AlKarkh University of Science
College Energy and Environmental Science

Lab 1
Overview of Biosystematics

Dr.Khattab Al-Khafaji

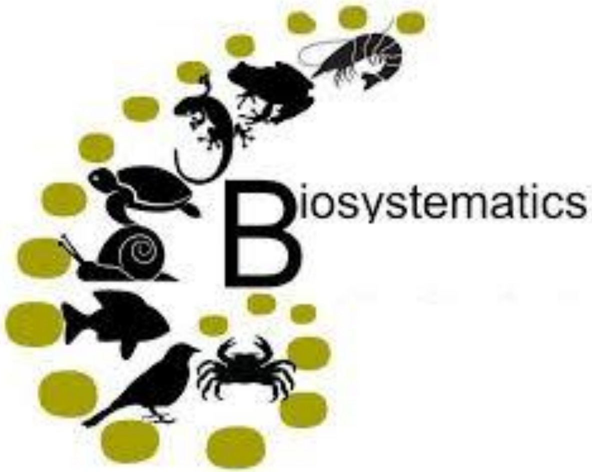
3rd Level

Overview of Biosystematics

- **A. Definition, Scope, and Significance:**

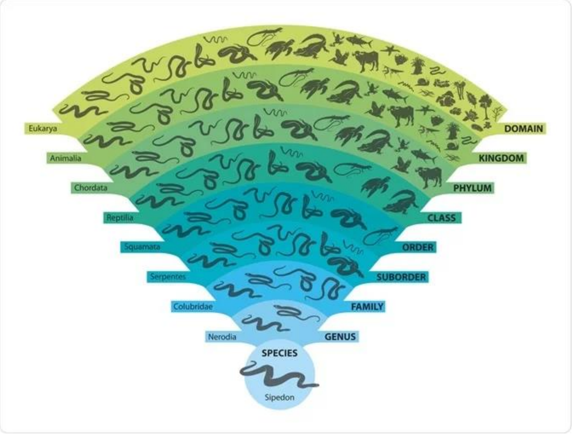
1. Definition:

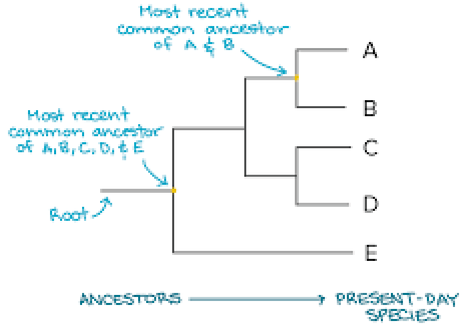
1. Biosystematics, also known as systematic biology or biological systematics, is the scientific study of the diversity of life and the relationships among living organisms. It involves the classification and naming of species based on their evolutionary relationships.



2. Scope:

1. Biosystematics encompasses various disciplines, including taxonomy, phylogenetics, ecology, and evolutionary biology. It involves the identification, classification, and understanding of the evolutionary history of organisms.





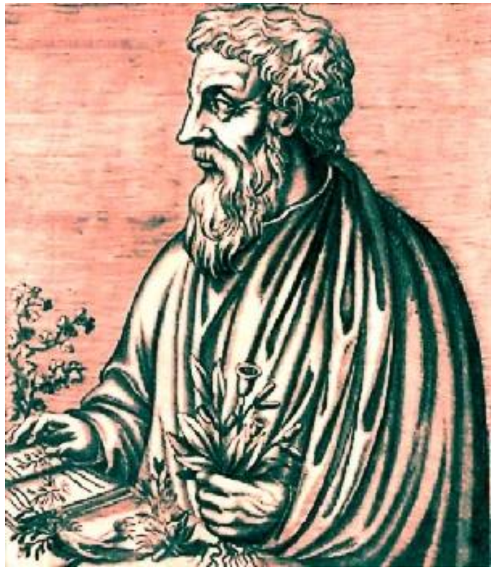
Overview of Biosystematics

- **Significance:**
- Biosystematics provides a framework for understanding the rich diversity of life on Earth.
- It aids in conservation efforts by identifying and preserving endangered species.
- The field is crucial for agricultural practices, medical research, and environmental management.

- **B. Brief History and Key Contributors:**

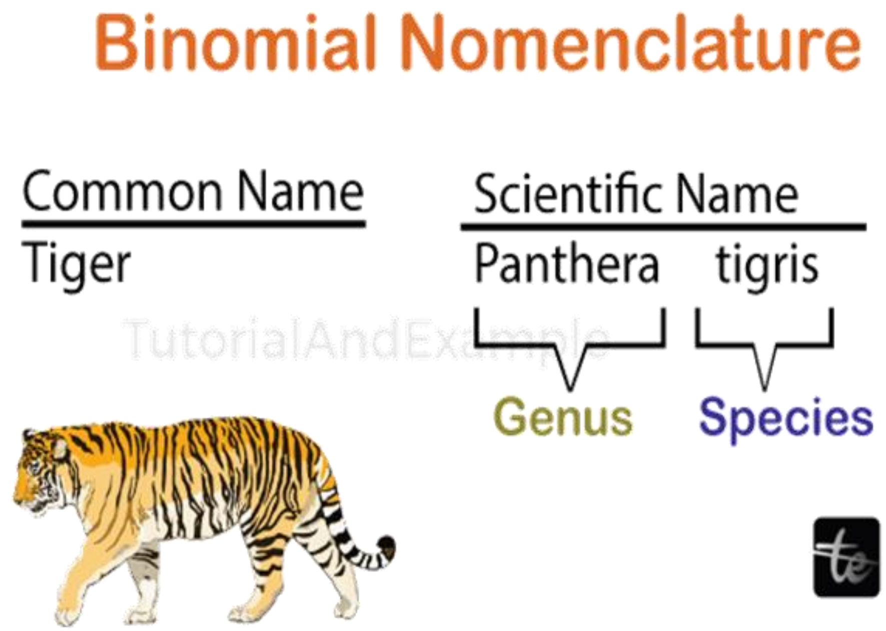
1. Early Taxonomy:

1. Ancient civilizations practiced rudimentary taxonomy for practical purposes such as medicinal plant identification.
2. Notable early contributors include Theophrastus and Dioscorides.



