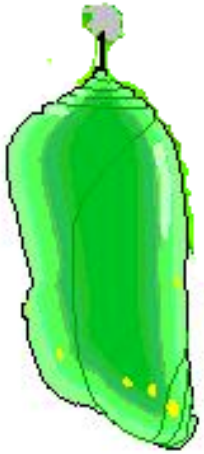
Metamorphosis in Insects



Insect life cycle

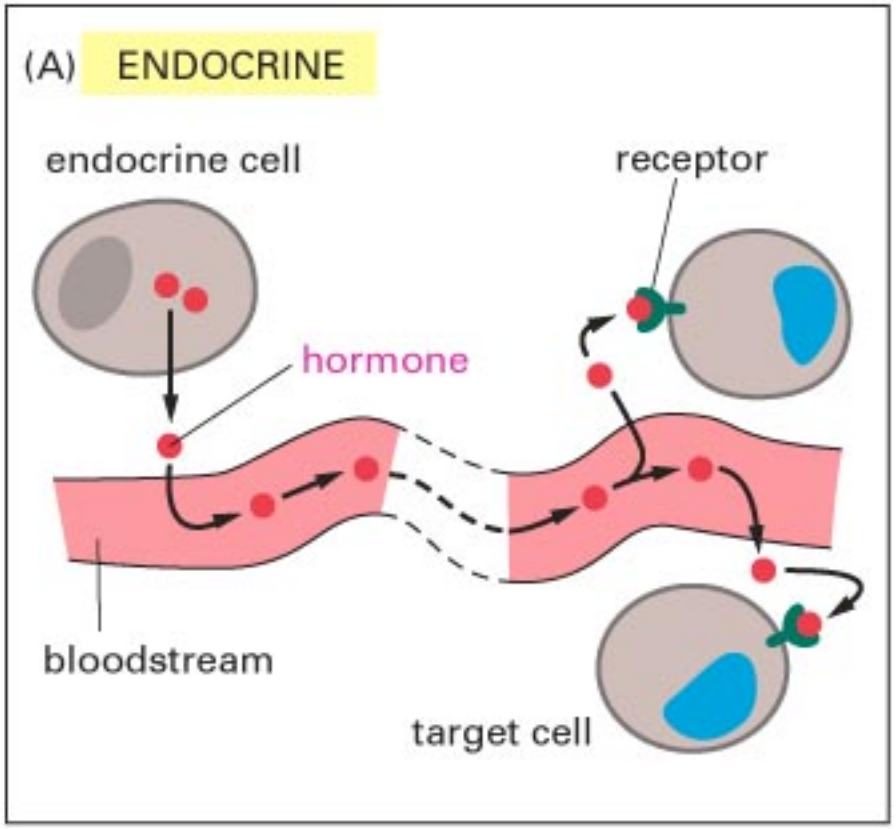
Development from egg to adult and again
to egg represents one life cycle or Generation

ENDOCRINE- describing or relating to any gland or other group of cells that synthesizes hormones and secretes them directly into the blood, lymph, or other intercellular fluid

