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Chapter 2 Biodiversity and classification

Question set 2.1

Remembering

1 Diversity can be considered at the levels of species, ecosystems and genetics.

2 **a** The biological species concept defines a species as a group of organisms whose members have the potential to interbreed in nature and produce viable, fertile offspring.

b The morphological species concept characterises a species by its form, or morphology.

c The phylogenetic species concept identifies a species as being the smallest group of organisms who can all trace their origins to a single common ancestor.

3 An ecosystem is made up of an interacting community of populations of organisms and the physical environment in which they live. Ecosystems are made of biotic components (living things) and abiotic components (non-living things).

Understanding

4 The biological species concept is limited for the following reasons:

- It is not possible to apply it to fossils of extinct organisms, since it is impossible to know which individuals could interbreed with another.
- It is not possible to apply it to zones where two identified species have populations that overlap. Hybrids are difficult to classify as they are the result of individuals from two different species interbreeding.

5 Biodiversity is the term used to describe the variety of life within an area; for example, Sydney Harbour supports 570 different species of fish and 3600 species of invertebrates.

6 Even though dogs vary in their morphological features, they are able to interbreed and produce fertile offspring so they are all members of the same species.

7 The greater the species diversity in an ecosystem, the more complex and more stable the ecosystem seems to be. Low species diversity equals low ecosystem diversity and high species diversity means a more biodiverse ecosystem.

Creating

8 Biodiversity has been severely reduced due to the bushfire. The following reasons outline why funding is needed and urgently.

- Biodiversity is a vital factor in the long-term survival of all life on Earth, including the societies in which we live.
- It gives educational and cultural benefits. Biodiversity provides clues about the changes in species over time and is also used in the spiritual life of some people groups such as Aboriginal and Torres Strait Islander Peoples. Biodiversity – the land, waters and all living things – form Indigenous creation and Dreamtime stories and Songlines about how they and the world around them came to be. Their traditions, food and culture are inextricably tied to the Australian landscape and its biodiversity. Recreational use such as bushwalking is beneficial for human wellbeing.

- It supports ecosystem processes essential to survival, such as: photosynthesis for converting light energy to chemical energy that can flow through food webs and providing oxygen to living things; nutrient cycling, which uses organic and inorganic matter from dead and decomposing organisms to support to new life and simultaneously cleans up wastes; population control, which involves competition and predation and maintains a balance of organisms and diversity; and pollination required by plants for the distribution of pollen by organisms such as insects, birds and mammals.
- It is vital to tourism and economics: a large amount of revenue is attributable to activities that rely on biodiversity in Australia. Tourism brings people who spend money, and this finances jobs in areas with natural attractions.
- It helps to produce food, purified water and air, fibre products such as wool and cotton, fuels, climate control and pharmaceuticals.

Question set 2.2

Remembering

1 **a** Living or growing on land

b Relating to water, fresh or salt

Understanding

2 Spatial scales consider the space or area of distribution, whereas temporal scales consider the distribution over different periods of time, such as different seasons or years.

3 Spatial scales are beneficial for describing the distribution of species, particularly for endangered species. Such information may help scientists in their planning of conservation strategies. Scientists may look for causal factors such as changes in weather patterns due to climate change. Scientists record changes in populations over time and, as a result, estimates of extinction rates can also be calculated over geological time. Patterns of biodiversity over time can allow scientists to plan for conservation strategies.

Applying

4 **a** The spatial scale was helpful because it could be compared over time to determine if population numbers increased or decreased. It can also help scientists look for patterns such as the particular sites on the property that numbats inhabited the most (e.g. where there are hollow trees, providing safety from predators).

b Temporal scales are of benefit because scientists can determine whether numbat numbers increase or decrease, and whether this occurs at a high or low rate; all of which can help them plan appropriate conservations strategies.

Question set 2.3

Remembering

1 First, the diversity of life on Earth is so enormous that classifying organisms is a way of organising information. Organisation of information about organisms allows for patterns and trends to be observed and relationships between organisms to be better understood.

Second, classification allows biologists to analyse information about organisms.

Third, classifying organisms allows biologists to communicate effectively with one another. It allows biologists to identify organisms that have already been discovered.

Applying

2 **a** This will depend on students' responses. Some examples are classifying young people as primary, secondary or tertiary students, classifying types of music and classifying types of books such as fiction or non-fiction.

b This will depend on students' responses to question **2a**. For example, classifying the type of books shows there are broad groups that indicate what the subject matter is about. It will be useful when choosing a book to read as you will already know something about the style before you read the first pages.

