NJU Principles of Paleobiology

Spring Semester, 2025

Mid-Term Examination

True-False Questions
Identify the following statements as being either true (**T**) or false (**F**).

1. The reason why so many different species concepts exist is that each mixes the qualities of a theory-neutral definition of discontinuities in variation with ideas about how those discontinuities arise and are maintained. **T**

2. Van Valen showed that their were more fossil taxa with short stratigraphic ranges than with long stratigraphic ranges. **T**

3. The basic data of paleobiology is morphology. **T**

4. Biological systematics is the study of the diversity of living forms (past and present) and their relations to one another and to their environment. **T**

5. Empirical data reassures us that taxonomic experts can be relied upon to provide correct and consistent identifications of biological species (Recent and fossil). **F**

6. The term "homology" refers to incomplete or degenerate remnant of an organ or structure in some species that functions in a normal sense and for a definite purpose in similar species. **F**

7. A synapomorphy is a novel trait or character that is unique to a particular group of phylogenetically related species. **F**

8. In describing a new fossil species it is only necessary to write out a description of the characteristics that will allow the new taxon to be distinguished from closely related taxa. **F**

9. Haeckel's and Darwin's representations of evolutionary trees were quite similar, underscoring similarities in their respective concepts of evolutionary processes. **F**

10. Evolutionary systematics sought to add objectivity and quantitative rigor to evolutionary systematics through the use of multivariate data analysis (e.g., ordination). **F**

11. Diachrony is the condition occupying different points in time. **T**

12. Periodization is a technique that can be used to infer the relative order of historical events based on the relation of those events to major transitions (cultural, technological, biotic, evolutionary). **T**

13. Biostratigraphy is the branch of stratigraphy that enables the assignment of dates to events in geologic time. **F**

14. Darwin was not concerned with the criteria used to define species (Recent and fossil) because he regarded all species to be arbitrary segments of continuously changing evolutionary lineages. **T**

15. The Linnean system of biological classification is an example of a hierarchical classification. **T**

16. Leonardo da Vinci showed how mathematics could be used to create a model of any organic body (Recent or fossil). **F**

17. Steno's "Law" of original horizontality states that, since each layer of unconsolidated sediment deposited on a solid base must have formed after the basal layer has been deposited, overlying layers of sediment are younger than underlying layers. **F**

18. The amount of time averaging characteristic of a fossil assemblage might range from days to a maximum of 10,000 years **F**

19. Simpson's evolutionary species concept requires that, whenever reproductive isolation occurs within a formerly contiguous population, two new species are formed and the parent species becomes extinct. **F**

20. Ideally, the representation of fossil morphologies by way of sets of landmark locations requires that all landmarks be able to be located unambiguously across all specimens included in an investigation.   **T**

21. Gingerich's stratophenetics represents the only available procedure that attempts to include patterns in stratigraphic first appearances as criteria that can be used to infer phylogenetic relations among species.   **F**

22. Chronostratigraphy is the scale of numerical time intervals, in terns of days, months, years, millennia, etc., geologists used to locate events in the Earth's past.   **F**
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23. Fossils can be used to characterize layers of rock.   **T**

24. Identification is the act determining how many groups a large set of objects, ideas, concepts, etc. may be divided into.   **F**

25. Ordination is a mathematical technique whereby similarity relations between objects can be summarized and portrayed graphically.   **T**

26. Sepkoski showed that there was no consistent structure in the family-level richness histories across fossil groups.   **F**

27. Linnaeus proposed that species (Recent and fossil) be recognized on the basis of both positive and negative evidence.   **F**

28. The "curse of dimensionality" holds that it is impossible for humans to conceive of mathematical spaces whose dimensionality is greater than three (3).   **F**

29. A clade is a group composed of the common ancestor of a evolutionary lineage and all of that ancestor's descendants.   **T**

30. A body fossil is the remains of a once living organism whose materials have been replaced, either by alternative forms of the original mineral or minerals precipitated from groundwater.   **T**

Matching
Match the items in following lists.

31.Assign the following characteristics to the appropriate systematic philosophy or approach category. Note: a characteristic may be able to be assigned to more than a single category.

A. Based on an assessment of the pattern of pairwise average similarities calculated across many different characters.

B. Employs stratigraphic first-appearance data in the inference of phylogenetic relations.

C. Seeks to create a holistic and synthetic summary of evolutionary relations by taking advantage of different sources of information (e.g., morphology, ecology, stratigraphy, geography).

