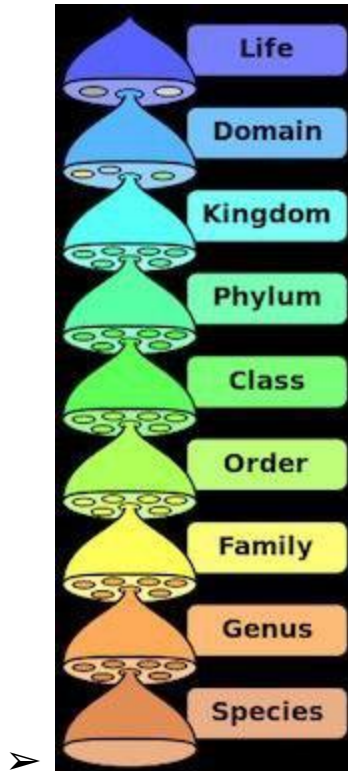


# MODULE I :Systematics and Evolutionary Biology

## 1.Systematics

### ❖ Basic concepts

- Systematics in biology is concerned with the classification systems and nomenclature of organisms. It is a branch of biological science that studies the distinctive characteristics of species and how they are related to other species through time .
- It is the basis used to understand the evolution of life. its main objectives are to provide **scientific names** for **organisms** ,to describe organisms, to preserve collections of organisms, to provide and apply classification systems, to help identify organisms, to determine the distributions of organisms, and to study the environmental adaptations of organisms.
- Systematics is sometimes used interchangeably with **taxonomy** .
- Because, taxonomy is a branch of science concerned also in finding, describing ,classifying and naming organisms, including the studying of the relationships between **taxa** and the principles underlying such a classification
- Systematics is more encompassing than taxonomy
- The latter does not include the study of evolutionary histories and the environmental adaptations of organisms
- For example ,animals that lay eggs and have scales we call reptiles, and animals that have live births and have fur on hair we call mammals



### ❖ Importance of Systematics

- Systematics plays a central role in biology by providing the means for characterizing the organisms that we study
- Through the production of classifications that reflect evolutionary relationships it also allows predictions and testable hypotheses
- Taxonomic characters have been variously defined, but for our purpose we can consider them as attributes of a taxon that allow its differentiation or potential differentiation from others .
- Characters or traits used in taxonomy are hypothesized as being under genetic control although this is rarely tested directly .
- Characters are used to construct classifications and to identify the taxa which classifications recognize
- A character useful for identification is not necessarily useful for constructing a classification and viceversa .
- Taxonomic characters can be conveniently categorized as **morphological ,physiological ,molecular ,ecological ,reproductive and behavioural .**

- The vast majority of classifications and keys for identification are based on morphological characters
- This is not because they are inherently better for systematics but because they are more easily observed and evaluated for variation
- The other kinds of characters often require expensive equipment, live material and they are more difficult to voucher
- Estimating variation in particular is not a trivial matter with non - morphological characters

### ❖ **Applications of systematics**

- **1.** systematics is the study of diversity of organisms including past and present and relationships among living things. relationships are established by making cladograms, phylogenetic trees and phylogenies. The phylogeny is the evolutionary history of an animal or plant, for a taxonomic group
- Phylogenies include two parts - the first part shows the group relationships and the second part indicates the amount of evolution. phylogenetic trees of species and higher taxa are established by morphological, physiological and molecular characteristics, and the distribution of animals and their ancestors are related to geography
- In this way the systematics is used to understand the evolutionary history of organisms
- **2.** The field of systematics provide scientific names of the organisms, description of the species, ordering the organisms into higher taxa, classification of the organisms and evolutionary histories
- **3.** Systematics is also important in implementing the conservation issues because it attempts to explain the biodiversity which is related to different kinds of species and could be used in preservation and protect the endangered animals and plants
- The loss of biodiversity is related to the extreme harmful of the existence of mankind. The unchecked human population destroy different kinds of plants and animals for food and other factors
- **4.** The destruction or suppression of harmful pests or animals by the introduction and increase of their natural enemies is called **Biological control.**

## **E ▶ ENTRI**

- The natural enemies of pests are often introduced for biological control for the advantage of agriculture and forestry .The natural enemies include insectivorous spiders,centipeds,some insects ,frogs and birds which are much more economical than the chemical control because they have no injurious side effects
- **5.**There are a lot of insects which act as vectors of various human diseases.For example ,some species of Anopheles sp.are the vector of malaria diseases.Aedes aegypti spreads the virus of dengue fever and phlebotomus argentipes spreads the pathogens of kala-azar fever
- So taxonomists play a vital role in identification of the species of vectors and control strategy programmes of the vectors should be planned in such a way the target species is attacked