Endocrine cells release protein and non-protein hormones

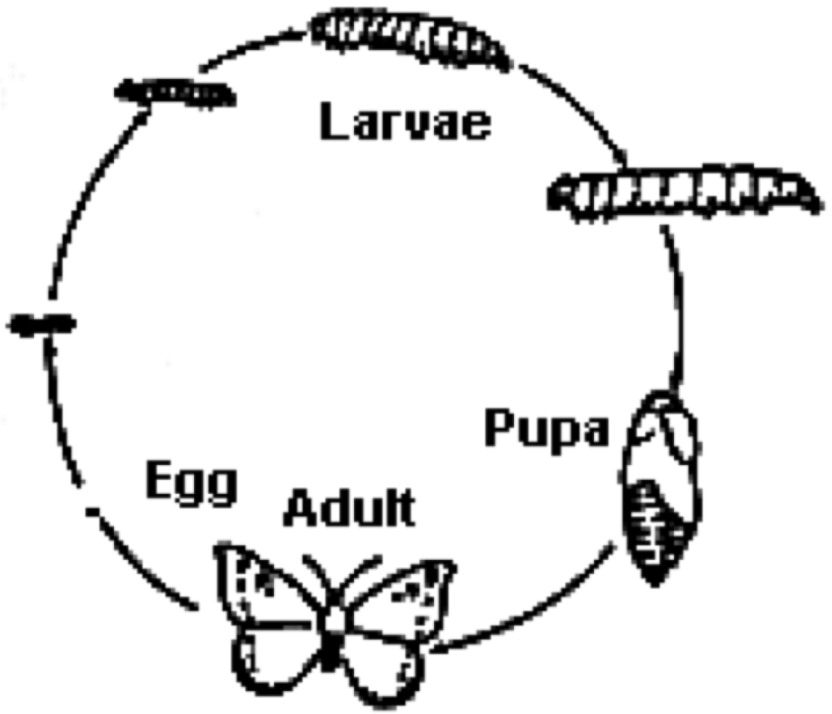
Synthesis of hormones is orchestrated by the CNS

Hormones effects are tissue dependent



Metamorphosis in Insects

The transformation of an immature insect from a larva to a pupa to an adult



Evolution of Metamorphosis

Complete metamorphosis occurs only in higher insects; it evolved only once

Early expression of juvenile hormone suppresses the development of adult characteristics

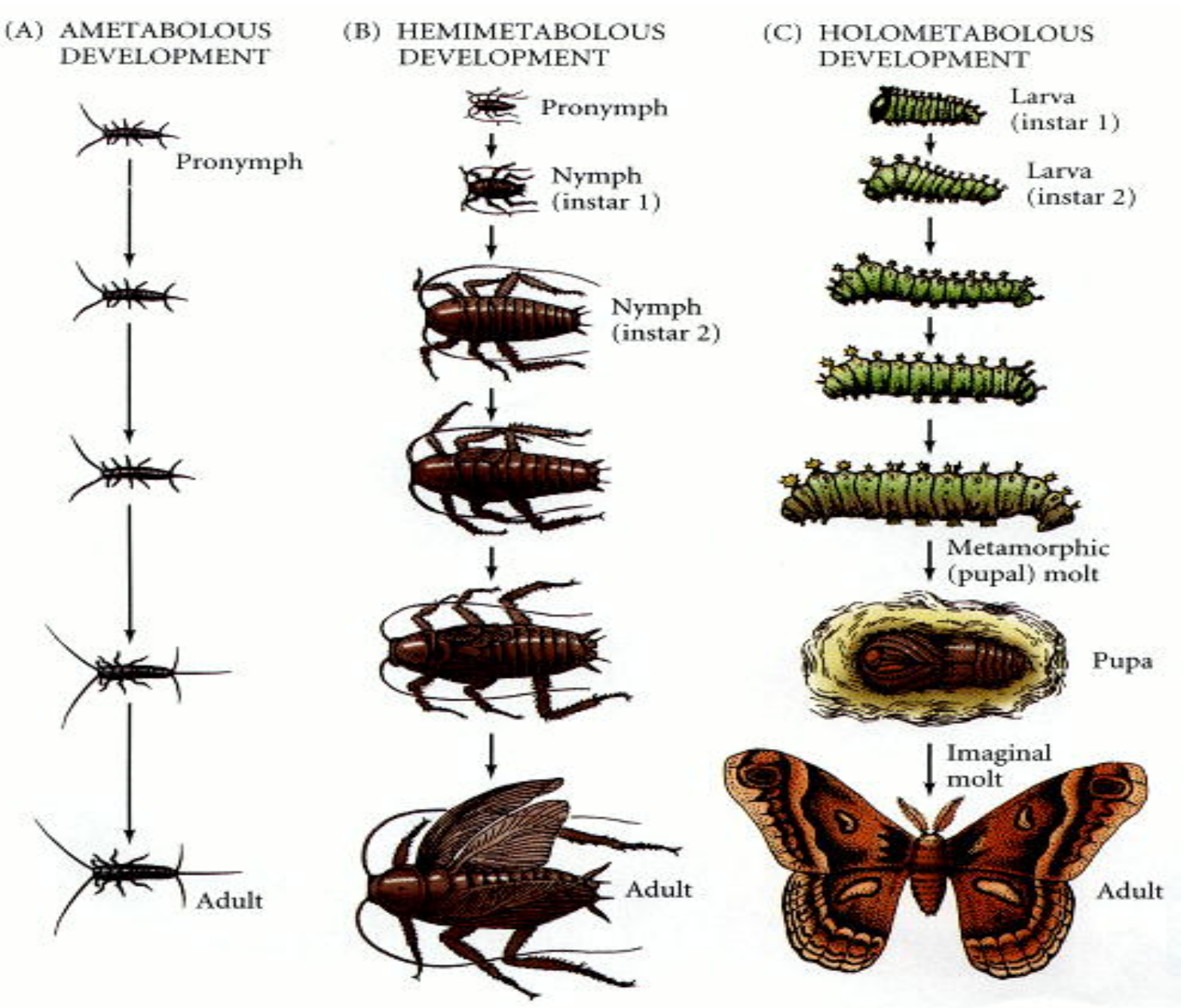
Larval and adult forms can occupy different environments and consume different food sources

