GOVERNMENT OF ANDHRA PRADESH

COMMISSIONERATE OF COLLEGIATE EDUCATION

ENDOCRINE ORGANS, METAMORPHOSIS AND MOLTING IN SHELL FISH

AQUACULTURE

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LEARNING OBJECTIVES

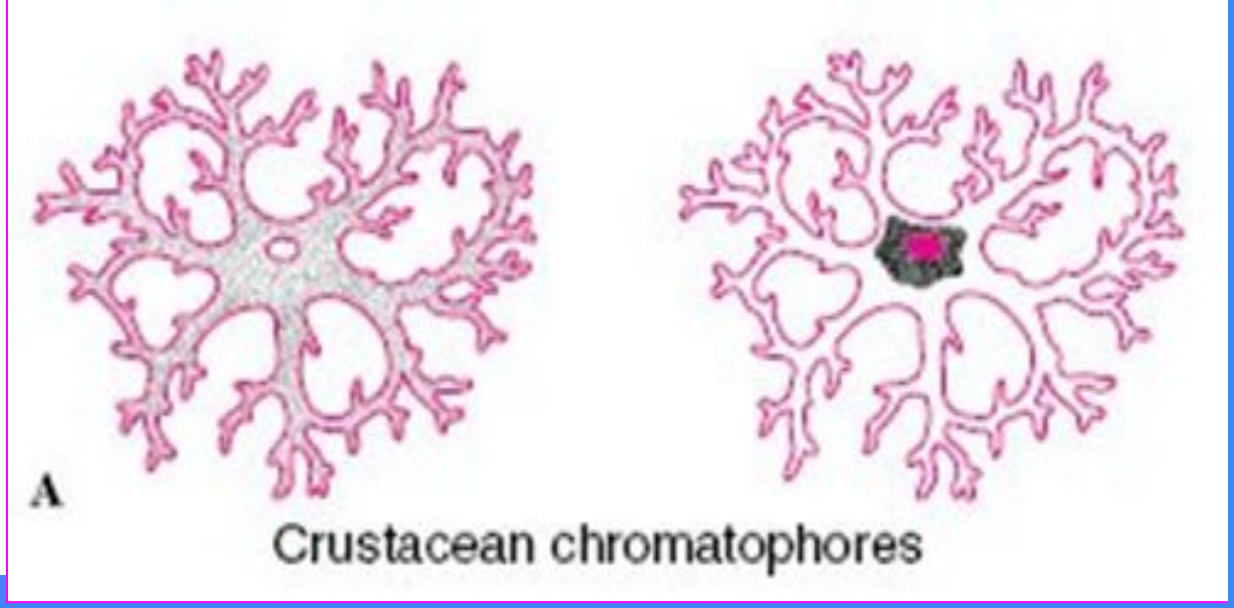
- Describe the structure of the cuticle
- Compare the anatomy of different larvae in shrimp development
- Outline the stages in the molting processes
- Explain the hormonal mechanism underlying the metamorphosis
- Apply the knowledge in domestication of the cultivable crustaceans
- Elucidate the relationship among various organs of endocrine system involved in the molting and metamorphosis

INTRODUCTION

- ★ Crustaceans provide rich and flavorful proteinaceous food
- ★ Global production of edible crustaceans is approximately 10 MMT as on 2019
- ★ Still production does not match growing world population
- ★ One of the reasons is limited availability of quality seed
- ★ Managing maturation of brood-stock is important for production of sufficient quantity of quality seed
- ★ Eyestalk ablation is in practice currently
- ★ Manipulation of neuro-endocrine system is a promising alternative

CHROMATOPHORES

- The specialized pigment cells with multiple branching processes
- They are present in epidermal cells and epidermal lining of internal organs
- The pigments synthesized are ommochromes, melanins, carotenoids, purines, and pterines
- Most species slowly change color as per the diet, developmental stage and season
- Rapid color change also occurs vis-a-vis background color, light intensity, or social context
- Many crustaceans can change coloration in response to exogenous or endogenous stimuli.
- Color change is under the control of Chromatotropins, the hormones of neuroendocrine system