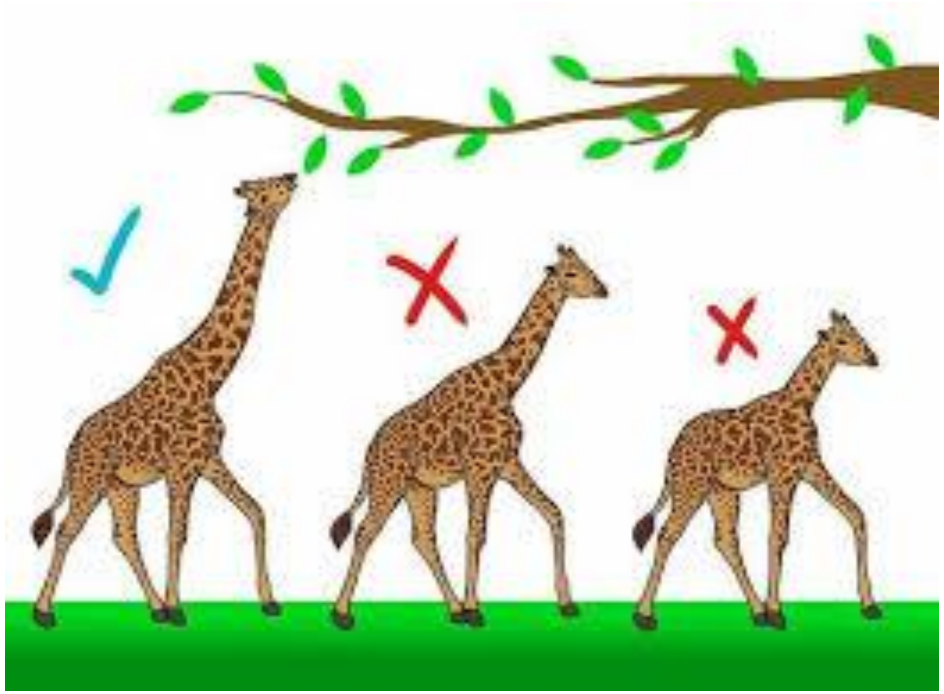
2. Linnaean System:

1. Carl Linnaeus (1707–1778) revolutionized taxonomy by introducing the binomial nomenclature (e.g., Homo sapiens).
2. His hierarchical classification system laid the foundation for modern taxonomy.



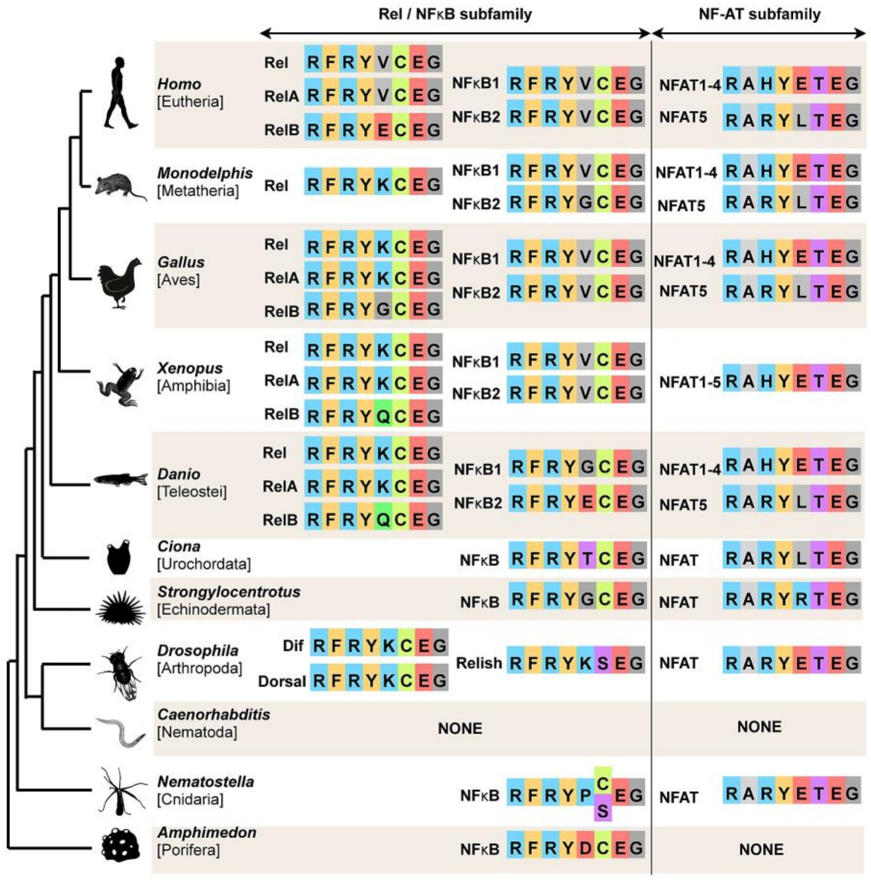
1.Evolutionary Context:

1. Charles Darwin (1809–1882) and Alfred Russel Wallace (1823–1913) formulated the theory of evolution by natural selection.
2. Evolutionary principles became integral to biosystematics.