Lack of competition between larva and adult allows species success and diversification

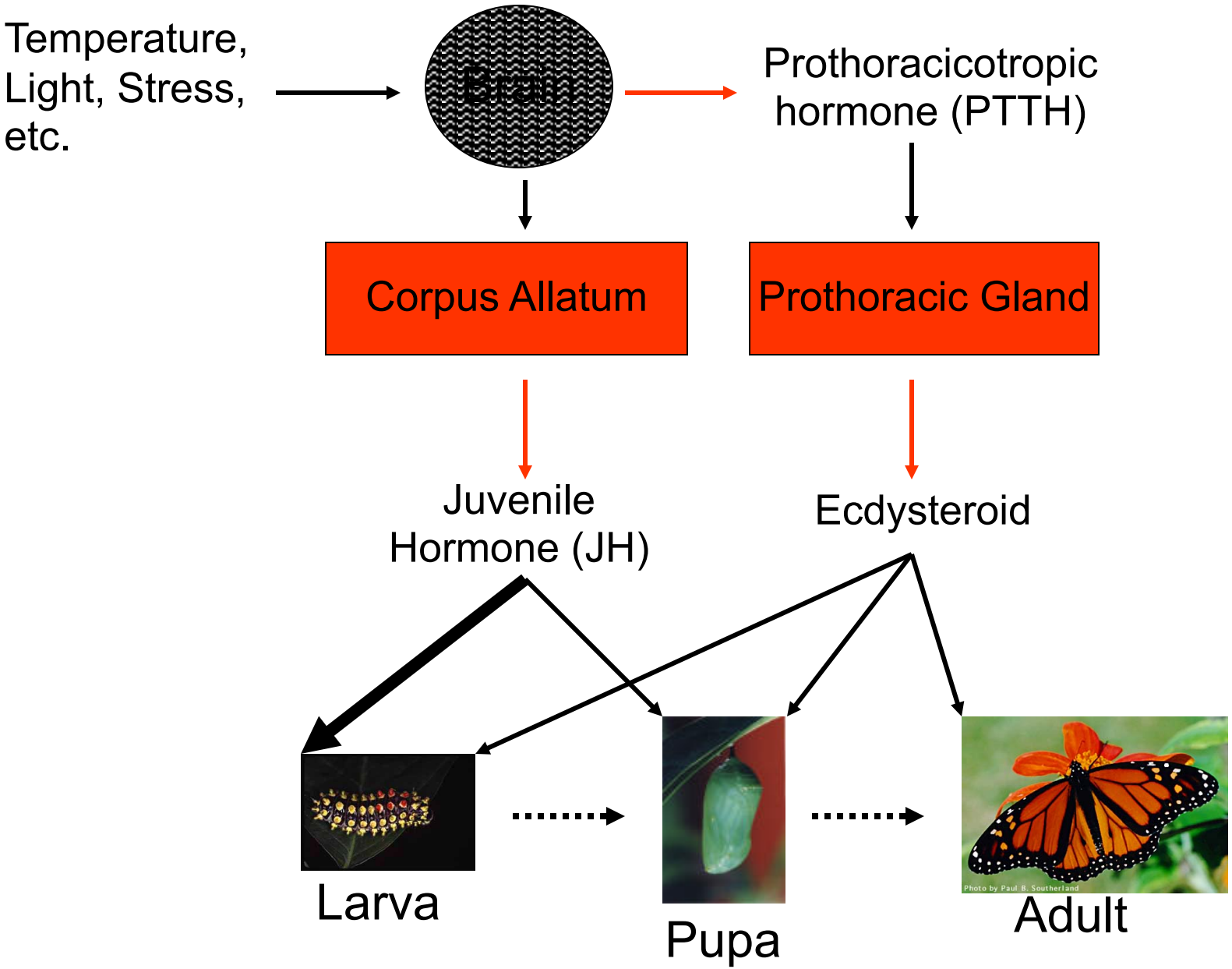
Metamorphosis can serve as a model for understanding how shifts in protein production can create different body forms