Crustacean chromatophores

Melanophores

Erythrophores

Xanthophores

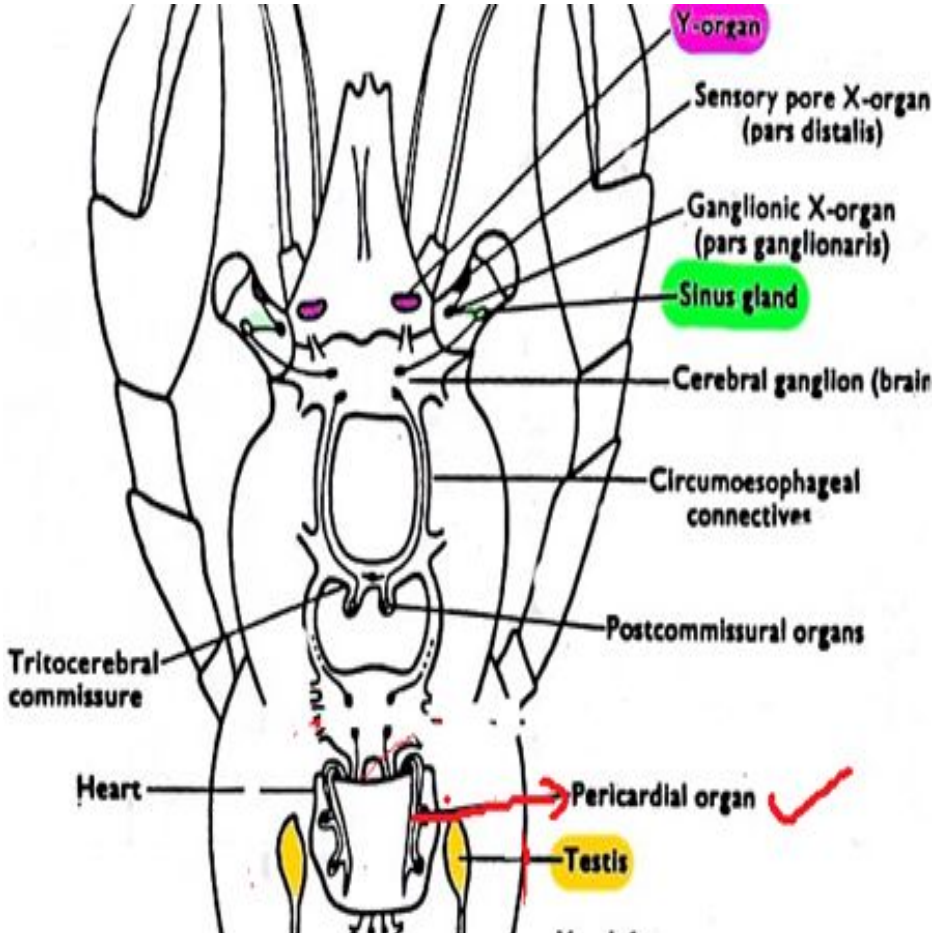
Iridophores

Leucophores

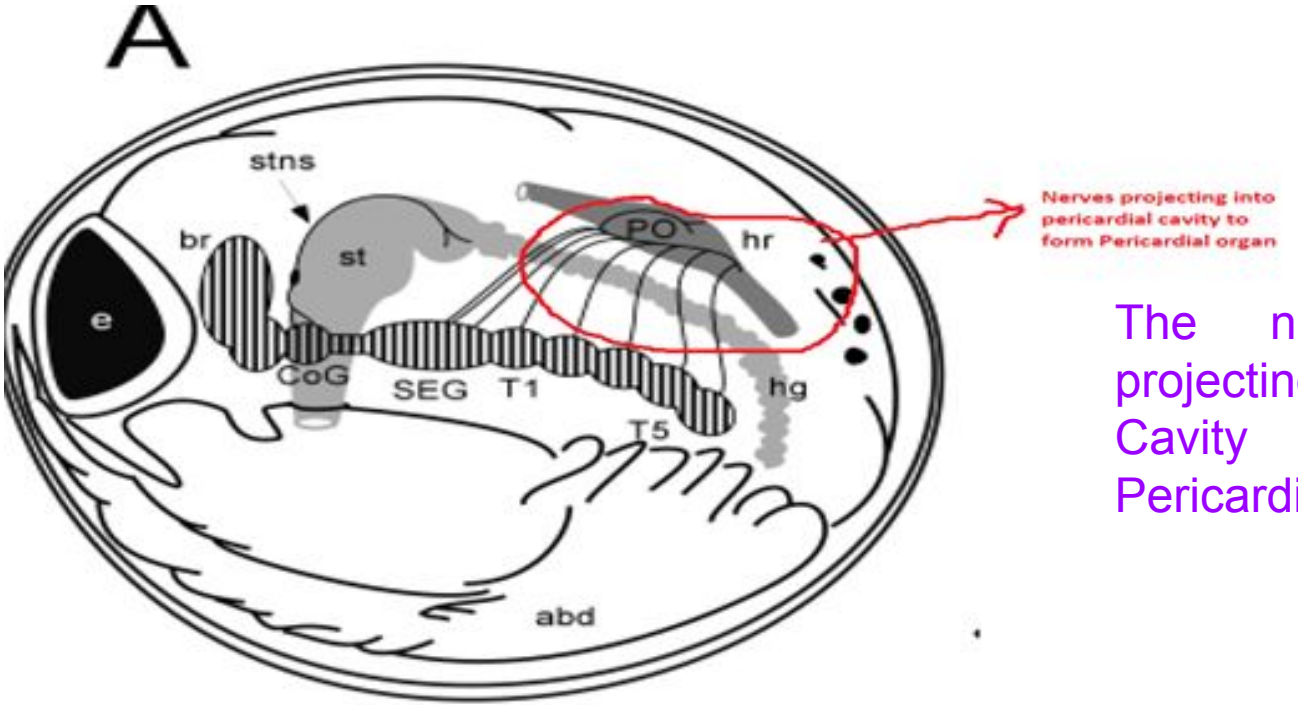
- These chromatotropins regulate the translocation of pigments and also the sensory mechanisms that lead to their differential release.
- Certain neurotransmitters - epinephrine, norepinephrine, dopamine etc - seem to control the release of chromatotropins

