VIDYASAGAR UNIVERSITY

Lecture for 4th Semester Special Paper
(BOT 403A) : **Molecular Systematics**

2. Numerical Systematics: Phenetic, Cladistic and Cladogram

	Characters									
Taxa	1	2	3	4	5	6	7	8	9	10
A	1	1	1	1	1	1	0	1	1	0
B	1	1	1	0	0	1	0	1	0	0
C	1	1	1	1	0	1	0	1	0	1
D	1	1	0	0	0	1	1	0	0	0
E	1	1	0	0	0	0	0	0	0	0
Out	0	0	0	0	0	0	0	0	0	0

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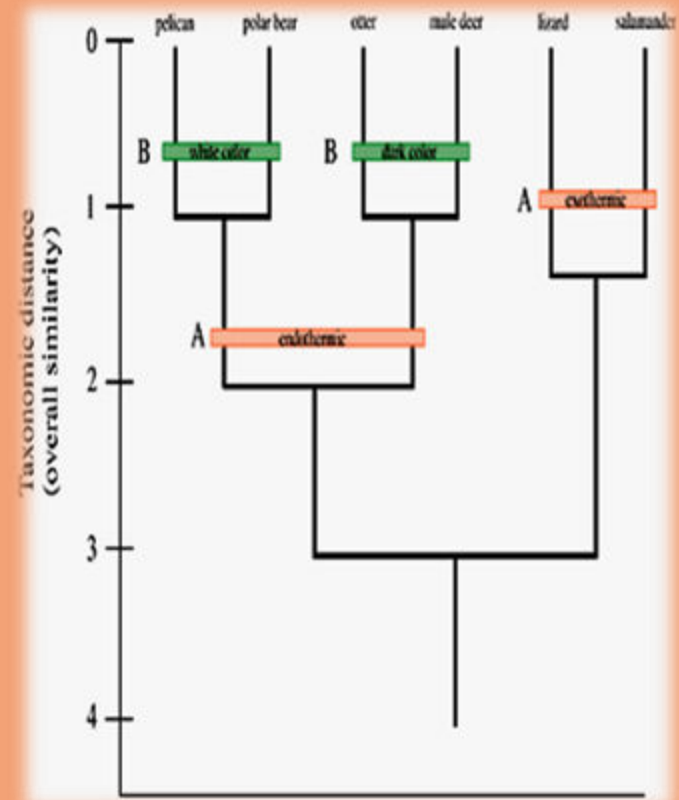Department of Botany & Forestry
Vidyasagar University

2nd April, 2020

PHENETIC

CLADISTIC

&

CLADOGRAM

Content

➢Introduction

➢History of Biological Classification

➢Phenetic Classification

➢Cladistic Classification

➢Cladogram

Biological History of Classification

1. Biological Taxonomy - Aristotle - mid 300's BCE
2. Hierarchical Taxonomy & Binomial nomenclature - Linnaeus - early to mid 1700's
3. Phenetic taxonomy - Adanson - 1750s
4. Phylogeny - Darwin, Haeckel - mid 1800's
5. Evolutionary taxonomy - Mayr and Simpson - mid 1900's
6. Phenetic taxonomy - Sneath and Sokal - 1960's
7. Cladistic taxonomy - Hennig - 1960's

Before going further I would like to clear the difference between two common terms, namely, "Classification" & "Identification".

When the organisms are classified on the basis of like properties, then it is called Classification, and after the classification, when the additional unidentified objects are allocated, then it is known as Identification.

The purpose of taxonomy is to group the objects to be classified into natural taxa.

Conventional taxonomists equate the taxonomic relationships with evolutionary relationships, but the numerical taxonomists defined them as three kinds:

❖**Phenetic: based on overall similarity.**

❖**Cladistic: based on a common line of descents.**

❖**Chronistic: temporal relation among various evolutionary branches.**

SPECIES CLASSIFICATION

Phenetic: Physical attributes, numerical Taxonomy (Resemblance: Based on Phenotypic similarity).

Cladistic (Phylogetic): Evolutionary relationships (descent: based on exclusively on the branching patterns of phylogeny.

Phenetics

☐ **Does not necessarily reflect genetic similarity or Evolutionary relatedness. Instead, groups are based on convenient, observable characteristics.**

☐ **It based on the organism characters, compared to give the expression of similarities and differences.**

Types of Phenetic Classification

Artificial Classification

Based on one or few easily observable characters of plants such as Habit

People who used the system:
- Theophrastus
- Herbalist
- Linnaeus

Natural Classification

Based on similarity, but this method used different characters.