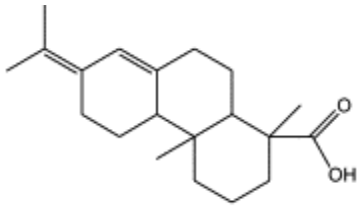
### **❖ Trends in systematics**

#### **➤ 1.chemotaxonomy**

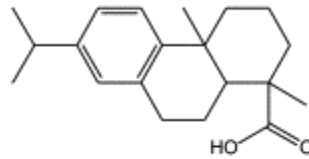
- Chemotaxonomy also called chemosystematics,is the attempt to classify and identify organisms (originally plants )according to confirmable differences and similarities in their biochemical compositions
- Chemotaxonomy based plant selection is a prerequisite for the successful natural product research
- Due to difficulty in **PCR amplification** ,molecular markers are very often inapplicable for yew extracts
- More importantly ,the gene variations cannot represent the variations cannot represent the variations at the metabolite level that are closely related to the manufacturing process of taxanes
- Novel classifications based on metabolic analysis are thus highly desirable
- Chemotaxonomy is based on the empirical observation that phylogenetically related organisms share common physiological or biochemical identity
- The application of chemotaxonomy ,numerical taxonomy and **DNA-DNA** hybridization methods have provided a basis for studying the taxonomy of Actinobacteria
- **Examples of chemotaxonomy are:**volatile oils are found in the family umbelliferae and family rutaceae.Tropane alkaloids are found in the family

**E ▶ ENTRI**

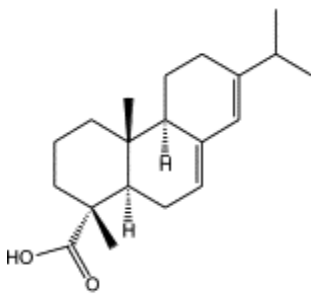
solanaceae.steroidal alkaloids occur in the family buxaceae .Diterpenoids are found in the family euphorbiaceae.



