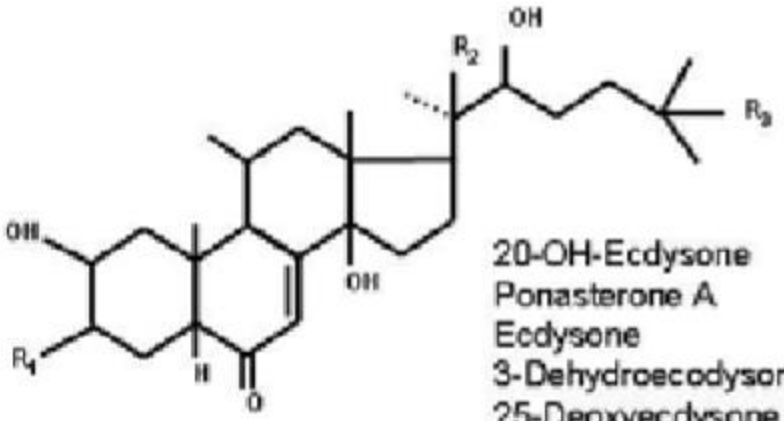
CHH: crustacean hyperglycemic hormone; MIH: molt-inhibiting hormone; VIH: vitellogenesis-inhibiting hormone; MOIH: mandibular organ-inhibiting hormone; RPCH: red-pigment concentrating hormone; GSH: gonad-stimulating hormone; MF: methyl farnesoate; B: brain; T: thoracic ganglia; Y: Y-organ; MO: mandibular organ; HP: hepatopancreas; VT: Vitellogenesis. + : stimulation; - : inhibition; ? = not established