People who used the system:
- de Jessieu–Genera Plantarum
- de Candolle–Prodromous Systematics Naturallis Vegetabilis
- Hooker & Bentham–(Genera Plantarum)

Cladistic (Phylogenetics)

Phylogenetics is the science of the pattern of evolution. Evolutionary theory states that groups of similar Organisms are descended from a common ancestor.

Phylogenetic Systematics is a method of Taxonomic classification based on their evolutionary history.
Phylogenetic Classification system: Groups reflect genetic similarity and evolutionary relatedness.

PHENETICS VS CLADISTIC

× **Phenetics**: (*Principles of Numerical Taxonomy,* 1963) by **Peter Sneath** nd Robert Sokal

× **Cladistics**: (*Phylogenetic Systematics,* 1966) by **Willi Hennig**

all out war in the….
1960s and 1970s!
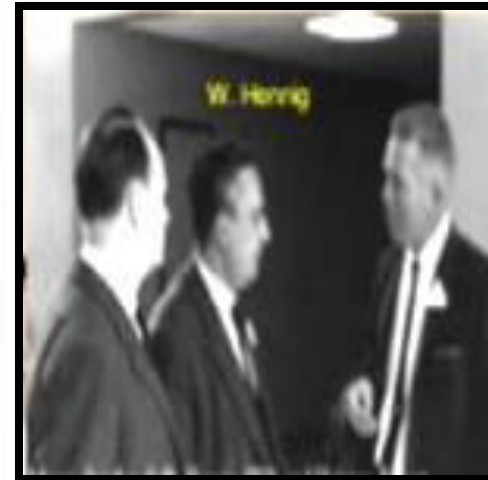
Within the field of taxonomy there are two different methods and philosophies of building phylogenetic trees:

cladistic and **phenetic**

* **Phenetic** methods construct trees (**phenograms**) by considering the current states of characters without regard to the evolutionary history that brought the species to their current phenotypes;

dendrograms are based on **overall similarity**

* **Cladistic** methods construct trees (**cladograms**) rely on assumptions about ancestral relationships as well as on current data;

cladograms are based

Assumptions of Cladistics

- All species in a group must have share a common ancestor.

- All species derived from a common ancestor must be included in the taxon.

PHENETICS VS CLADISTIC

PHENETIC

Overall similarities

	A	B	C
A	–	.60	.20
B		–	.20
C			–
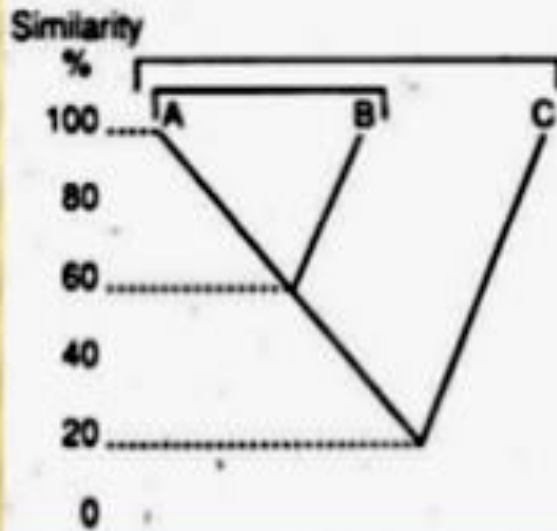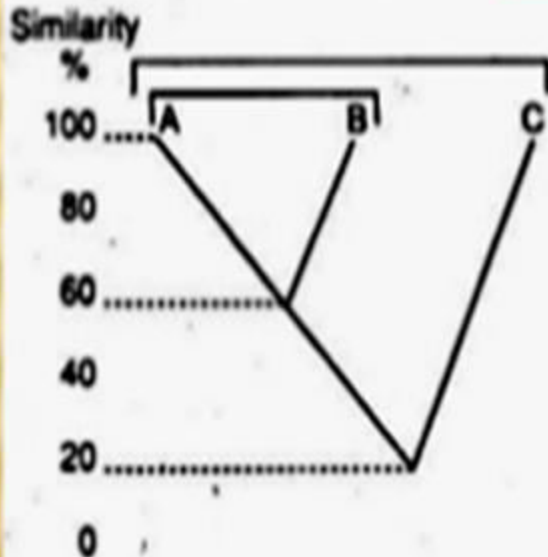
Similarity %