There are four basic types of metamorphosis in insects.

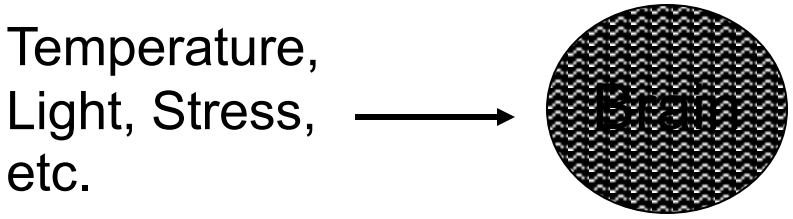
- No metamorphosis
- Gradual metamorphosis (Paurometabola)
- Incomplete metamorphosis (hemimetaboa)
- Complete metamorphosis


(A) AMETABOLOUS DEVELOPMENT
Pronymph
Adult
(B) HEMIMETABOLOUS DEVELOPMENT
Pronymph
Nymph (instar 1)
Nymph (instar 2)
Adult
(C) HOLOMETABOLOUS DEVELOPMENT
Larva (instar 1)
Larva (instar 2)
Metamorphic (pupal) molt
Pupa
Imaginal molt
Adult

Hormonal Control of Insect Metamorphosis



Control of Metamorphosis by Internal and External Factors



Temperature (day degrees)

Critical size matched (availability of food)