D. Restricts the type of data that can be used to infer valid phylogenetic relations.

E. Results in the specification of monophyletic, paraphyletic and polyphyletic groups.

i. Evolutionary Systematics

ii. Phenetic Systematics

iii. Phylogenetic Systematics

iv. Stratophenetics

v. Stratocladistics

31.   A.   ii   B.   iv, v   C.   i   D.   iii   E.   i, ii

32. Match the follow images to the appropriate fossil preservation types.

A.   B.

    i.   Body Fossil

    ii.   Cast Fossil

    iii. Mold Fossil
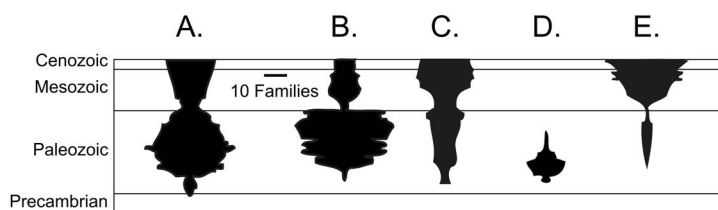
    iv. Trace Fossil

    v.   Indeterminate

C.   D.   E.

32.   A. __iii__ B. __i__ C. __i__ D. __ii__ E. __iii__

33. Assign each spindle diagram to the appropriate evolutionary fauna.

    i.   Modern Fauna

    ii.   Cenozoic Fauna

    iii. Mesozoic Fauna

    iv. Paleozoic Fauna

    v.   Cambrian Fauna

33.   A. __iv__ B. __iv__ C. __i__ D. __v__ E. __i__

34. Match the following attribute with the correct species concept. Note: an attribute may match more than a single concept.

A. Views species as representing a single lineage of ancestor-descendant populations which maintains its identity from other such lineages and has its own evolutionary tendencies.

B. Emphasizes the process of reproductive isolation as being critical to the creation of new species, but is agnostic with regard to the mechanisms by which this isolation might come about.

C. Specifies that, whenever reproductive isolation occurs within a formerly contiguous population, two new species are formed and the parent species becomes extinct.

D. Considers species as being the smallest aggregation of populations (sexual) or lineages (asexual) diagnosable by a unique combination of character states in comparable individuals.

E. Regards species as being any set of organisms that are phenotypically similar to one another and phenotypically different from members of other species.

i. Evolutionary Species Concept

ii. Hennig's Species Concept

iii. Phylogenetic Species Concept

iv. Phenetic Species Concept

v. Biological Species Concept

34. A. __i__ B. __v__ C. __ii__ D. __iii__ E. __iv__

35. Match the following list of attributes to the correct type of stratigraphy.

A. Does not require its fundamental unit to be mappable.

B. A unit that cannot be observed directly; but must be inferred based on various other stratigraphic criteria.

C. The branch of stratigraphy that characterizes rock layers by their physical (compositional) content.

D. Assesses the relative placement to stratigraphic units based on their fossil content.

E. A unit that cannot be observed directly; but must be inferred based on a preserved field-based characteristic of the Earth as a planetary body.

i. Lithostratigraphy

ii. Biostratigraphy

iii. Magnetostratigraphy

iv. Isotopic/Chemostratigraphy

v. Chronostratigraphy

35. A. __iii__ B. __iii, iv, v__ C. __i__ D. __ii__ E. __iii__

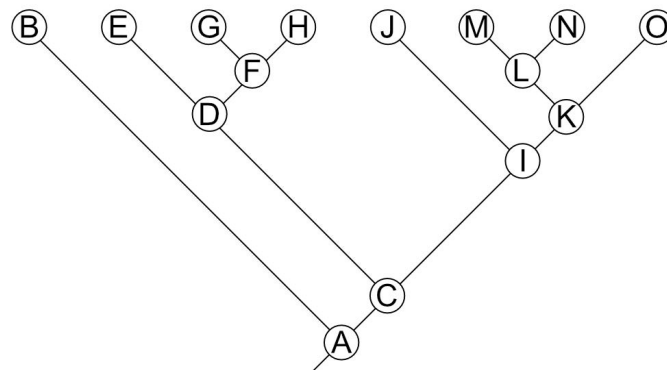36. Match the landmark to the correct landmark type.
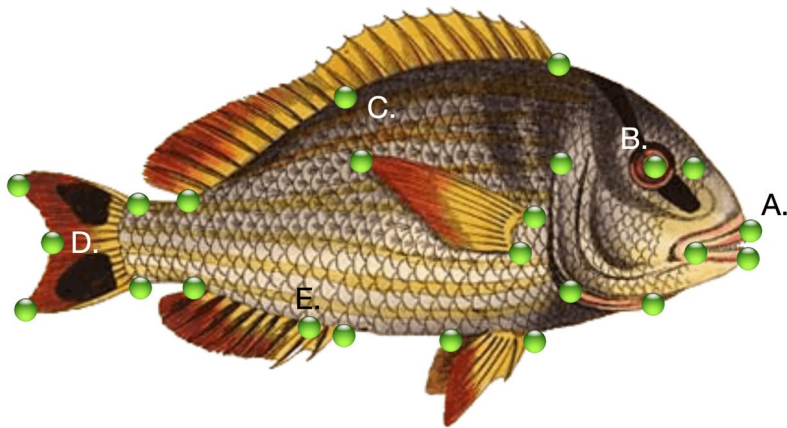
i.   Type 1 Landmak