1.Phylogenetics and DNA Era:

1. Advances in molecular biology in the 20th century allowed for DNA-based phylogenetic analyses.
2. Pioneers like Carl Woese (1928–2012) contributed to the understanding of evolutionary relationships at the molecular level.



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Lab 2
Taxonomic Principles

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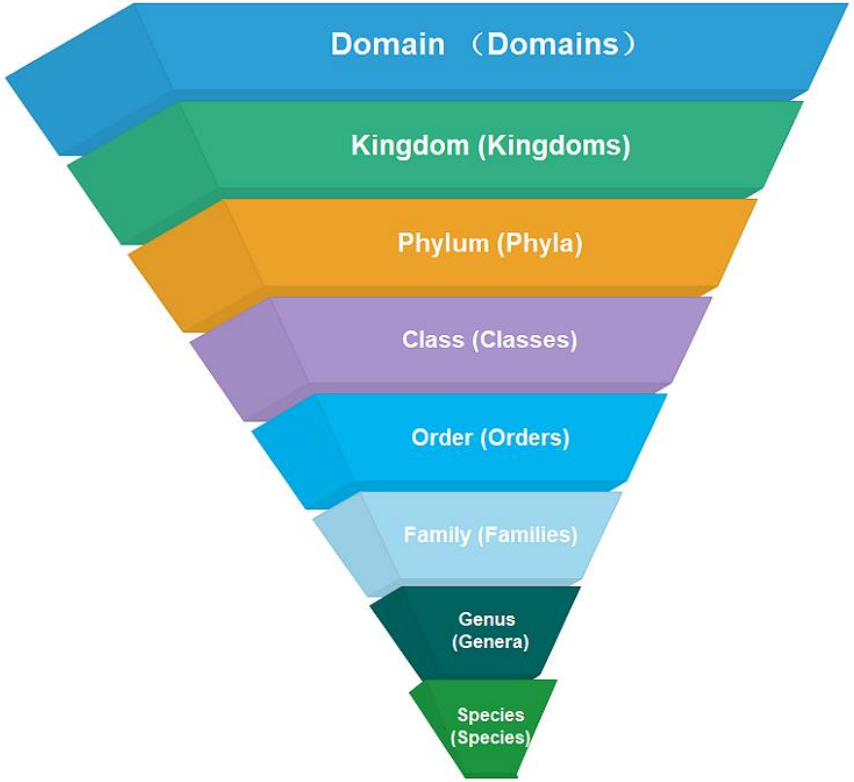
Taxonomic Hierarchy and Nomenclature

1.Introduction to Taxonomy:

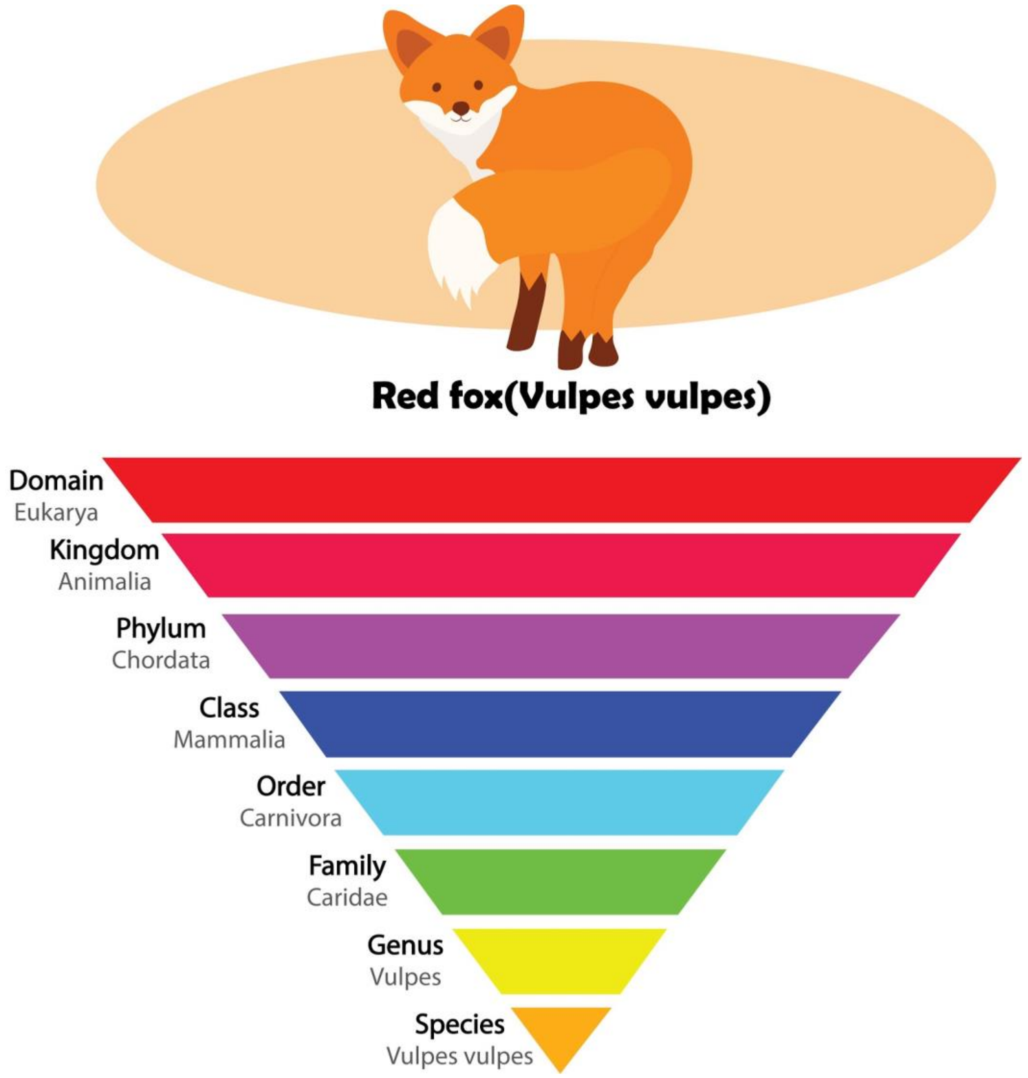
Taxonomy is the science of classification, naming, and categorizing organisms based on shared characteristics and evolutionary relationships. It involves organizing organisms into a hierarchical system.