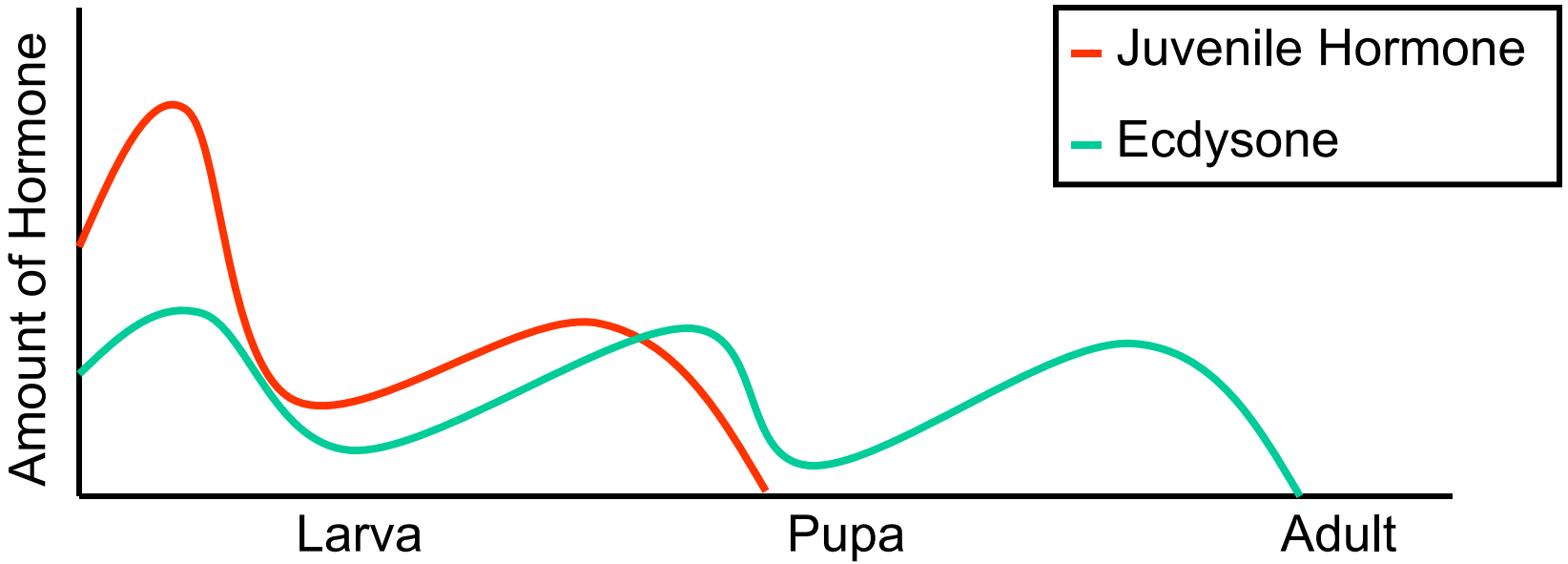
Light (photoperiod)

Chemicals

Amount of moisture

Stress: mutagens, predators, etc.

