# CHEMICAL CO-ORDINATION

## ENDOCRINE GLAND IN CRUSTACEAN

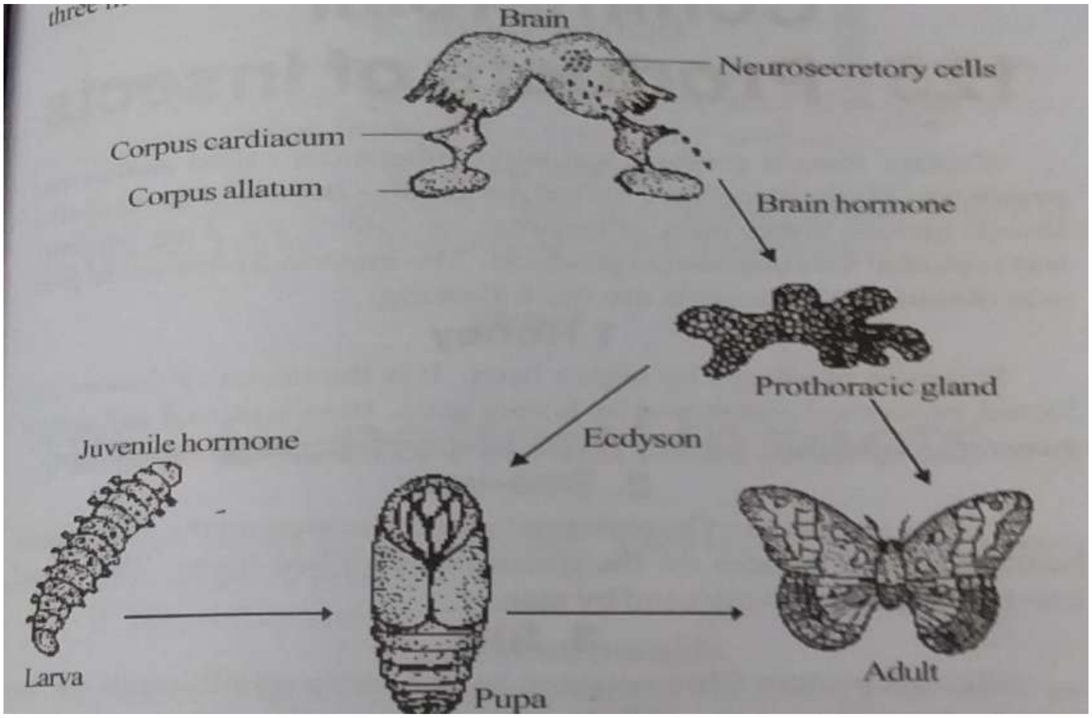
- The sinus gland at the base of the eye-stalk is known to h a number of hormones. They are supposed to control the spread of pigment in the chromatophores of the epidermis and in an compound eyes.
- They also seem to have some regulatory power over moulting and affect the deposition of lime salts in the eskeleton. The blood probably distributes the hormones like the higher forms.
- The exact mechanism by which the physiological processes are carried out is still very obscure.
- Extensive research indicates that there is an **X-organ** in the **eye-stalk** along with the **sinus gland**.
- Neurosecretory cells in the **X-organ** and in the **brain** produce a **moult-preventing hormone** which is stored in the **sinus gland** . Example -Palaemon

    - When eye-stalks are removed experimentally from a non-moulting specimen, moulting will occur in a few days because the inhibiting effect of the hormone is removed ;
    - when eye-stalks from non-moulting specimen are implanted into the body of an eye-stalkless specimen, moulting is delayed.
    - A **Y-organ**, which produces a moult accelerating hormone, has been described in some crustaceans.
    - The interaction of the moult-preventing and moult-accelerating hormones may be the regulatory device in the moulting process.