Taxonomic Hierarchy and Nomenclature

- **Taxonomic Hierarchy**:

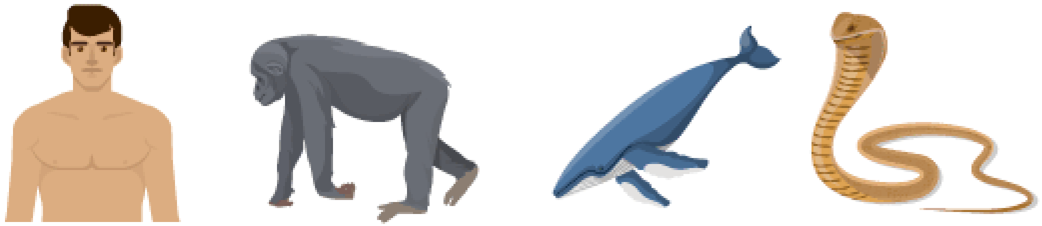
Explanation of the hierarchical levels of classification including Domain, Kingdom, Phylum, Class, Order, Family, Genus, and Species.



Taxonomic Hierarchy and Nomenclature

- **Binomial Nomenclature**:

The system developed by Carl Linnaeus for naming species using a two-part Latinized name (e.g., Homo sapiens for humans).



Taxon	Human	Chimpanzee	Blue whale	Snake
Species	*sapiens*	*troglodytes*	*musculus*	*naja*
Genus	*Homo*	*Pan*	*Balaenoptera*	*Naja*
Family	Hominidae	Hominidae	Balaenopteridae	Elapidae
Order	Primates	Primates	Artiodactyla	Squamata
Class	Mammalia	Mammalia	Mammalia	Reptilia
Phylum	Chordata	Chordata	Chordata	Chordata
Kingdom	Animalia	Animalia	Animalia	Animalia

Taxonomic Hierarchy and Nomenclature

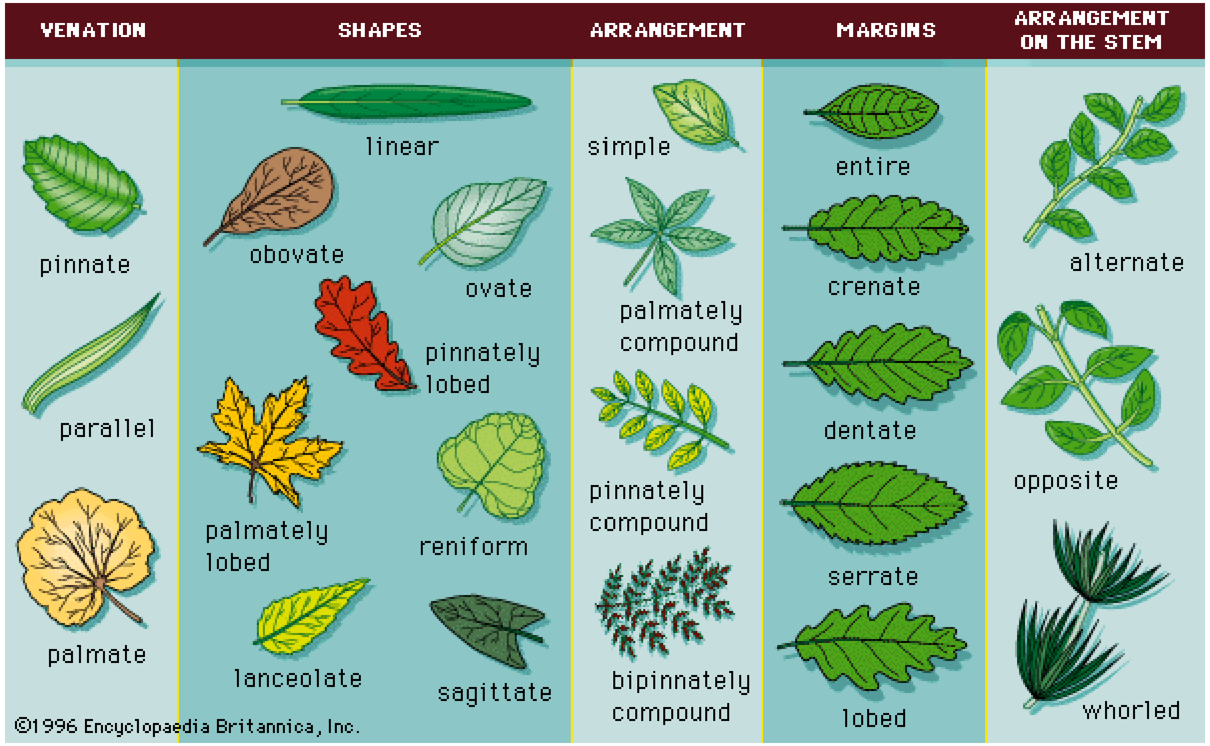
- **International Codes of Nomenclature**:
- Overview of the rules and conventions governing the naming of organisms, including the International Code of Zoological Nomenclature and the International Code of Nomenclature for algae, fungi, and plants.
- he International Code of Nomenclature for algae, fungi, and plants (ICN), formerly the International Code of Botanical Nomenclature (ICBN), is the formal regulatory framework that governs the scientific naming of plants, fungi and algae.