PERICARDIAL ORGANS OF CRUSTACEA

- ➔ Web like anastomosis on pericardial wall and heart ligaments
- ➔ Paired on either side of heart
- ➔ They are just nerves and ganglia
- ➔ Neurosecretory
- ➔ Secretions - neuromodulatory
- ➔ Cardio-excitatory
- ➔ Amine and Peptide in nature
- ➔ In Lobster, *Homarus americanus,* serotonin, dopamine, and cholecystokinin are present

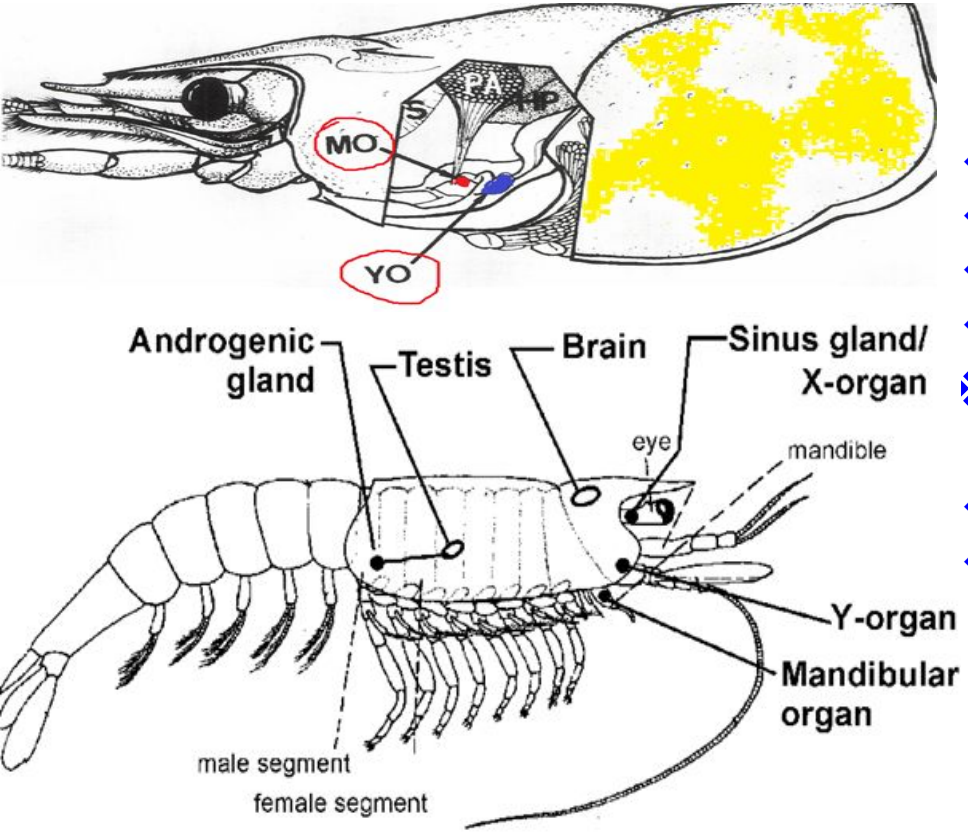


PERICARDIAL ORGANS CRAYFISH



The nerves which are projecting into the Pericardial Cavity form the paired Pericardial Organs