Regulation of JH Levels

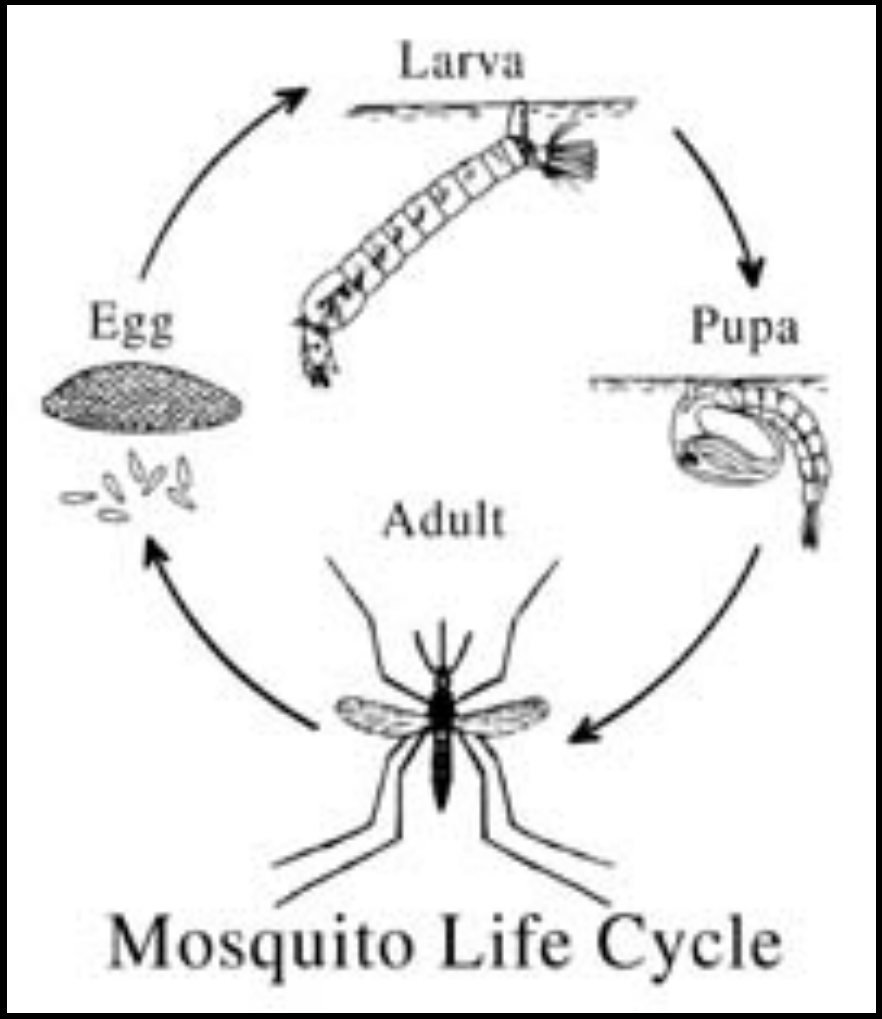


Low = larva stage; Medium JH levels = pupa stage; No JH = adult stage

Rate of release limited by synthesis

Amounts of JH also regulated by protein degradation and methyltransferase levels (can be protected by JH binding proteins, degraded by JH esterase)

Which Stage would You Target?



Insect control by targeting metamorphosis

Juvenile hormone mimic: Keep insects in larval stage

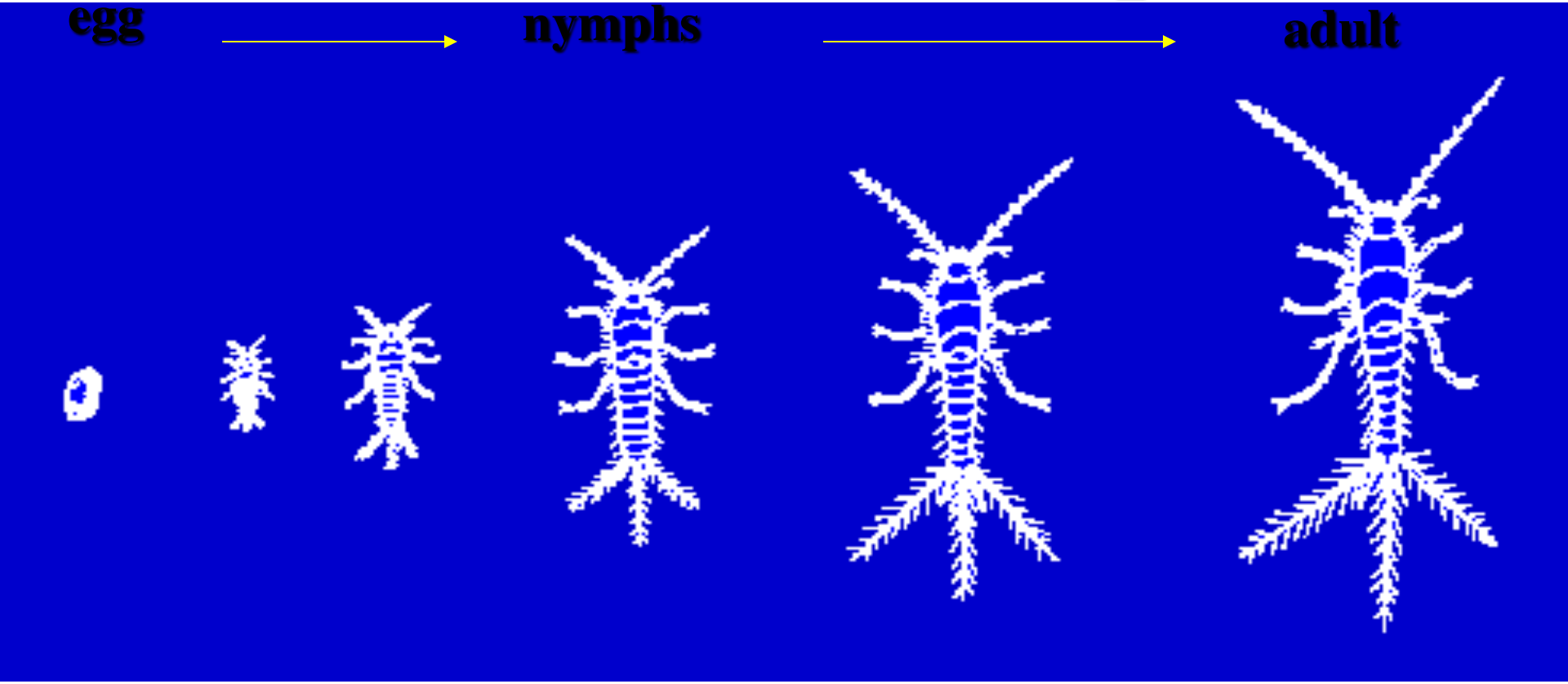
-- Effective control for insects such as mosquitoes