ii. Type 2 Landmrk

iii. Type 3 Landmark

iv. Semilandmark

36.   A.   i or iii   B.   i or iii   C.   i   D.   ii   E.   i

37. Match the following sets of taxa with the correct phylogenetic group type.

a. D - E - F - G - H

b. M - N - O - G - H - B - E

c. I - J - K - L - M - N

d. M - N - O - L - K

e. F - G - H - J

i.   Monophyletic Group

ii. Polyphyletic Group

iii. Paraphyletic Group

37.   A.   i   B.   ii   C.   iii   D.   i   E.   ii

38. Match the concept description to the correct concept name.

A. Unconsolidated sediments deposited on a solid base would have formed continuous sheets or bands of material.

B. The self-renewing process of sediment deposition, uplift, deformation and erosion.

C. Any rock body (A) that intrudes into another rock body (B) must be the younger of the two.

D. The idea that changes to landscapes in geological history result chiefly from sudden, violent and unusual events.

E. The characterization and arrangement of rock bodies in their superposition sequence based on their unique fossil content, irrespective of the sequence of lithologies.

i. Smith's Law of Faunal Succession

ii. Hutton's Law of Cross-Cutting Relations

iii. Cuvier's Principle of Catastrophism

iv. Hutton's Uniformitarian Rock Cycle

v. Steno's Law of Original Horizontality

38.   A. ___v___   B. ___iv___   C. ___ii___   D. ___iii___   E. ___i___

39. Match the paleobiological classification category set to the correct classification.

A. Bathymetry

B. Biogeographic Relam

C. Lithostratigraphy

D. Habitat

E. Topography

i.   Valley

ii. Neritic

iii. Australasian

iv. Grassland

v.   Formation

39.   A. ___ii___   B. ___iii___   C. ___v___   D. ___iv___   E. ___i___

40. Place the following characters in their correct phylogenetic character category.

Species	A. 1	2	3	4	5	B. 6	7	8	9	C. 10	11	D. 12	13	14	15	16	17	18	19	20	E. 21	11
A										1	1	1										
B										1			1				1		1			
C	1			1						1							1		1	1		
D	1									1						1	1		1	1		
E	1		1							1							1	1	1	1		
F		1								1				1	1		1		1			
G			1				1			1				1	1		1		1			
H								1	1	1				1	1		1		1			
I						1				1		1									1	1
J							1			1		1									1	1
K			1							1		1									1	1

i.   Apomorphy

ii. Autapomorphy

iii. Plesimorphy

iv. Synapomorphy

v.   Synplesiomorphy

40.   A.   iv   B.   ii   C.   iv   D.   v   E.   iv

Multiple-Choice Questions
Select the correct answer from the alternative lists provided. More than one alternative may be correct. Be sure you select the best answer that is correct.

41.   From the following list identify the types of uniformitarianism outlined by Charles Lyell.
      a. Uniformity of law
      b. Uniformity of form
      c. Uniformity of rate
      d. Uniformity of state
      e. All the above

42.   Identify the topics that need to be included in any complete description of a fossil species.

      a. Written description
      b. Diagnosis
      c. Type locality
      d. Known stratigraphic range
      e. All the above

43.   According to Albert Oppel, and index fossil is …

      a. … a fossil that's easy to identify
      b. … a fossil that's geographically widespread
      c. … a fossil taxon selected to give its name to a chronostratigraphically useful assemblage of fossils.
      d. … a fossil with a narrow stratigraphic range
      e. All the above