Y-ORGAN



Endocrine glands in shrimp

- Paired cephalic ecdysial glands
- Only in higher Malacostracans
- Secrete ecdysteroids/Molting Hormone
- Its activity is regulated by MIH
- MIH is secreted from the X-organ-Sinus Gland Complex
- Its function is molting
- Ecdysteroids, Methyl Farnesoate and Gonad Stimulating Hormone (GSH) promote reproduction and maturation of ovaries

Structure of the Cuticle

- Rigid - protection from predators & diseases
- Calcification occurs
- 4 layers - epicuticle, exocuticle, endocuticle and membranous layer

Epicuticle

- Thin(1-5 Microns), outermost, unmineralized & waterproofed by lipids

Exocuticle

- Mineralized/calcified with uneven distribution of minerals
- One-fifth of the entire integument
- Formed before ecdysis
- Mineralization occurs after ecdysis

Exoskeleton/Cuticle

Endocuticle

- Thickest calcified layer of all
- Formed after ecdysis
- Chitin-protein complex in lamellae form

Chemical Composition of Cuticle

- Major components - Chitin, Proteins and Calcium Carbonate
- Minor components - Proteoglycans, lipids and other inorganic materials
- Calcium carbonate - Calcite crystals, amorphous calcium carbonate
- Calcite reduces flexibility and elasticity reduces flexibility and elasticity
- Chitin forms a scaffold of framework for Calcium carbonate deposition
- Magnesium, Phosphorus, Sulphur may also be present in trace quantities as the salts

STAGES OF MOLTING PROCESS

Post-molt

- Post ecdysis
- Increase in the influx of water - gills, gut, epidermis
- Only epicuticle and endo cuticle are seen in this stage
- With in hours endocuticle forms

Inter-molt

- Cuticle becomes harder with mineral and protein deposition
- Weight of the animal increases by 3-4%

Exoskeleton/Cuticle

STAGES OF MOLTING PROCESS

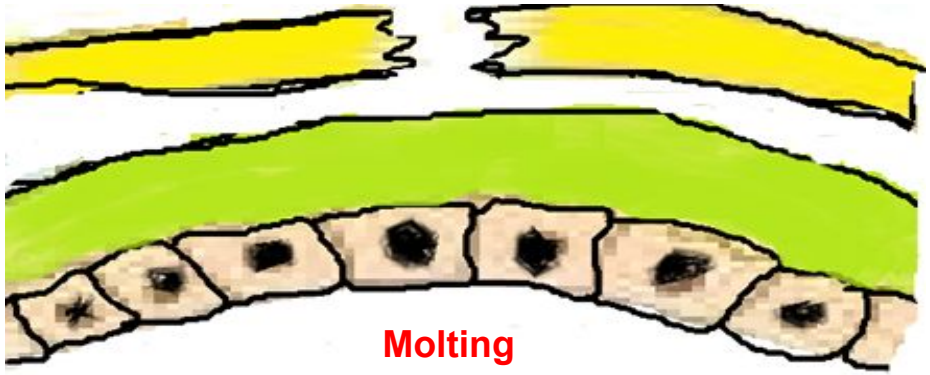
Pre-molt

- Titre of Ecdysone increases
- Old exoskeleton separates from epidermis
- Hypertrophy of epidermis
- Secretion of exocuticle and epicuticle
- Feeding declines and ceases by the end

Apolysis - separation of epidermis from the cuticle

Molt

- Very short period
- Old exoskeleton opens at the junction of thorax and abdomen
- Cuticle hardens after a few hours



Molting

METAMORPHOSIS IN DECAPOD CRUSTACEANS

➔ Penaeid shrimps pass through 4 stages in life cycle - nauplius, zoea, Mysis and PL