Taxonomic Hierarchy and Nomenclature

- The names of 'plants' can be divided into two categories: the scientific, international (Latin) names, and other names, national, regional or local. It is only names of the former kind that are regulated by the ICN. The code, as ICN is often called, traces its origins all the way back to the naming rules that Linnaeus established in Philosophia botanica (1751), but gradually some of these were departed from.

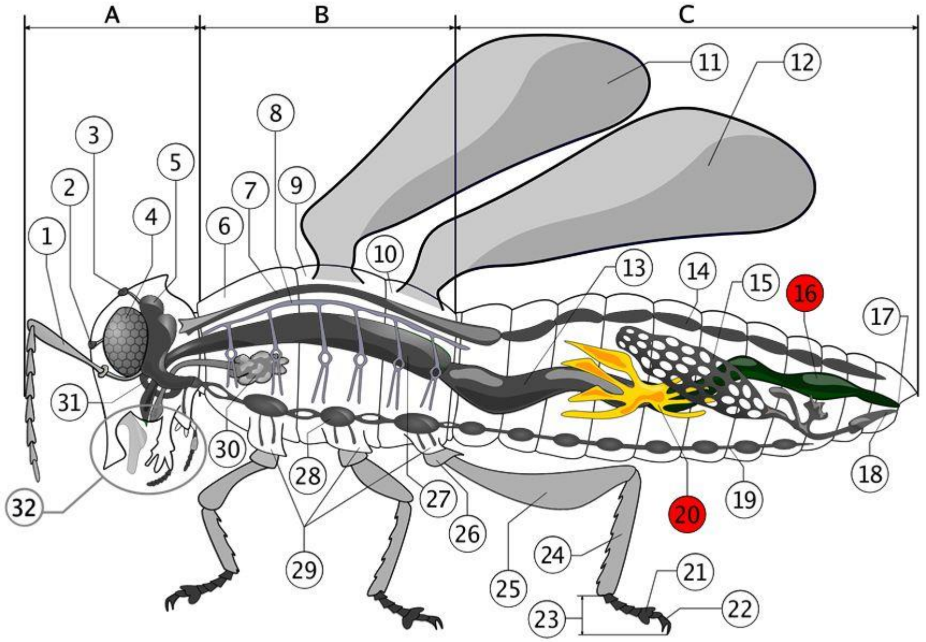
Morphological, Anatomical, and Molecular Approaches to Taxonomy

- **Morphological Taxonomy**:
- Study of the external and internal physical characteristics of organisms for classification. This includes features such as shape, size, color, and structure of various body parts.



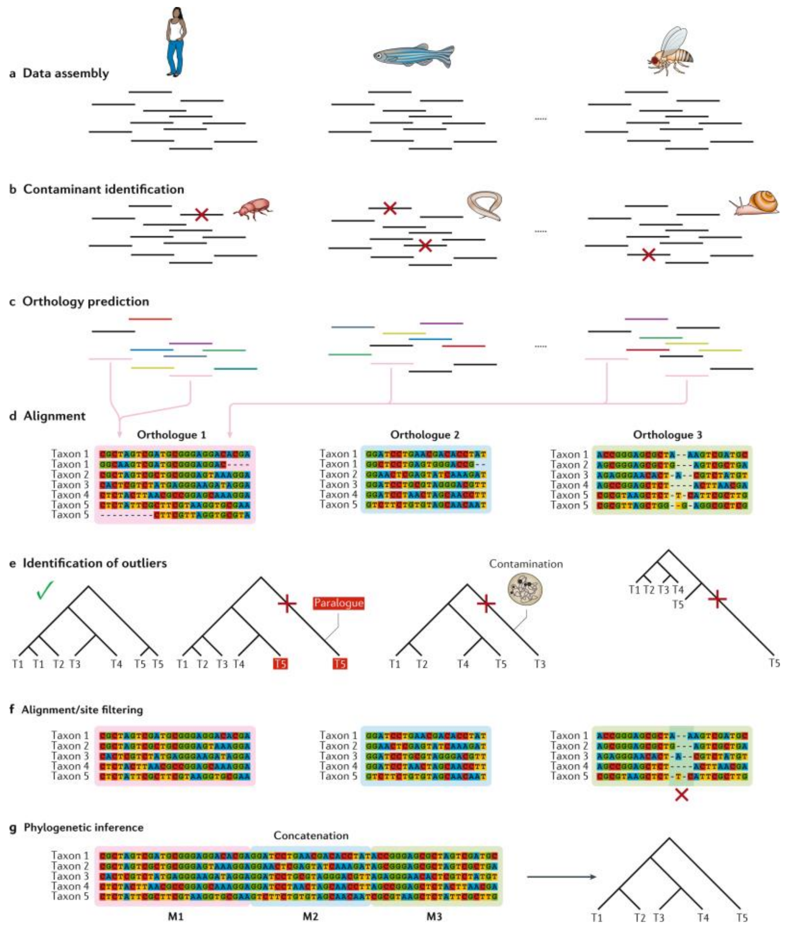
Morphological, Anatomical, and Molecular Approaches to Taxonomy