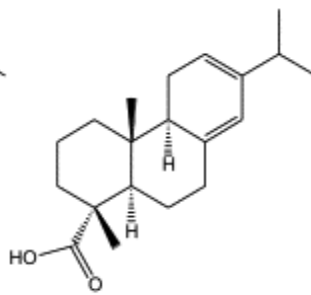
Neoabietic acid



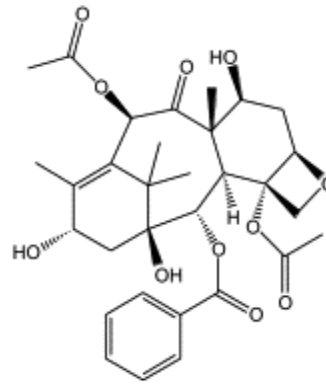
Dehydroabietic acid



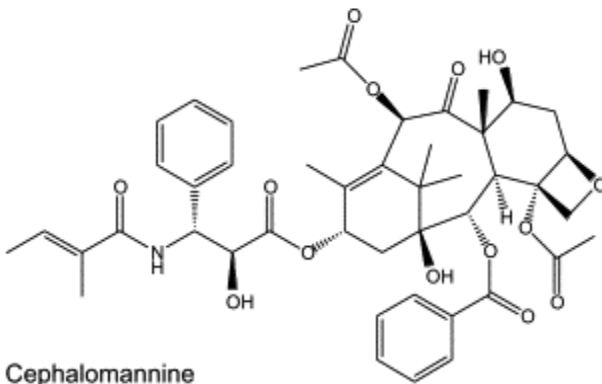
Abietic acid



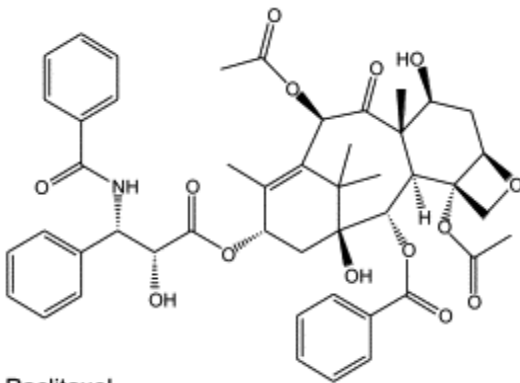
Levopimaric acid



Baccatin III



Cephalomannine

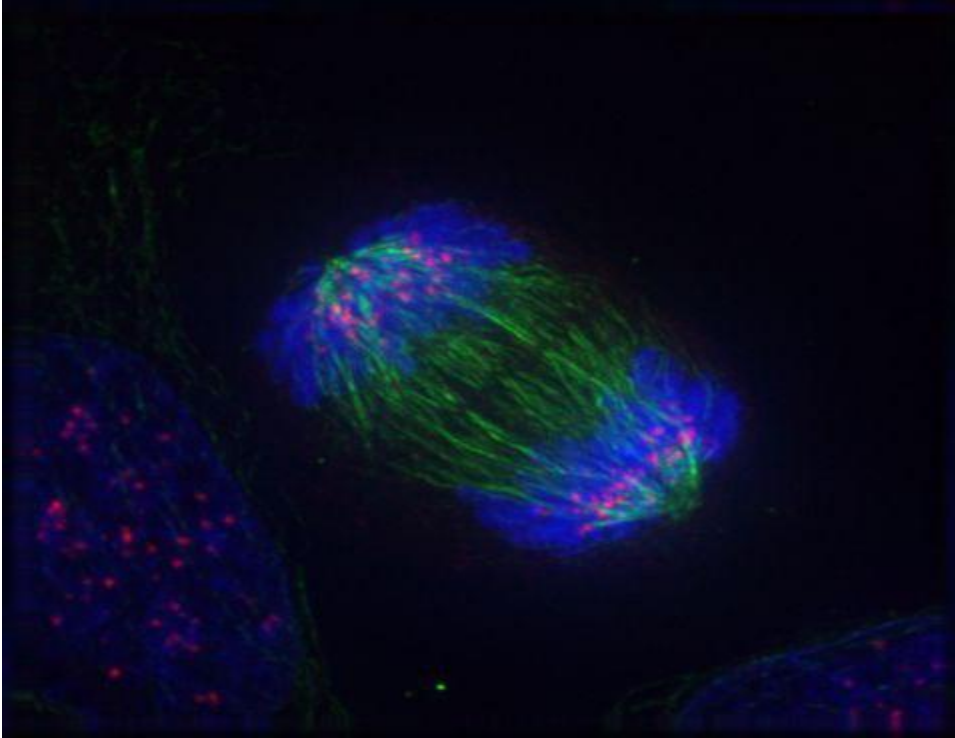


➤ Paclitaxel

➤ **2.Cytotaxonomy**

## E ▶ ENTRI

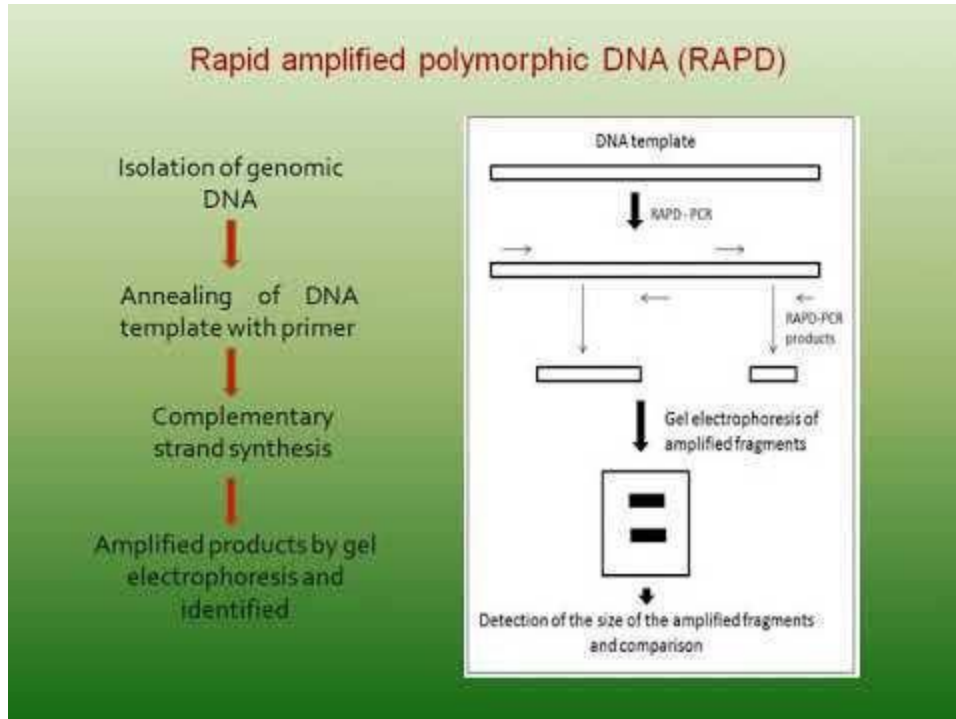
- It is the branch of taxonomy in which organisms are classified according to their chromosome number, structure and behavior
- Cytotaxonomy deals with the classification and relationship of organisms based on their detailed comparative chromosome analysis
- Chromosome numbers are determined at the stage mitosis and most cell types carry two sets of chromosomes ( $2n$ )
- Depending on the position of centromere chromosome are classified into three categories: therefor **Acrocentric, meso-centric and telocentric chromosome**
- Position of the chromosome is an important taxonomic character
- Cytogenetic studies represent both structural and functional homologies among taxa based on their evolutionary conservation
- It has been known that some large chromosomes have been known that some large chromosomes have been made by the fusion of smaller chromosomes
- The role of cytotaxonomy is very important in taxonomic studies  
.cytotaxonomy is more significant than physiological taxonomy because it is the comparative study of chromosomes at the molecular level
- Small changes in chromosomes can be detected among the individual  
.chromosomes are constituted by the DNA ,variation in the DNA leads to change in chromosome which ultimately causes variation among the individual ,species ,genus and everything .