- For the expansion and contraction of the pigments into and out of the chromatophore processes, certain chromatophorotropic hormones in the sinus gland appear to be responsible as revealed by the removal of the eye-stalks (darkening effect) or by the injection of eye-stalk extracts (paling effect).
- A specific hormone from the sinus gland is known to control the **retinal pigment movements also.**

## ENDOCRINE GLAND (NEUROSECRETION) IN INSECTS

- Certain nerve cells are modified to secrete hormones.These nerve cells are called *neurosecretory cells.* The secretion of neurosecretory cells are called neurosecretions.
- The neurosecretions are temporarily stored in special structures called ***corpus cardiacum***. It is well established that *moulting* and *metamorphosis* in insects are controlled and regulated by neurosecretions and hormones.
- The brain contains groups of glandular cells called **neurosecretory cells.** These cells secrete a hormone called ***brain hormone***. This hormone is transported by the axons of the neurosecretory cells to a pair of lobe-like endocrine glands called ***corpora cardiaca*** (sl. corpus cardiacum)
- The corpus cardiacum releases the brain-hormone into the blood This hormone acts on a highly branched gland present in the prothorax called ***prothoracic gland*.**
- In response to the brain-hormone, this gland secretes a hormone called ***ecdysone***. It brings about **ecdysis or moulting**.
- There is another pair of lobe-like endocrine glands called **corpora allata** (sl. corpus allatum). The hormone secreted by the corpus allatum is called ***juvenile hormone***. Its action **retains the larval characters**.
- The juvenile hormone acts in a curious way. As long as the hormone remains in the larva, the larva does not differentiate into an adult. In other words, the withdrawal of juvenile hormone initiates metamorphosis.
- If a larva **moults four times** in its life and the fourth moult converts the larva into **a pupa,** the juvenile hormone concentration will remain high during the first three moults and it will decrease during the fourth moult. As a result, the fourth moult converts the larva into a pupa. This fact is confirmed by a series of transplantation experiments.
- When the corpora allata are removed in the first stage larva, the next moult convert the larva into a pupa even though it has to go through three more moults in normal development.




**Role of hormones in insect metamorphosis**

- When the corpora allata of a fourth-stage larva are transplanted to a first-stage larva, the larva pupates immediately.
- When the corpora allata of a first-stage larva are transplanted to a fourth-stage larva, the fourth-stage larva does not pupate, but it grows into a large larva for three or four moults and then only pupates.

# PHEROMONES

## Pheromones (Communication in Animals):

The chemical substances used for communication are called semiochemicals. They are divided into two groups—

i. **Intraspecific** –These chemicals are used for communication between individuals of the same species.

ii. **Interspecific** –These chemicals are used for communication between individuals of different species.

- It was KARLSON(1959) who first coined the term pheromone for intraspecific semiochemicals. Thus**, a pheromone is a chemical or mixture of chemicals that are released into the environment by an organism and that cause specific behavioral and physiological response in the receiving organism of the same species**.
- The pheromones may be ingested or absorbed through the body surface or perceived by olfaction before they stimulate a particular response.
- The first isolated pheromones were anal gland secretions of animals such as the **civet and the musk deer**. Later on, these substances were available in copious quantities and were used as bases in the perfume industry but there biological significance was completely ignored.
- Later, the sex attractant pheromones of **Lepidoptera** were studied since long it was a known fact that the caged females of some moths attract males from long distances. This is due to a scent produced by the female **moths from eversible glands at the tip of the abdomen.**
- It has also been established that animals of many kinds, including mammals, fish and amphibians make use of pheromones as a means of communication. There is evidence of their use in man in the form of skin odours and volatile sexual characters.

## Types of pheromones:

Pheromones are of following types-

1. Sex pheromones
2. Aggregation pheromones
3. Marker pheromones
4. Alarm pheromones
5. Trial pheromones

1. **Sex pheromones** – These attract the opposite sex. These are widespread in the animal kingdom. They are commonly found in insects, but also known to occur in crustaceans, fish, salamanders, snakes and mammals.

a). **Pheromones produced by females-** Most insect sex pheromones are secreted by females and act as stimuli for males. This carries a message, males are aroused, locate the female by upward orientation, initiate the mating procedure and copulate with her. **Bombykol** secreted by female **silk moths** in an important example.

b)**Produced by males-** Male insects also produce sex pheromones which facilitate their mating processes. In human beings, **α-androsterol** has been separated from the sweat. It attracts the females. **Civetone in civet rat** and **oxodee-2 enoic acid in honey bee** are other examples.