Species	Characters				
	1	2	3	4	5
A	0	0	0	0	0
B	1	1	0	0	0
C	1	0	1	1	1

- Phenetics uses "overall similarity" - all characters Used
- Graphical representation is called a phenogram, dendrogram, network

PHENETICS VS CLADISTIC

- Cladistics uses only phylogenetically informative characters
- Derived state is shared by 2 but not all taxa - "shared derived character states"
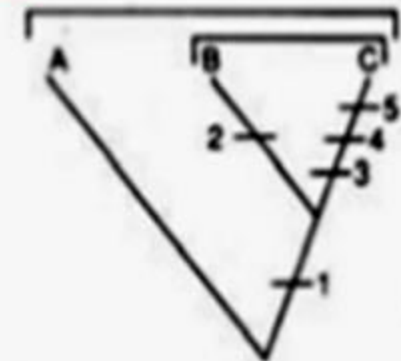
# PHENETICS VS CLADISTIC

CLADOGRAM (PHYLOGENETIC TREE)

× **Node:** a branchpoint in a tree (a presumed ancestral OTU)
- **Branch:** defines the relationship between the taxa in terms of descent and ancestry
- **Topology:** the branching patterns of the tree
- **Branch length** (scaled trees only): represents the number of changes that have occurred in the branch
- **Root:** the common ancestor of all taxa
- **Clade:** a group of two or more taxa or DNA sequences that includes both their common ancestor and all their descendent
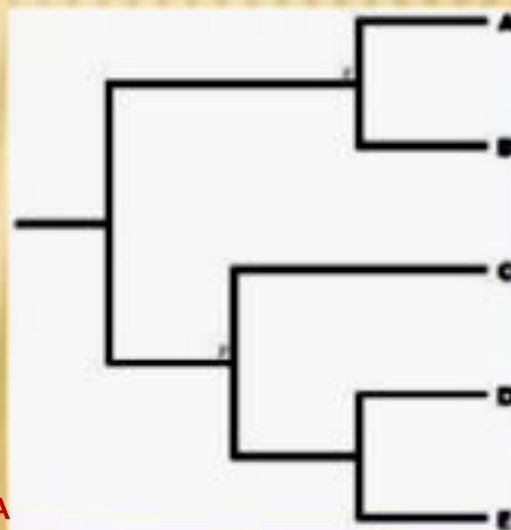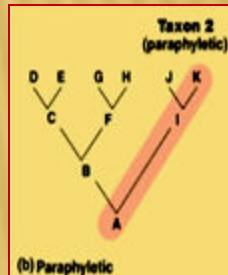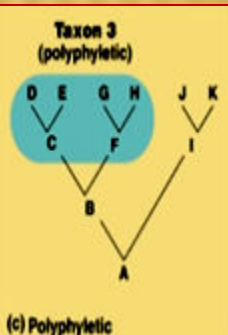
Cladogram
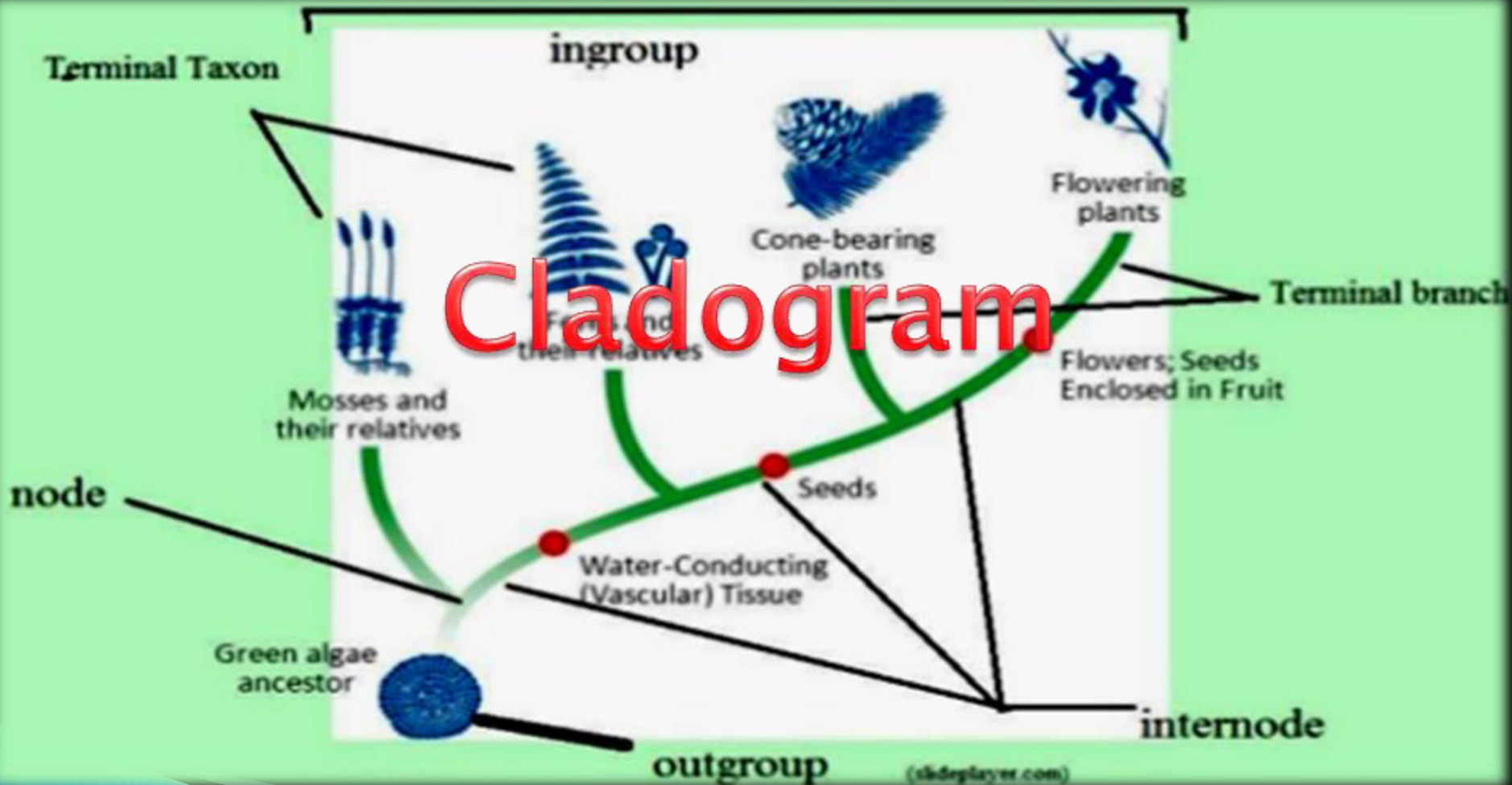
* **Monophyletic** pertains to a taxon that is derived from a single ancestral species. only legitimate cladogram type!
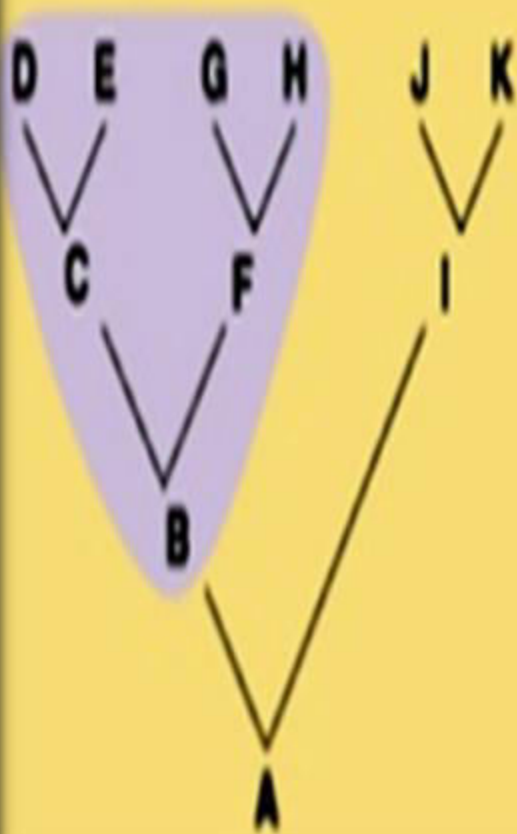

Taxon 1 (monophyletic)