➤

### ➤ **3.Molecular Taxonomy**

- Molecular taxonomy is the branch of science that deals with the presence of chemicals inside our body
- It is the method of identifying and distinguishing the specimens in a fast and exact manner which is based on the interspecific variations
- This helps in establishing the genetic relationship with the help of the molecular techniques between the members of various groups of taxonomy
- To study different species and their genetic relationship various methods are used that include immunological methods, DNA and protein sequencing, **DNA-DNA or DNA -RNA** hybridization methods
- **The objectives of molecular taxonomy are as follows:**
  - 1.it helps in reconstructing the genetic relationship between various species
  - 2.it helps in the study of evolution in a sequential manner
  - 3.it helps in finding the time of divergence occurring in between the various species

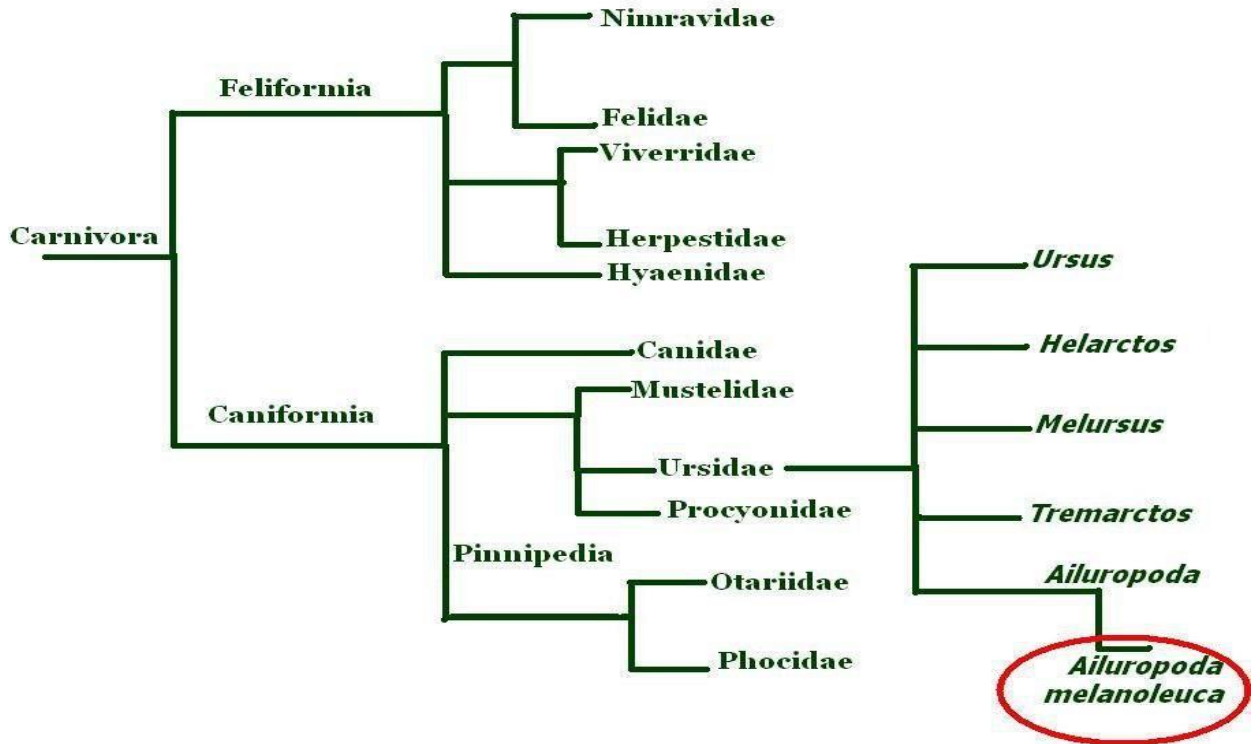


➤

#### ➤ **4. cladistics Taxonomy**

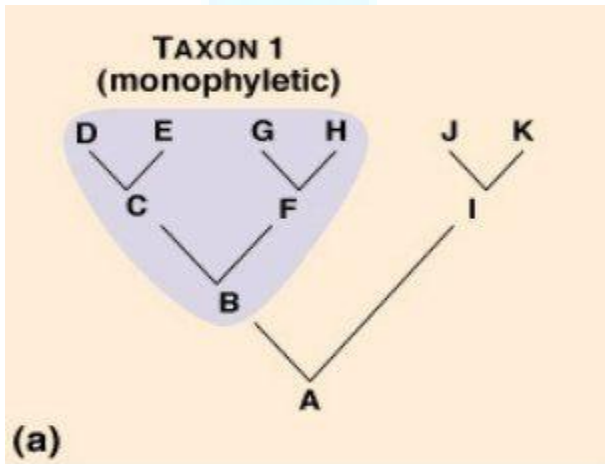
- The method of classifying organisms into monophyletic group of a common ancestor based on shared apomorphic characters is called **cladistics**
- The outcome of a cladistic analysis is a cladogram ,a tree shaped diagram that represent the best hypothesis of phylogenetic relationships
- Cladistics is one of the primary methods of constructing **phylogenies or evolutionary histories**
- Cladistics uses shared,derived characters to group organisms into clades
- These clades have atleast one shared ,derived character found in their most recent common ancestor that is not found in others groups
- Hence they are considered more closely related to each other
- These shared characters can be morphological such as leaf,flower ,fruit ,seed and so on
- Cladistics accept only monophyletic groups,paraphyletic and polyphyletic taxa are occasionally considered when such taxa conveniently treated as one group for practical purposes
- **Example :dicots ,sterculiaceae ,polyphyletic groups are rejected by cladistics**





➤

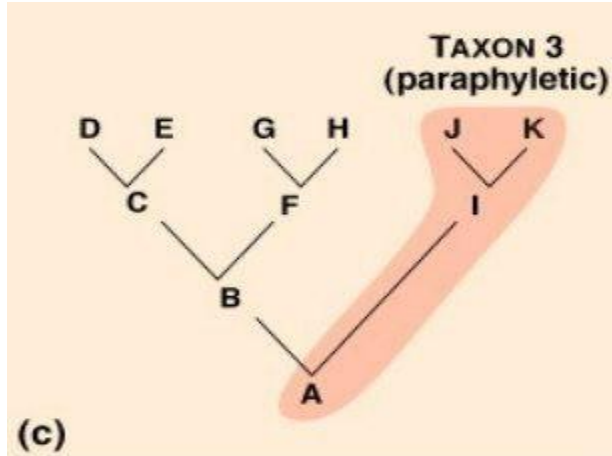
➤ **1. Monophyletic group** : taxa comprising all the descendants of a common ancestor .



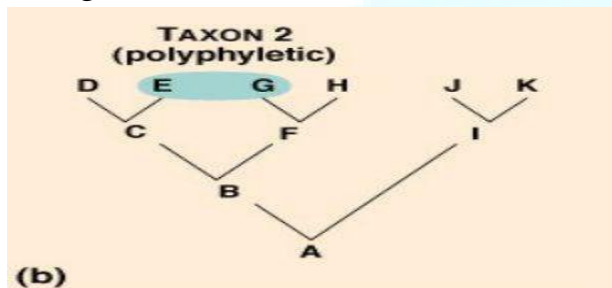
➤

➤ **2. Paraphyletic group** ;taxon that includes an ancestor but not all of the descendants of that ancestor

## E ▶ ENTRI



- (c)
- **3.polyphyletic group** : taxa that includes members from two different lineages



- (b)
- **5.Numerical Taxonomy**
  - This is classified based on numerous characteristics
  - The total number of characters they have in common
  - Their characteristics are-**physiological ,morphological ,biochemical ,behavioural .**
  - This type of classification is called **phenetic classification**
  - Various groups are linked together according to the degree of similarity between them which gives a tree like diagram called a dendrogram
  - It's aim to create a taxonomy using numeric algorithms like cluster analysis rather than using subjective evolution of their properties