2. **Aggregation pheromones-** this pheromone are secreted by both the sexes to aggregate. Such pheromones serve to aggregate insects for protection, reproduction or feeding**. Geradiol in honey bees** attracts the other workers to the same flower for nectar collection. These are also found in beetles and butterflies.

3. **Marker pheromones-** These have been primarily studied in tiger. It is reported that tigers and tigresses mark the trees and shrubs with their strong musky fluids. Its smell lasts up to one week. This fluid is called marking fluid or marking pheromone. In rabbits, each group territory has characteristics odour to which strangers entering the territory respond immediately. The highest ranking male in each group urinates on his family members giving them a specific odour which aids in recognition. Faeces are coated with a pheromone and then laid within the territory to mark the home range.

There are more than 100 species of mammals which have anal glands. These release marking pheromones in faces and urine**. Dogs** urinate on bushes, poles etc. to mark their territory.

4. **Alarm pheromones-** These are produced when a social insect in threatened in some way. Response to them varies from alert, withdrawl and hiding. Alarm pheromones are highly volatile so they are quickly dissipated, otherwise the colonies might be in a continuous disturbed states. Aldehydes and Ketones are common components of alaram pheromones. These are also reported in certain **fishes,black-tailed deer and stripped hyena**.

5**.Trail pheromones-**Trail forming behavior of **social insects**, which facilitates food finding by other members of the colony, depends upon pheromones. eg: Termites produce a trail pheromones from a gland on the ventral surface of the ubdomen. In ants scent is produced in poison glands of hindgut.

## Pheromones in Human Beings:

- The various aspects of our social life needs some communication so that an individual should be able to respond appropriately to the environment.
- Sources of pheromones in human beings - The main sources of pheromones are glands which produce odoriferous substances. These are found in various parts of the body.

1. **Auxiliary glands** - These are made up of several types of glands. Odour production is assisted by bacterial decomposition.

2. **Mammary glands** - These are composed of well-developed sudoriferous glands. The odour of areolar glands found in mammary glands could be the first impression in the life of a human being.

3. **Circumoral glands** – These are sebaceous glands which open into the lips.

4**. Pubic glands**-Several types of pubic glands are found in pubic region. These glands produce pheromones in man and women.

5. **Salivary glands** - Saliva contains different types of amino acids which make important components of human pheromones.

6. **Tear glands** - The tears secreted by the tear glands also contain certain pheromones.The urine and sweat of human beings also contain pheromones.

**Mode of action of pheromones** – The pheromones is carried by the olfactory pathways to the hypothalamus. From here the message is transmitted to the motor organs which alter the behavior of the organism. Pheromones bring about changes in the physiology of the animal which in turn changes the behavior.

## Human sex Pheromones:

- It has been observed that male monkeys and goats attain intensive. Sexual excitement in the presence of menstruating females. But no such behavior has been found in man.
- Dr.J.K.KLOEK(1961) reported that men and women in their blood carry certain pheromones which are secreted by the sex glance and adrenal cortex. These are excreted along with urine and sweat.
- According to Dr.MeCLINTOCK(1971), in those girls which frequently come in contact with boys have shorter menstrual cycles. This shortening of duration of menstrual cycle is due to pheromonal action.

## Dogs and Human Pheromones :

- Dogs smell friendship, fear or hate in human beings. They are also able to discriminate colors of different individuals. After smelling a man, dog can easily recognize the belongings of the man. As a matter of fact, dog is able to identify the pheromones secreted by man.

## Mosquitoes and Man:

- Mosquitoes are attracted towards man due to the secretion of certain volatile odorous substances by him. This pheromones are perceived by the chemoreceptor's of mosquitoes. These pheromones contain amino acids, steroids and amines. It has been reported that L-Lactic acid in human sweat is a major component which attracts the female yellow fever mosquito, Aedes aegypti.
- Due to physical exercise, more L-Lactic acid is secreted in the sweat. This makes more mosquitoes attracted towards him. Attraction of mosquitoes to human females varies with the menstrual cycle as the changes are proportional to the estrogen excretion.