44. Based on his analysis of 25,000 stratigraphic successions, Sadler (1981) found with of the following statements to be true

    a. Rates of rock accumulation over time were highly variable.
    b. There exists a positive association between the stratigraphic thickness and the timespan of sediment accumulation
    c. Generally speaking long stratigraphic successions are less complete than short stratigraphic successions.
    d. All stratigraphic successions are complete at some level of time resolution.
    e. All of the above

45. Identify the attributes of the principle of parsimony.

    a. The simplest hypothesis or explanation
    b. The hypothesis that existed the greatest level of consistency across the data as a whole.
    c. The hypothesis that is perfectly consistent with the data.
    d. All the above
    e. None of the above

46. Identify the primary principles used to order the fossil record.

    a. Stratigraphy (Time)
    b. Geography
    c. Phylogeny
    d. Taxonomy
    e. Ecology

47. Identify the systematic philosophies and methods that accept polyphyletic and paraphyletic groupings of taxa.

    a. Evolutionary systematics
    b. Phenetic systematics
    c. Phylogenetic systematics
    d. Stratophenetics
    e. Stratocladistics

48. Identify the factors that experimental taphonomy has identified as being important in determining the preservation potential of taxa.

    a. Agitation (probability of physical disturbance)
    b. Resistance of skeleton to breakage
    c. Temperature
    d. Time prior to burial
    e. All the above

49. Identify the attributes of expert zooplankton taxonomists documented by the SCOR WG-30 Project.

    a. Tally counts of identifiable taxa exhibited wide variation between taxonomic experts.
    b. Self consistency of expert identifications are variable between different taxonomic groups.
    c. Expert count consistencies were higher overall and binning consistencies.
    d. Expert identification performance exhibited with-laboratory similarities, but between-laboratory differences.
    e. None of the above

50. Identify the attributes of a hierarchical classification system.

    a. Organized into a series of progressively more inclusive groups
    b. Members of higher (more specific) categories exhibit all the attributes of the lower-level (more generalized) categories.
    c. Reflects a nested series of relations between classification-category attributes.
    d. All the above
    e. None of the above

51. Identify the utility of data from fossil taxa in a phylogenetic analysis.

    a. Addition of new character states
    b. Resolution of ambiguous character-state transitions
    c. Improvement of tree quality indices
    d. Clarification of relations among extent taxa
    e. None of the above

52. Identify which of the following evolutionary character distributions can be used to create a hierarchical biological classification system.

    a. Monophyletic distribution
    b. Polyphyletic distribution
    c. Paraphyletic distribution
    d. All the above
    e. None of the above

53. Identify the periodization terms that refer to chronostratigraphic categorization.

    a. Eon
    b. Erathem
    c. Period
    d. Series
    e. Stage

54. From the following list identify the procedures used in geochronologic analysis.

    a. Astrostratigraphic dating
    b. Cosmogenic nucleotide dating
    c. Dendrochronologic dating
    d. Rare earth & heavy metal dating
    e. Radioisotopic dating

55. Identify the statements that are true of Type 3 landmarks.

    a. A topological point that represents a biological homology across all specimens in the sample.
    b. A topological point that represents the juxtaposition of different tissues, organs, bones, sutures.
    c. a topological point whose location contains at least one 'deficient' or 'dependent' coordinate.
    d. a topological point that represents some geometric aspect of the form.
    e. A topological point whose location is referenced to the preceding position in a unified geometric sequence.

56. Identify the primary uses of ordination methods in paleobiological contexts.

    a. Summarization of similarities and differences among objects and/or variables in complex sets of data
    b. Statistical hypothesis testing via comparison with probability distributions
    c. Visualization of relations between and among groups
    d. Dimensionality reduction
    e. All the above

57. Identify the attributes of a ancestral taxon in phylogenetic systematics.

    a. Possession of unique autapomorphic character states.
    b. Possession of a unique set of synapomorphic character states.
    c. Possession only of synplesiomorphic character states.
    d. Possession of a unique set of synplesiomorphic character states.
    e. None of the above

58. Identify the marine environments characterized by fossil assemblages whose time averages would typically be > 100 years.

   a. Event beds
   b. Forereef beds
   c. Hiatal hard grounds
   d. Lagerstaatten
   e. Rafted remains

59. Identify the taxonomic groups that have high (> 75%) preservation potential.

   a. Asterozoa (starfish)
   b. Bivalvia (pelecypods)
   c. Brachiopoda
   d. Cephalopoda (ammonites, squid, octopi)
   e. Malacostraca (crustaceans)