(a) Monophyletic
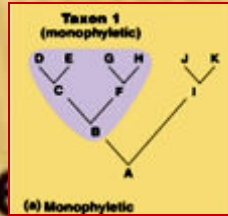
* **Polyphyletic** pertains to a taxon whose members were derived from two or more ancestors not common to all members.
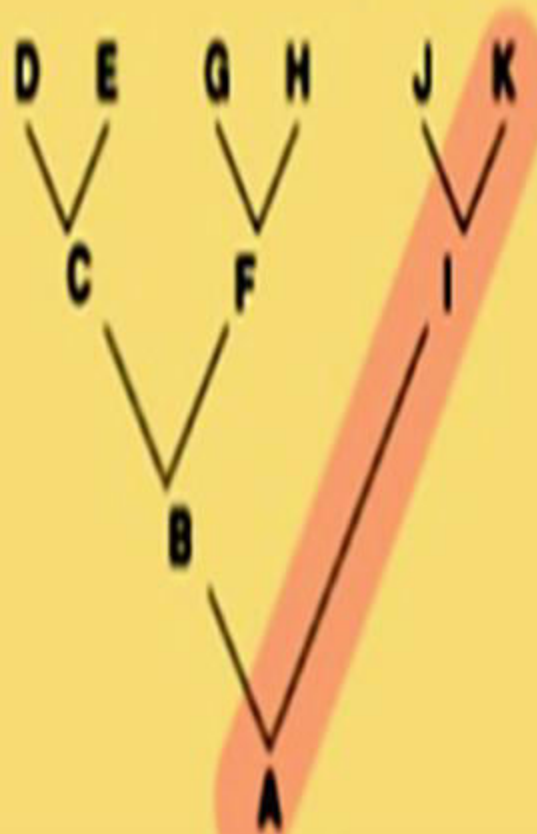

Taxon 2 (paraphyletic)

(b) Paraphyletic

* **Paraphyletic** pertains to a taxon that excludes some members that share a common ancestor with members included in the taxon.

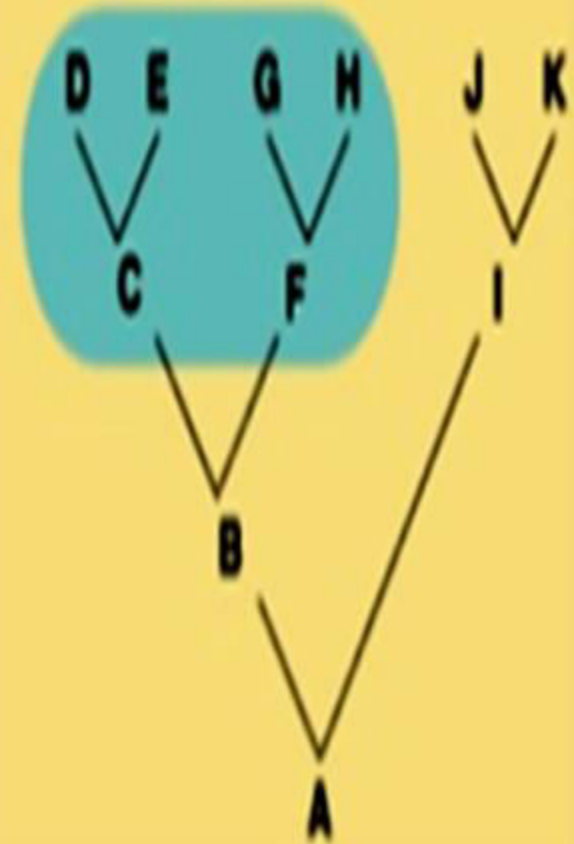Taxon 3 (polyphyletic)

(c) Polyphyletic

Monophyletic   Paraphyletic   Polyphyletic

Basic steps in Cladograms

1) select group of organisms
2) determine characters & states
3) for each character, classify ancestral & derived
   comparison to outgroup
   traits shared with outgroup = ancestral
4) group by shared derived characters
   (synapomorphies)
5) choose most parsimonious tree
   (fewest evolutionary transitions)

Seed Plants

Taxa	Cotyledon	Carpels	Perianth	Seeds
Conifer	2			present
Dicot	2	Present	Present	Present
Gnetales	2		Present	Present
Monocot	1	Present	Present	Present
outgroup	-	-	-	-