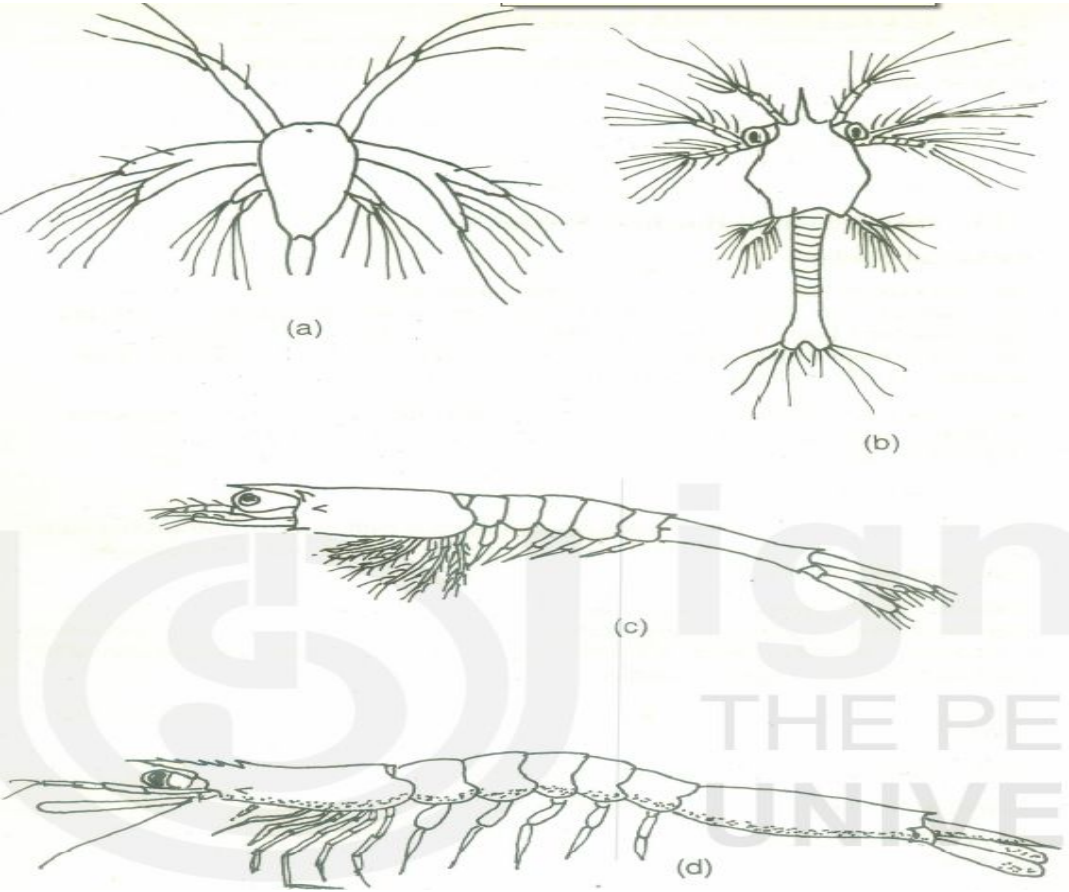
Naplius: Pear shaped, 3 pairs of appendages
- No digestive tract and mouth, feeds on yolk
- Swim with the help of antennae and mandibles intermittently
- Six sub-stages differentiated with the help of number of spines on furca
- From one stage to the other - 24 to 48 hours
- The nauplius molts into Zoea in 24-48 hours

Zoea:
- Continuously swims with the antennae
- More elongated
- Digestive tract, feeds on unicellular algae - filter feeding
- Three sub-stages last 24-48 hours depending on temperature and feed available

Mysis:
- Swims with the help of abdomen and head down
- Three sub-stages run 24-36 hours
- Feeds on phyto & zooplankton

PL:
- Resemble adult
- Setae first appear
- Feed on zooplankton and dead-organisms
- Like to attach to solid surfaces

STAGES OF CRUSTACEAN METAMORPHOSIS



(a Nauplius (b) Protozoea (c) Mysis (d) Post Larva

SUB-STAGES IN CRUSTACEAN METAMORPHOSIS

Table 7.1: Life span and identification features of larval stages of *P. mondon*

Stage	Life span	Identification Features
Hatching	12-15 hrs. after spawning	Furcal spines 1+1, the setae on appendages are not plumose
NI	5-6 hrs.	Furcal spines 1+1, the setae not well developed
NII	5-6 hrs.	Furcal spines 1+1, the setae on appendages are plumose (well developed)
NIII	5-6 hrs	Furcal spines 3+3
NIV	5-6 hrs.	Furcal spines 4+4
NV	5-6 hrs.	Furcal spines 5+5
NVI	15-20 hrs.	Furcal spines 6+6 then 8+7
ZI	1½-2 days	No eye stalks
ZII	1 day	Stalked eyes
ZIII	1½-2 days	A pair of biramous uropods and dorsomedian spines on abdomen
MI	1½-2 days	Rudiments of pleopods (Mysis swims with its head down)
MII	1day	Unsegmented pleopods with terminal setae
MIII	1½-2 days	Segmented pleopods with terminal setae
PL1	1day	Segmented pleopods with setae all over (post larvae swim horizontally)