**Mother-Baby Communication:**

- A well-fed and healthy baby is more comfortable with its mother than an ill- fed and sick baby. As a matter of fact human babies recognize their mothers by smell as early as when they are hardly six days old. Mother's odour acts as a great shock absorber and provides him the comfort and safety.

**Practical Applications of Pheromones:**

1. With the help of pheromones house mice, moles, rats and other animals can be controlled. These animals damaged the food stuffs and are carrier of a number of diseases.
2. The pheromones have been found useful in the control of insects. A toxic effects of insecticides like D.D.T., B.H.C, etc., are well known. The use of pheromones will also be useful to solve the problem of pollution and insecticidal resistance in insects.
3. Pheromones control important animal interactions like stress, coexistence, predation, parasitism, fear etc., These also control the rate of offsprings and their number. Pheromones can also be used in the control of various pests.
4. According to some medical experts, cystic fibrosis and other types of brain tumours can be controlled by pheromones.
5. The pheromones are likely to be used as tranqalisers in place of oral drugs in the near future.

# ALLELOCHEMICALS

Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial or detrimental effects on the target organisms and the community.

- Allelochemicals are released into the environment by plant organs such as roots, rhizomes, leaves, stems, bark, flowers, fruits and seeds.

- The huge number of allelopathic interactions is typically negative in character, with positive relations being rare.

- Allelopathic compounds affect germination and growth of neighboring plants by disruption of various physiological processes including photosynthesis, respiration, water and hormonal balance. The underlying cause of their action is mainly inhibition of enzyme activity.

- Ability of an allelochemical to inhibit or delay plant growth and/or seed germination is usually defined as its "allelopathic (or phytotoxic) potential". An excellent example of allelopathic interaction is seen in soil exhaustion due to the accumulation of allelopathins that can be prevented by using fertilizers and rotating crops. Plants producing allelopathins are considered as "donor" organisms while the plants which allelopathins are directed to are referred to as "target" plants or "acceptors". The after-effects and strength of allelopathic interactions are diverse due to modifications of the allelopathins taking place in soil.

- Most of the allelochemicals penetrate the soil as already plant-active compounds, e.g. phenolic acids, cyanamide, momilactones, heliannuols etc.

- Some have to be modified into the active form by microorganisms or by specific environmental conditions (pH, moisture, temperature, light, oxygen etc.), e.g. juglone, benzoxazolin-2-one (BOA), 2-amino-3-H-phenoxazin-3-one (APO).

**Advantages and disadvantages of allelochemicals as bioherbicides**:

- Mode of action of some allelochemicals is similar to synthetic herbicides.
- These features have allowed them to be considered for possible use in weed management as bioherbicides. However, the field of knowledge is poorly studied but it is a very attractive area to explore.