Methyl farnesoate

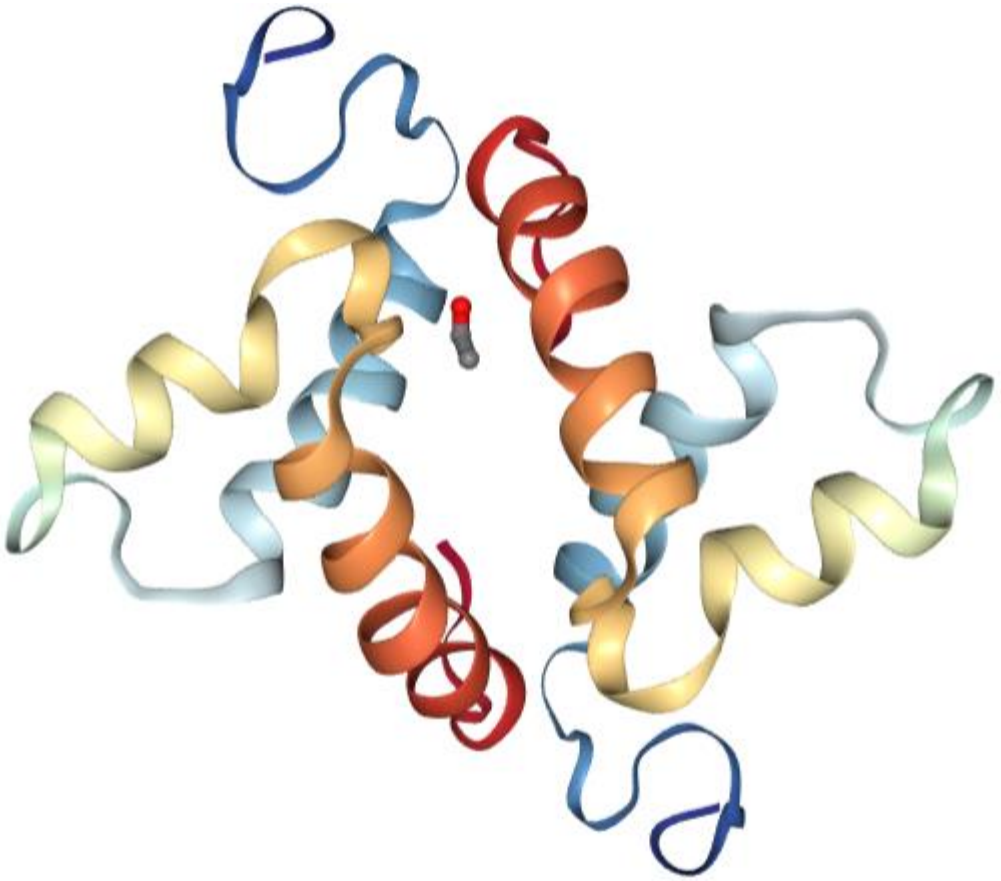


Juvenile hormone III

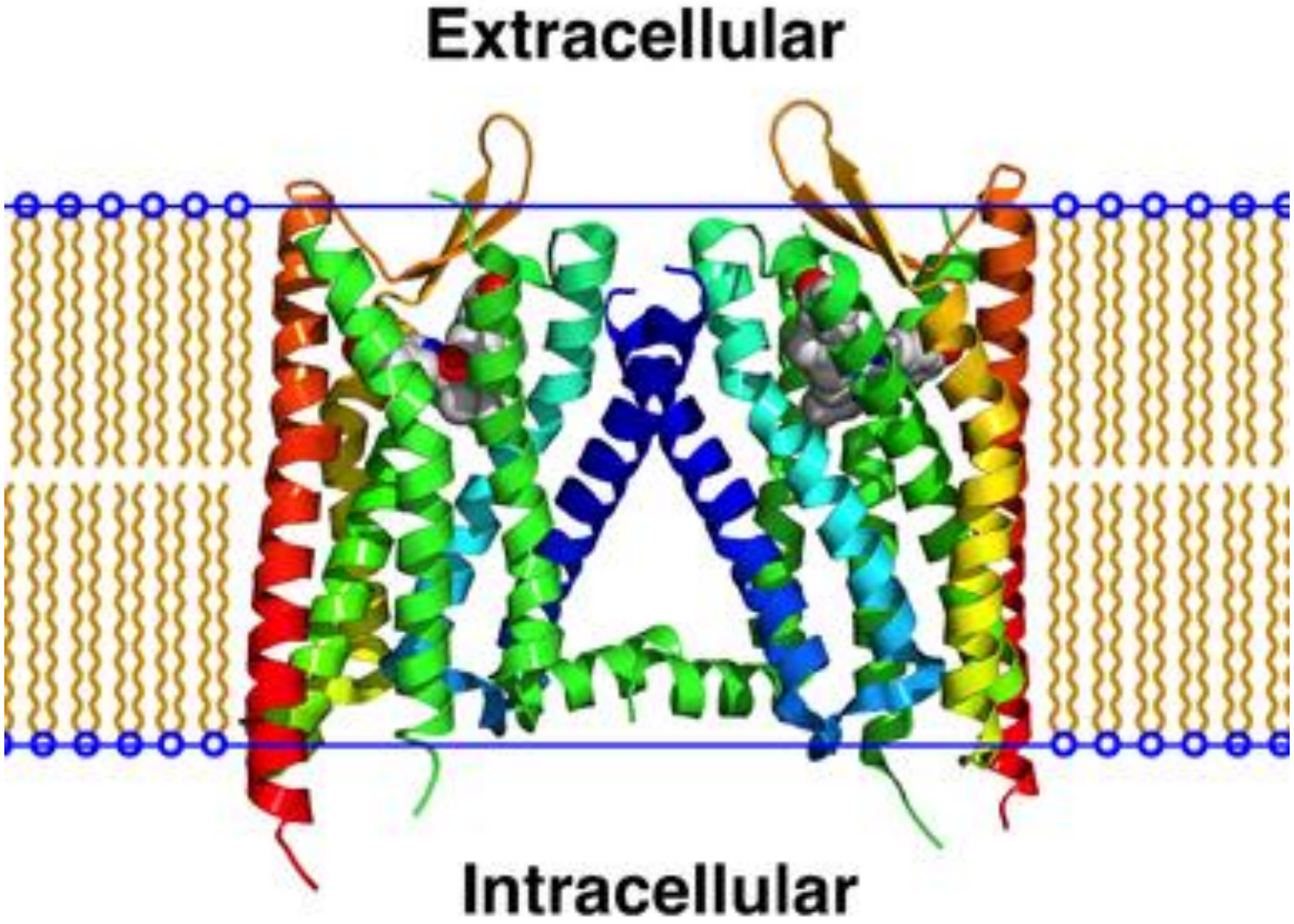


20-OH-Ecdysone	: $R_{1,2,3}$= OH
Ponasterone A	: $R_{1,2}$= OH, R_3= H
Ecdysone	: $R_{1,3}$= OH, R_2= H
3-Dehydroecodysone	: R_1=O, R_2= H, R_3=OH
25-Deoxyecdysone	: R_1= OH, $R_{2,3}$= H

Ecdysteroids



The crystal structure of a crustacean hyperglycemic hormone precursor from the kuruma prawn



A typical G- protein coupled receptor

Conclusion

- OIH or GIH of X-organ-sinus gland complex is reported to control the ovarian development.
- Ovary develops rapidly and undergoes vitellogenesis and maturation if MIH is inhibited.
- Because, of its specific role in vitelleogenesis it is called VIH (Vitellogenesis Inhibiting Hormone). It is for this reason that eye stalk ablation is practiced to induce ovarian maturation in crustaceans.
- During eye-stalk ablation X-organ sinus gland complex is removed along with the eye-stalk thereby the ovary is free from the inhibiting effect of OIH and MIH.

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- If the eye stalks are ablated, it deprives the body of these hormones, as the ovary inhibiting hormone is meant to inhibit the maturation of oocyte, once this gland is removed with eyestalk, the oocytes undergo maturation quickly .

- If both eye stalks are ablated, all the physiological activities controlled by other neurohormones of X-organ sinus gland complex shall be halted thereby adversely affecting normal physiology & growth, hence unilateral eyestalk ablation is preferred.

- **Vitellogenesis** (also known as yolk deposition) is the process of yolk formation via nutrients being deposited in the oocyte, or female germ cell involved in reproduction of lecithotrophic organisms. In insects, it starts when the fat body stimulates the release of juvenile hormones and produces vitellogenin protein.
- **Endocrine glands** are **glands** of the **endocrine**system that secrete their products, hormones, directly into the blood rather than through a duct. The major**glands** of the **endocrine** system include the pineal**gland**, pituitary **gland**, pancreas, ovaries, testes, thyroid **gland**, parathyroid **gland**, hypothalamus and adrenal **glands**.
- "**Androgenic**" is the adjective form of the noun "**androgen**," a word referring to any of the male hormones, including testosterone and androsterone. **Androgenic** development -- that is, the development of male characteristics -- begins in puberty.