MOLTING Vs. METAMORPHOSIS

- ➔ Given the hardened exoskeleton, growth proceeds through a series of molts only
- ➔ In some crustaceans(crayfish), growth from juvenile t adult involves no dramatic changes. But only size changes
- ➔ In others (shrimp), change of form also occurs along with molting at several stages (metamorphosis)

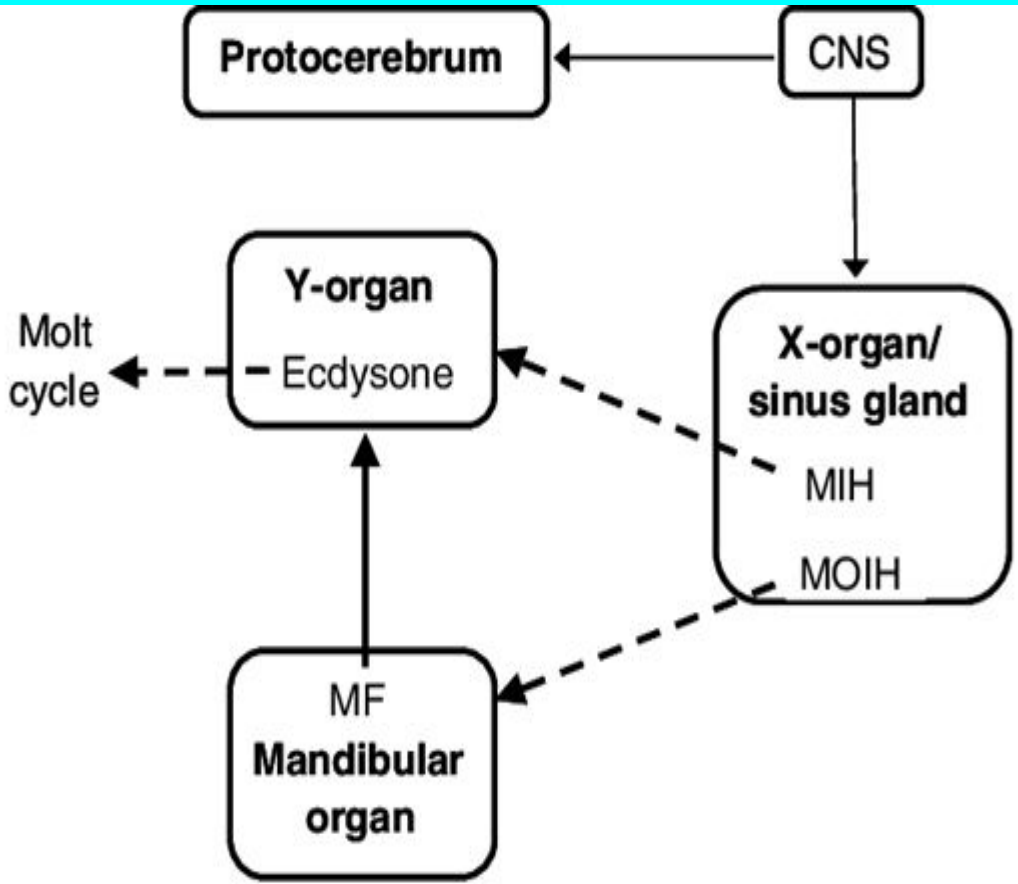
HORMONAL CONTROL OF METAMORPHOSIS

- Endocrine system consists of major control center called X-organ-Sinus Gland complex.
- It is located in eye-stalk.
- X-organ produces hormones like MIH which are stored and released by Sinus gland, a neurohemal organ
- MIH is part of a family of Crustacean Hyperglycemic Hormones
- Y-organs are non-neural - MH

HORMONAL CONTROL OF METAMORPHOSIS

- ➔ Mandibular Organs which synthesize MF - Methyl Farnesoate - has role in vitellogenesis and stimulating the secretion of MH
- ➔ Other hormones like CCAP - Crustacean Cardio Active Peptide, a neuropeptide - play role in ecdysis
- ➔ All these hormones are crucial in maturation process
- ➔ Only MH, MF and GSH are non-eyestalk hormones involved in the maturation of ovaries.
- ➔ External Factors like temperature, salinity, pH, food availability and heavy metals in the pond regulate ovarian maturation through endocrine route

HORMONAL CONTROL OF METAMORPHOSIS



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