Juvenile hormone antagonist: Cause death of larva or early metamorphosis

-- Effective control for crop pests such as hornworm

Genes for juvenile hormone binding hormone and JH esterase have been identified

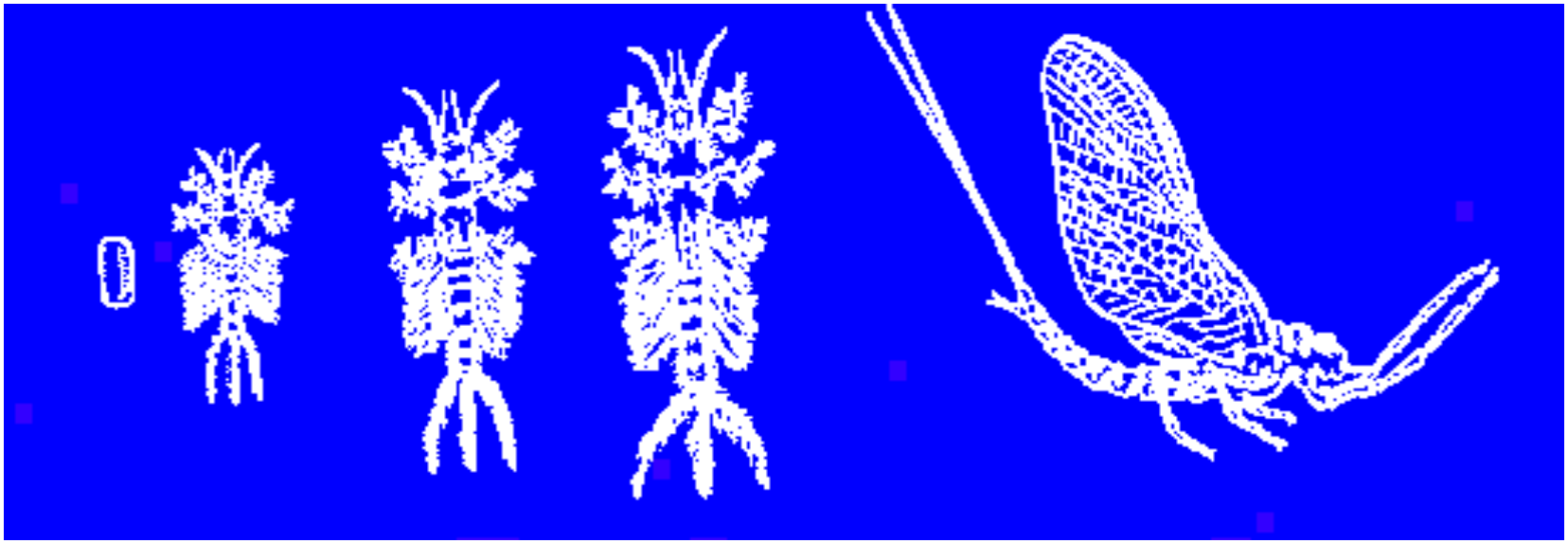
Without Metamorphosis



The first type is "without" metamorphosis which the wingless primitive orders such as silverfish (Thysanura) and springtails (Collembola) possess. The young resemble adults except for size.