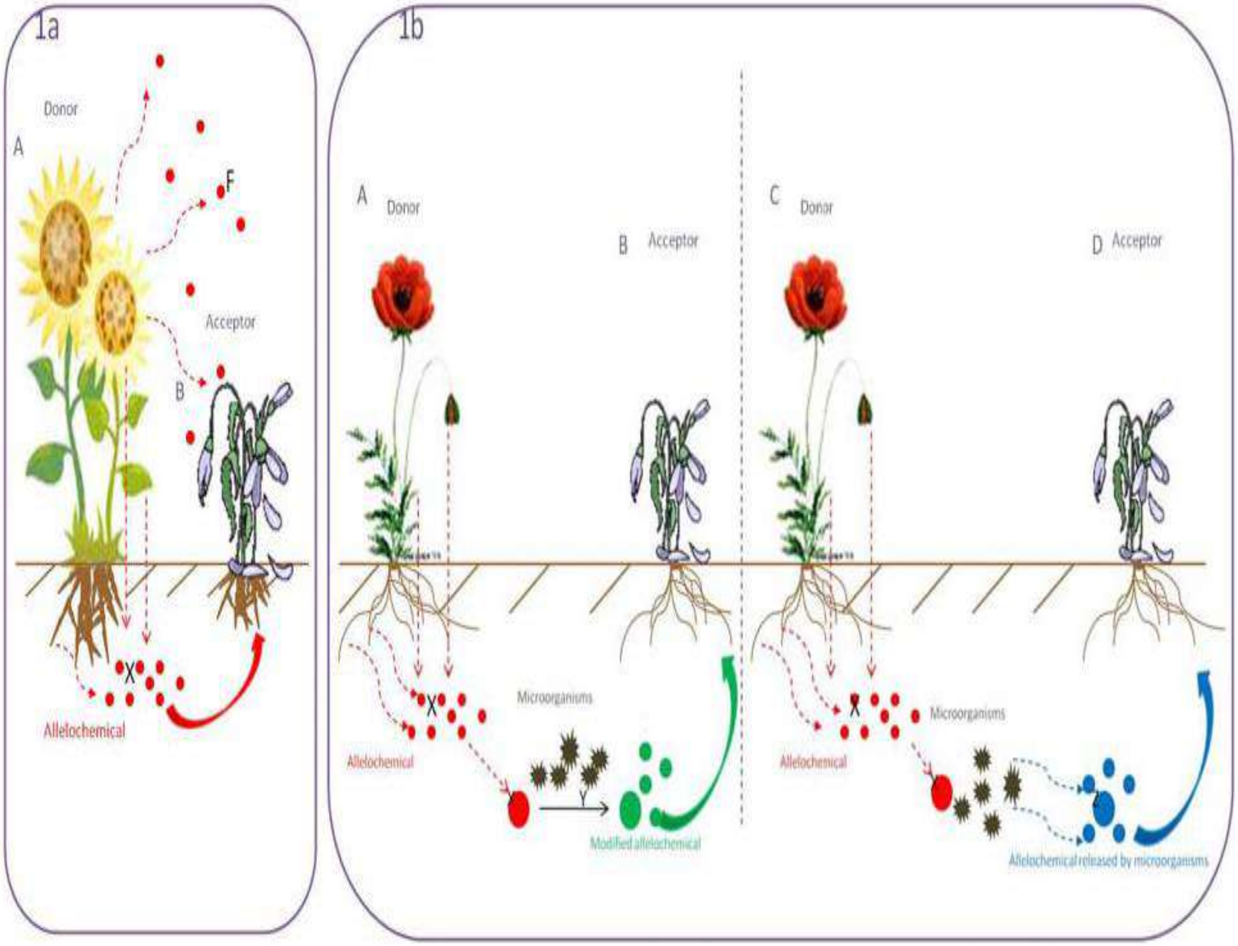



Figure 1.

**Multi-dimensional nature of allelopathic interacions. (1a) Plant A releases allelochemicals X and F which directly affect growth of plant B. (1b) left side; Plant A releases allelochemical X which is modified or activated by microorganisms to allelochemical Y that affects growth of plant B. (1b) right side; Plant A releases allelochemical X which stimulates microorganisms to produce allelochemical Z that affects growth of plant B.**

- Allelochemicals are highly attractive as new classes of herbicides due to a variety of advantages. However, in the perspective of bioherbicides based on allelopathins, effects caused by these compounds on target plants are also classified as "phytotoxic".
- Most of allelopathins are totally or partially water-soluble which makes them easier to apply without additional surfactants .