- **Anatomical Taxonomy**: Examination of internal structures and organs of organisms, often requiring dissection and microscopic analysis.



Morphological, Anatomical, and Molecular Approaches to Taxonomy

- **Molecular Taxonomy**:
- Use of molecular techniques, such as DNA sequencing, to determine evolutionary relationships among organisms. This includes DNA barcoding for species identification and phylogenetic analysis for reconstructing evolutionary trees.



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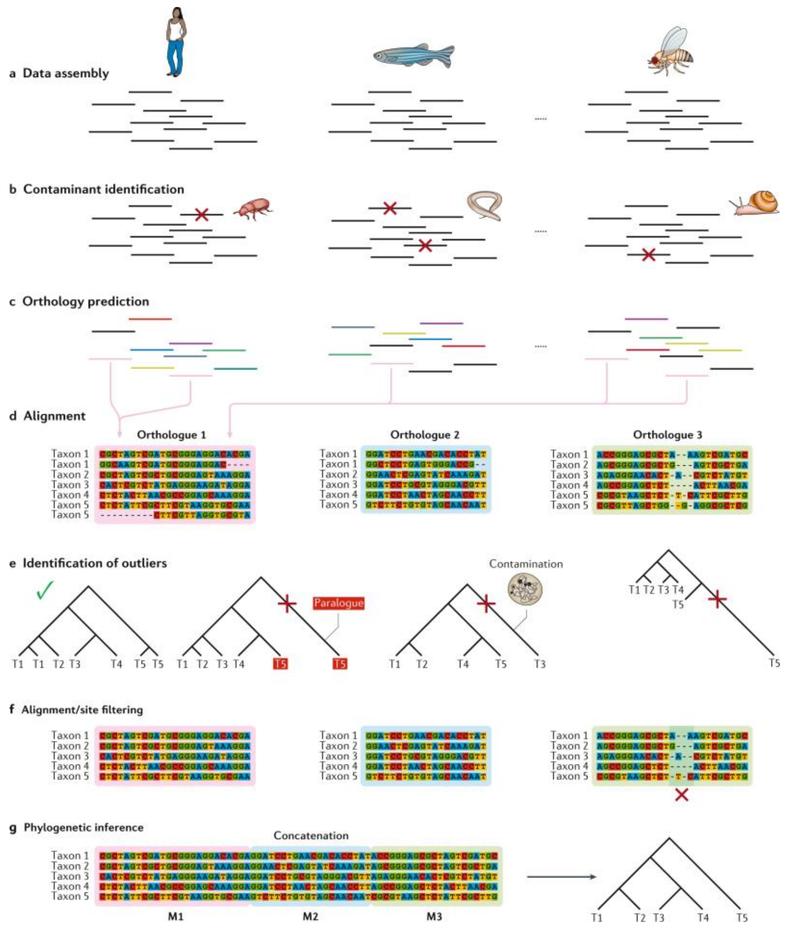
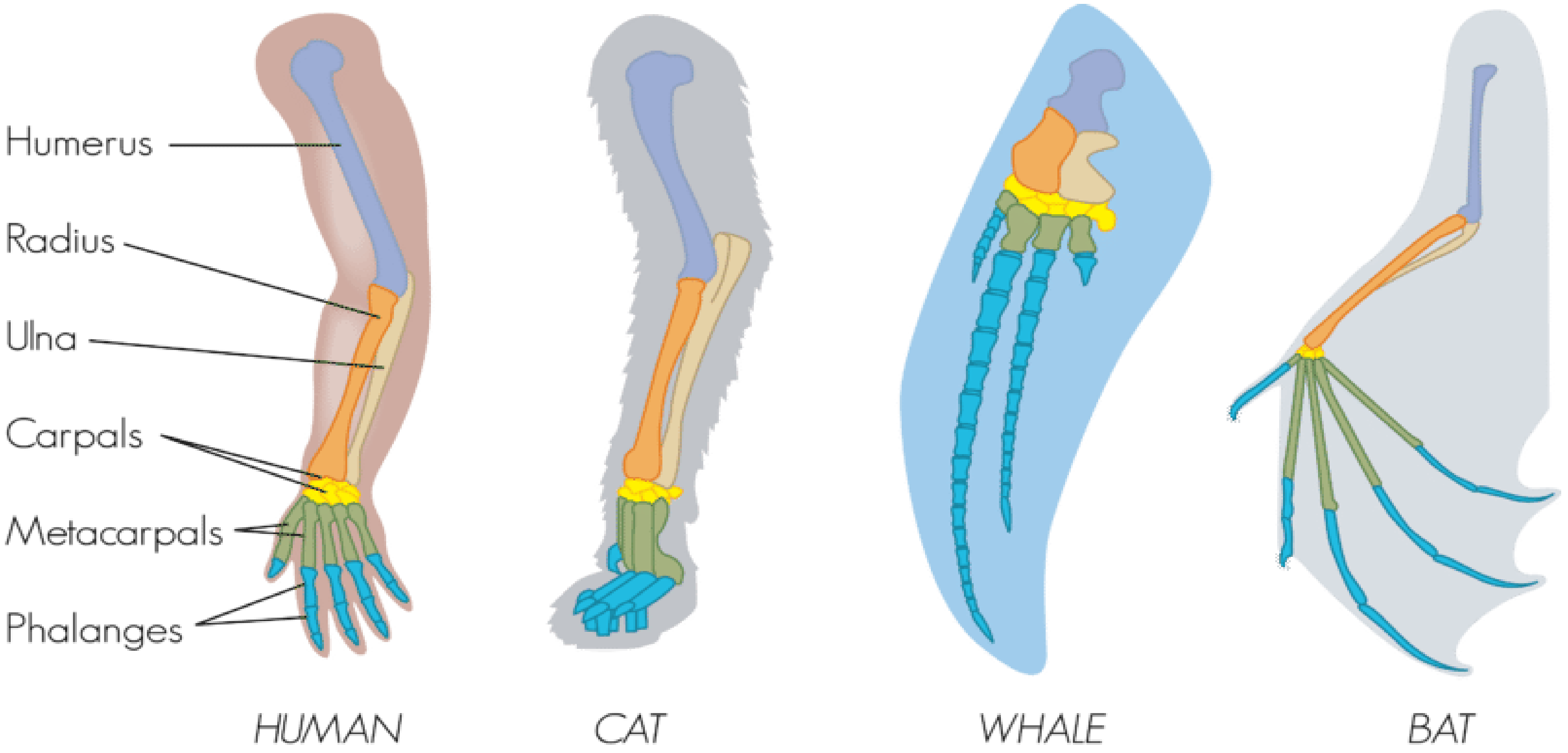