Incomplete Metamorphosis

egg → **naiads** → **adult**

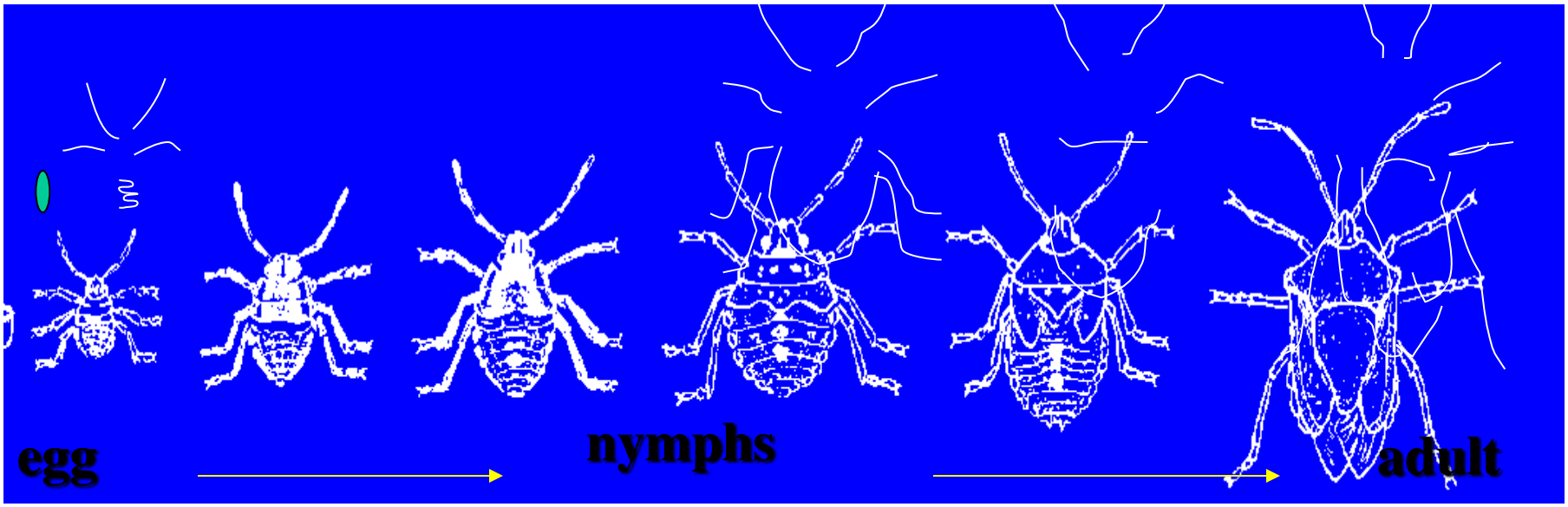


The second type is "incomplete" metamorphosis which is found among the aquatic insect orders such as mayflies (Ephemeroptera) and dragonflies (Odonata).

Gradual Metamorphosis

The third type is "gradual" metamorphosis seen in such orders as the grasshoppers (Orthoptera), termites (Isoptera), thrips (Thysanoptera), and true bugs (Hemiptera). This life cycle starts as an egg, but each growth, or nymphal stage looks similar, except it lacks wings and the reproductive capacity that the adult possesses.

Gradual meta



Complete Metamorphosis

The fourth type is "complete" metamorphosis found in butterflies (Lepidoptera), beetles (Coleoptera), flies (Diptera), and bees, wasps, and ants (Hymenoptera). This life cycle has the four stages of egg, larva, pupa, and adult. Each stage is quite distinct.