Parsimonious Tree
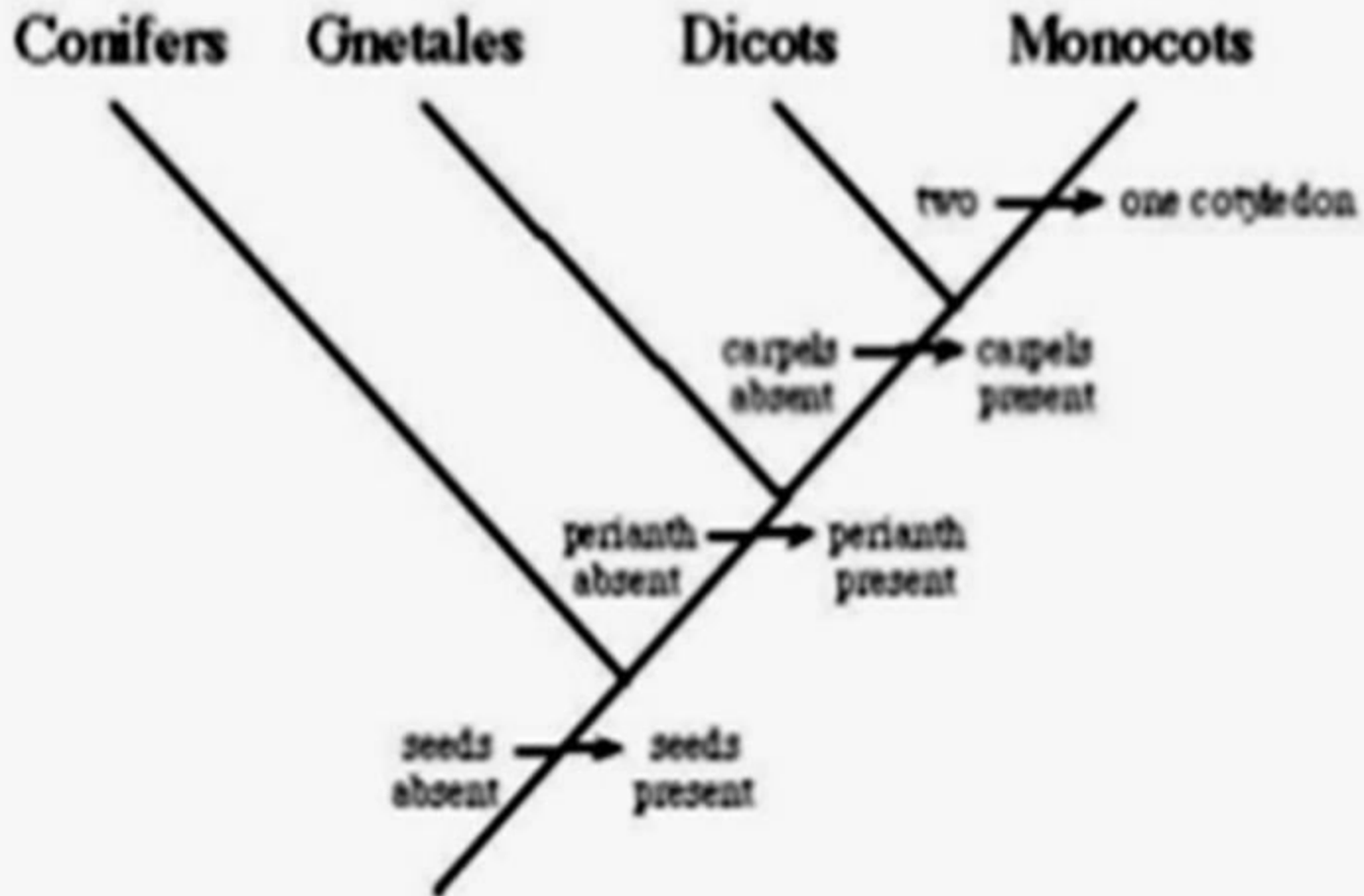
Acknowledgement:

I would like to thank our *Honourable Vice Chancellor* **Professor Ranjan Chakarborti** for giving me the opportunity to contribute in E-learning process which will be very much helpful for our students during unprecedented situation due to **CORONA Virus (COVID-19)**.

We shall overcome!!!!!!!!
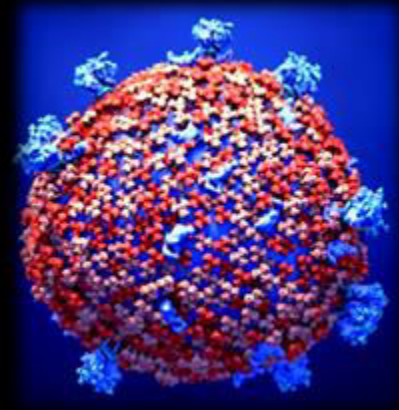#SAVE FROM CORONA
Stay Home
Save your Life
Save your Family
Save your Society
Save your Country
Save your beautiful Planet

THANK YOU

Thank you!

2nd April, 2020