Morphological, Anatomical, and Molecular Approaches to Taxonomy

- **Comparative Anatomy and Homology**: Understanding homologous structures across different species and their significance in evolutionary relationships.



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Lab 3, 4
Molecular Techniques in Biosystematics

Dr.Khattab Al-Khafaji

3rd Level

PCR and DNA Sequencing:

- 1. **DNA Extraction:**
- **Objective:** Extract DNA from biological samples (e.g., cells or tissues).
- **Procedure:** Students will perform DNA extraction using various methods such as phenol-chloroform extraction, silica membrane-based extraction, or commercial kits.
- **Importance:** Understanding the initial step in molecular biology and genomics research.
- 2. **Polymerase Chain Reaction (PCR):**
- **Objective:** Amplify specific DNA regions using PCR technique.
- **Procedure:** Students will set up PCR reactions, including preparing reaction mixtures, adding DNA templates, and running thermal cycling.
- **Importance:** Hands-on experience in a fundamental technique for DNA amplification.

- 3. **DNA Sequencing:**
- **Objective:** Determine the nucleotide sequence of amplified DNA.
- **Procedure:** Introduction to Sanger sequencing or Next-Generation Sequencing (NGS) methods, including sample preparation, sequencing reactions, and data analysis.
- **Importance:** Practical exposure to the technology that enables decoding the genetic information.

- 4. **Analysis of Obtained Sequences:**
- **Objective:** Interpretation of raw sequence data.
- **Procedure:** Students will learn to use bioinformatics tools to clean, align, and analyze sequencing data.
- **Importance:** Connecting the experimental work with bioinformatics skills for meaningful interpretation.

Phylogenetic Tree Construction:

- 1. **Using Software for Phylogenetic Trees:**
- **Objective:** Understand the evolutionary relationships among organisms.
- **Procedure:** Students will use bioinformatics software (e.g., MEGA, PhyloSuite) to input aligned sequences and construct phylogenetic trees.
- **Importance:** Visualization and interpretation of evolutionary patterns.

- 2. **Interpretation of Tree Topologies:**
- **Objective:** Analyze and draw conclusions from the constructed phylogenetic trees.
- **Procedure:** Students will explore the branching patterns, node distances, and evolutionary significance of the constructed trees.
- **Importance:** Developing skills in interpreting and communicating biological relationships.

- 3. **Discussion and Presentation:**
- **Objective:** Communicate findings and insights.
- **Procedure:** Students will discuss and present their phylogenetic tree interpretations, fostering scientific communication skills.
- **Importance:** Integration of experimental and computational biology with effective communication.

- These practical activities aim to provide a comprehensive understanding of molecular biology techniques, sequencing technologies, and bioinformatics analysis in the context of evolutionary relationships among organisms. Students will gain hands-on skills essential for both laboratory work and data interpretation, preparing them for various applications in genetics, genomics, and evolutionary biology.

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Lab 5,6
Molecular Techniques in Biosystematics

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Field Trip:

- 1. **Collection of Plant and Insect Specimens:**
- **Objective:** Acquire firsthand experience in biodiversity sampling.
- **Procedure:** Students will use various collection methods (nets, traps, etc.) to capture insects and collect plant specimens. Emphasis on ethical and sustainable collection practices.
- **Importance:** Understanding the diversity of local ecosystems and the importance of specimen preservation.