- Their chemical structure is more environmentally friendly than synthetic ones. They possess higher oxygen- and nitrogen-rich molecules with relatively few so called ‘heavy atoms’, a halogen substitute, and are characterized by the absence of ‘unnatural’ rings. These properties decrease a chemical’s environmental half-life; prevent accumulation of the compound in soil and eventual influence on non-target organisms.
- Allelochemical’s are unstable. Therefore, rapid degradation of one of the chemical groups can significantly decrease bioactivity of the whole compound.
- The diversity of allelopathins makes them promising tools possessing specific properties in discovering novel, specific target sites in acceptor plants.
- . Even if they inhibit photosynthesis or respiration, they may also bind to proteins at different sites than synthetic herbicides .
- This provides the opportunity to eliminate weeds that are already resistant to commercialized herbicides with the same mode of action.
- Allelochemicals are also characterized by multi-site action in plants without high specificity which is achieved in the case of synthetic herbicides. Therefore, this feature excludes the application of an allelopathic compound as a selective herbicide or totally prohibits its usage in weed management.
- On the other hand, effects of allelopathins in acceptor plants are highly dose-dependent.
- This allows the opportunity to search out compounds exhibiting selectivity. Generally, monocotyledonous plants are more resistant to allelochemicals than dicotyledonous ones. Therefore, usage of a compound as a potential herbicide is possible but rather restricted to cultivation of exact crops with a defined weed composition.
- A high number of limitations does not exclude allelochemicals as possible herbicides. In particular, they can be alternatives in weed management strategy. Widely developed bioinformatics and cheminformatics support development of new herbicides .

**Allelochemicals from Allelopathic Crop Cultivars:**

1. Allelopathic weeds produce and release allelochemicals that affect crop plants. Fortunately, a few crop cultivars are allelopathic as well, which results in a natural inhibition of weeds.

2. These allelopathic crop cultivars have been investigated and identified from several germplasm collections, particularly for the principal grain crops rice and wheat. Allelopathic crop cultivars can produce and release their own ‘herbicides’ (i.e., allelochemicals) to suppress weeds, permitting ecological weed control. Therefore, much effort has gone into investigating and determining allelochemicals from allelopathic crop cultivars. Thus far, the key allelochemicals from allelopathic cultivars of the principal grain crops have been identified, such as tricin and momilactone B from rice (Oryza sativa), benzoxazinoid hydroxamic acids from wheat (Triticum aestivum) and maize (Zea mays), and sorgoleone from sorghum (Sorghum bicolor) .

3. Research regarding plant-derived allelochemicals and signaling chemicals has made considerable progress in theory and practice.

4. Plant may detect or identify competitors, herbivores, or pathogens through signaling chemicals and then defend them by allelochemicals.

5. The plant-organism interactions that are mediated by allelochemicals and signaling chemicals have important implications in natural and managed ecosystems, particularly for their importance and consequences in agro-ecosystems.

6. The development of agricultural pest management is striving towards a future of sustainable agriculture.

7. Plant-derived allelochemicals and signaling chemicals may regulate crop-pest interactions to improve crop production.

8. Once herbivores, pathogens, or weeds stress crop plants, crop plants may identify and detect them and then produce and release defensive allelochemicals against the pests, providing an advantage for their own growth. Such natural chemical-defense techniques for agricultural pest management are most easily transferable to the small-farm intensive agricultural systems, particularly in organic crop-farming systems.

9. This significant progress will reduce heavy use of pesticides, generating tremendously rewarding changes for present crop production systems. Some allelochemicals, such as momilactones A and B, also showed strong correlation with drought and salinity and submergence tolerance. Thus, the role of allelochemicals and signaling chemicals in crops should be further investigated.

**Conclusions:**

- The phenomena of allelopathy and phytotoxic interactions between plants are strongly expanding branches of biological science.
- Allelochemicals, as a group of substances also called Allelochemicals as Bioherbicides Present and Perspectives biocommunicators, seem to be a fruitful challenge for combining traditional agricultural practices and new approaches in pest management strategies.
- Allelochemicals have already been used to defend crops against pathogens, insects or nematodes, parallel to some attempts to use them for weed control. Crop rotation, cover crops, dead and living mulches are being employed in agriculture. Both in natural and agricultural ecosystems allelopathic interactions are involved in practically every aspect of plant growth, as they can play the role of stimulants and suppressants.

- Complex plant-plant and plant-microbe interactions in ecosystems and currently developing studies on molecular, cytological and physiological levels bring us to a better understanding of processes occurring around us.
- The ancient knowledge of well-known toxic properties of water extracts of a variety of allelopathic plants give us a basis that could be used in the creation of a novel approach in weed control.
- Creation of bio- herbicides based on allelochemicals generates the opportunity to exploit natural com- pounds in plant protection and shows the possibility to cope with evolved weed resistance to herbicides.