60. Identify situations in which it would be appropriate to use landmark coordinates to represent the forms of a set of fossils.

   a. Whenever a digital image of the fossil morphologies can be obtained.
   b. When the location of a structural component part (or aspect thereof) can be represented by a single point.
   c. Whenever an accurate representation of the form's overall geometry is needed.
   d. When the hypothesis under consideration pertains to, or can be reasonably supposed to involve, structures whose positions relative to other structures that can be represented by sets of landmark points.
   e. All the above

61. Identify the factors that affect human performance in the task of assigning objects to a classification category.

   a. Ambient environment
   b. Experience at this task
   c. Objectivity of category definitions
   d. Motivation
   e. Time allotted to the task

62. Identify the strategies that can be used to polarize multi-state characters in a phylogenetic systematic analysis.

   a. Allometric polarization
   b. Cluster polarization
   c. Outgroup polarization
   d. Ontogenetic polarization
   e. Unpolarized

63. Identify which of the items in the following list constitute evidence for evolution.

   a. Similarity of structures
   b. Presence of intermediates
   c. Presence of analogous organs and structures (e.g., eyes, claws, wings)
   d. All the above
   e. None of the above

64. Identify the advantages of principal components analysis (PCA).

   a. Results in a re-description of the data based on a set of linear combinations of all variables (= the principle components)
   b. Principal components aligned geometrically with major directions of variation in the data
   c. Principal components mutually orthogonal (oriented at right angles) to one another
   d. Principle components always find group-level structure in the data
   e. All the above

65. Identify the component parts of a taxon range zone.

    a. Global first appearance
    b. Diachronous local first occurrences
    c. Finite geographic range
    d. Isochronous last occurrences
    e. Global last appearance

66. Identify the indices used to assess compare alternative arrangements of taxa in phylogenetic systematics.

    a. Count of the number of tree branches
    b. Tree Length
    c. Sum of all eigenvalues
    d. Consistency Index
    e. Retention Index

67. Identify the primary advantages of phenetic systematics.

    a. Ability to integrate data from different sources objectively
    b. Ability to extend the scope and sensitivity of data analysis over that which can be achieved using qualitative and/or narrative methods
    c. Ability to distinguish between monophyletic, polyphyletic and paraphyletic groups
    d. All the above
    e. None of the above

68. Identify the different types of allometry.

    a. Ecological
    b. Ontogenetic
    c. Physiologic
    d. Phylogenetic
    e. Static

69. In order to obtain a valid ordination result the relation between sample size and the number of variables collected should conform to which of the following relations. Choose the best answer.

    a. Sample size << number of variables
    b. Sample size < number of variables
    c. Sample size = number of variables
    d. Sample size > number of variables
    e. Sample size >> number of variables

70. Identify the attributes of systematics fro the following list.

    a. Study of the patterns, rates and causes of species diversification over time
    b. Establishes category names and arrangements into taxonomic categories that facilitate study
    c. Discovers discontinuities of the structure of objects, concepts, ideas
    d. Provides explanations as to how discontinuities originated and were/are maintained over time
    e. Changes primarily as a result of conceptual and theory-based advances in our understanding of species

71. Identify the unique disadvantages inherent in the representation of fossil forms using a set of linear distances.

    a. Distance endpoints usually specified only approximately.
    b. Sets of distances usually cannot be collected for many complex characteristics
    c. Distances only measure morphological variation in certain directions.
    d. Sets of linear distances cannot retain any geometric information.
    e. All the above

72. Identify the characteristics of a fossil taxon associated with the modern index fossil concept.

    a. Ease of identification
    b. Long stratigraphic range
    c. Wide geographic distribution
    d. All the above
    e. None of the above

73. Identify the types of stratigraphy for which chronostratigraphic inferences can be made with confidence in single stratigraphic successions.

    a. Lithostratigraphy
    b. Biostratigraphy
    c. Magnetostratigraphy
    d. All the above
    e. None of the above

74. Identify the advantages of using thin plate spine representations of differences between geometric forms.

    a. Easy to interpret
    b. Can be used to extend the researcher's level of perception
    c. Can be used to quantify shape similarities and/or differences in the form of a distance.
    d. Results valid across the entire deformation grid
    e. All the above

75. In the following list, identify which of the numerical taxonomic methods could be used in the data consists of both dependent and independent variables.

    a. Cluster analysis
    b. Canonical analysis
    c. Factor analysis
    d. Multiple regression
    e. All the above