- 2. **Specimen Preparation in the Field:**
- **Objective:** Learn proper techniques for preserving specimens.
- **Procedure:** Students will practice techniques such as pinning insects, pressing and drying plants, or preserving samples in suitable containers.
- **Importance:** Preservation of specimens for future study and reference.

Morphological Identification:

- 1. **Hands-on Identification Using Dichotomous Keys:**
- **Objective:** Develop skills in using dichotomous keys for identification.
- **Procedure:** Students will be provided with dichotomous keys for both plant and insect specimens. They will work through the keys, making choices based on morphological characteristics to arrive at correct identifications.
- **Importance:** Understanding the systematic approach to identification and recognizing the importance of morphological traits in taxonomy.

- 2. **Recognition of Diagnostic Features:**
- **Objective:** Identify and understand the significance of key features.
- **Procedure:** Instructors will guide students in observing and recognizing diagnostic features such as leaf arrangements, flower structures, insect wing venation, and other characteristics crucial for accurate identification.
- **Importance:** Building a foundation for accurate species identification based on observable traits.

- 3. **Species Documentation and Recording:**
- **Objective:** Document and record identified species.
- **Procedure:** Students will maintain a field notebook or use digital tools to record details like location, date, habitat, and observed features for each collected specimen.
- **Importance:** Creating a record for future reference and contributing to biodiversity databases.

- **Overall:**
- The field trip and associated activities aim to immerse students in the practical aspects of field biology, providing them with valuable skills in specimen collection, preservation, and identification. The emphasis on using dichotomous keys and recognizing diagnostic features enhances their ability to navigate taxonomic literature and contribute to ecological research. Additionally, documenting and recording findings contribute to a broader understanding of local biodiversity.

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Lab7,8
Species Concepts and Hybridization

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Hybrid Identification:

- 1. **Analyzing Specimens for Signs of Hybridization:**
- **Objective:** Develop skills in identifying hybrid organisms.
- **Procedure:** Students will examine specimens collected from the field trip and other sources, looking for morphological, genetic, or behavioral indicators of hybridization.
- **Importance:** Understanding the complexities of species boundaries and the occurrence of hybridization in nature.

- 2. **Case Studies on Hybrid Species:**
- **Objective:** Explore real-world examples of hybridization.
- **Procedure:** In-depth examination of case studies involving hybrid species, covering the ecological, genetic, and evolutionary aspects. Students analyze literature and relevant data.
- **Importance:** Gaining insights into the consequences of hybridization and its role in species evolution.

Species Concept Debate:

- 1. **Group Discussions on Different Species Concepts:**
- **Objective:** Explore and understand various species concepts.
- **Procedure:** Students participate in group discussions focusing on biological, morphological, ecological, and genetic species concepts. Emphasis on the strengths and limitations of each concept.
- **Importance:** Developing a comprehensive understanding of the diverse ways species are defined in biology.

- 2. **Presentations and Critical Analysis:**
- **Objective:** Present and critically analyze different species concepts.
- **Procedure:** Each group prepares a presentation discussing a specific species concept, highlighting its applications and challenges. Presentations are followed by open discussions.
- **Importance:** Encouraging students to think critically about the implications of different species concepts on biodiversity research and conservation.

- 3. **Debates on Controversial Cases:**
- **Objective:** Engage in debates on controversial species cases.
- **Procedure:** Students take on roles advocating for different species concepts in debates on cases where species boundaries are contentious. This may involve using real-world examples.
- **Importance:** Enhancing communication and argumentation skills, as well as understanding the complexities of defining species.

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Lab 9,10
Current Issues and Conservation Applications

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Conservation Project:

- 1. **Project Design:**
- **Objective:** Develop a conservation plan grounded in biosystematic principles.
- **Procedure:** Students will choose a target species or ecosystem, considering its ecological and genetic characteristics. They will analyze the distribution, population dynamics, and potential threats using biosystematic data.
- **Importance:** Applying biosystematic knowledge to real-world conservation challenges.

- 2. **Literature Review:**
- **Objective:** Understand the existing knowledge and conservation status of the chosen species or ecosystem.
- **Procedure:** Students conduct a thorough review of scientific literature, including biosystematic studies, population genetics, and ecological assessments related to their selected conservation project.
- **Importance:** Ensuring the conservation plan is informed by the latest scientific insights.

- 3. **Field Assessment:**
- **Objective:** Collect additional field data to support the conservation plan.
- **Procedure:** Depending on the chosen project, students may conduct field surveys, monitor populations, or gather additional biosystematic information. This may involve collaboration with local experts or conservation organizations.
- **Importance:** Integrating hands-on fieldwork with theoretical knowledge.

- 4. **Data Analysis:**
- **Objective:** Analyze biosystematic data to inform conservation strategies.
- **Procedure:** Students will use statistical and analytical tools to process and interpret the collected data. This could include genetic analyses, population modeling, or assessing ecological parameters.
- **Importance:** Ensuring data-driven decision-making in conservation planning.

- 5. **Conservation Plan Development:**
- **Objective:** Create a comprehensive conservation plan based on biosystematic insights.
- **Procedure:** Students integrate the findings from their literature review, field assessment, and data analysis to develop a conservation plan. This plan should address key threats, propose management strategies, and consider the genetic diversity of the target species or ecosystem.
- **Importance:** Translating biosystematic knowledge into practical conservation actions.

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- **Objective:** Create a comprehensive conservation plan based on biosystematic insights.
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