3 **a** Classification systems are artificial. There may be exceptions to the system and there may be new species not yet discovered that may challenge the existing classification.

b This will depend on students' responses. Most students will discuss the benefits of classification systems outweighing the limitations.

Question set 2.4

Remembering

1 Carl Linnaeus developed the binomial system of naming organisms. Before Linnaeus introduced the binomial system, organisms had descriptive Latin names, which could be very long. His system revolutionised the way that scientists describe and communicate about organisms.

2 Animalia, Plantae, Protista and Fungi

3 The taxonomic level is the classification of organisms into a series of groups that form a hierarchy or series of nested levels.

Understanding

4 Organisms within a phylum can be grouped according to similar features; these smaller groupings are called classes.

5 A binomial name consists of two parts, a generic name and a specific name. The first part (generic name) denotes the genus and is common to all organisms within that genus, and the second part is specific to the species; for example, Australia's floral emblem the golden wattle has the name *Acacia pycnantha*.

Question set 2.5

Remembering

1 Classification is based on the idea of organisms that share the same characteristics being grouped together and separated from organisms that do not share these characteristics.

Understanding

2 **a** Classification based on physical characteristics includes the examples of the presence or absence of fur, feathers and a back bone, and the number of limbs.

b Classification based on methods of reproduction includes using asexual and sexual reproduction to classify organisms. Sexual reproduction involves the union of two gametes

produced by two different individuals. Asexual reproduction does not involve gametes and reproduction is from one individual. Some organisms are able to reproduce using both processes for reproduction depending on the environment.

c Classification based on molecular sequences includes the comparison of DNA and amino acid sequences between organisms to classify species. For example, if an amino acid sequence is similar between organisms the implication is that they are more closely related than organisms with sequences showing fewer similarities.

Question set 2.6

Remembering

1

Phyla (Number Of Species)	Description of Animal Phylum
Porifera (5500) Sponges	1) Asymmetrical (no definite symmetry) 2) Body is multicellular, with few tissues and no organs 3) Cells and tissues surround a water-filled space but there is no true body cavity 4) All are sessile (as an adult, live attached to something) 5) Reproduce sexually or asexually
Cnidaria (10 000) Jellyfish, sea anemones and corals	1) Radially symmetrical (body plan is circular with structures that radiate out) 2) Gastrovascular cavity with single opening that serves as both mouth and anus 3) Reproduce sexually or asexually 4) Simple, net-like nervous system 5) Live in aquatic environments, mostly marine
Platyhelminthes (20 000) Flatworms	1) Bilaterally symmetrical (left and right halves of body are mirror images) 2) Gastrovascular cavity with single opening that serves as both mouth and anus 3) Body has three layers of tissues, with organs 4) Body without cavity 5) Body has blind gut (mouth but no anus) 6) Flattened body shape
Mollusca (100 000) Molluscs	1) Bilaterally symmetrical 2) Body without cavity 3) Body has through gut (with mouth and anus) 4) Uses muscular foot for locomotion 5) Open circulatory system with heart and aorta

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Phyla (Number Of Species)	Description of Animal Phylum
Annelida (16 500) Segmented worms	1) Bilaterally symmetrical 2) Body has more than two cell layers, tissues and organs 3) Body cavity, nervous system and closed circulatory system 4) Body has through gut (with mouth and anus)
Nematoda (25 000) Roundworms	1) Bilaterally symmetrical 2) Cylindrical morphology 3) Body covered by tough cuticle (of collagen and chitin) 4) Alimentary canal (digestive system) with mouth and anus, but no circulatory system 5) Found in most aquatic habitats, soil, moist tissues of plants, and body fluids and tissues of animals
Arthropoda (1 000 000) Arthropods	1) Usually bilaterally symmetrical 2) Segmented 3) Hard exoskeleton (external skeleton) of protein and chitin 4) Most have through gut (with mouth and anus) 5) Jointed appendages (body parts attached to main trunk such as arms, legs, wings); have 3–400+ pairs of jointed legs
Echinodermata (7000) Starfish	1) Five-rayed symmetry, mostly radial, sometimes bilateral 2) Body has more than two cell layers, tissues and organs 3) Thin epidermis covering an endoskeleton; most species prickly due to skeletal bumps and spines 4) Most have short, through gut (with mouth and anus) 5) Body shape highly variable, but with no head
Chordata (57 000) Chordates	1) Ninety per cent are vertebrates (have backbones), but Chordata does include two invertebrate groups 2) Have the following features during development (possibly as embryo): • pharyngeal slits: series of openings connecting inside of throat to outside of 'neck'; often, but not always, used as gills • dorsal nerve cord: bundle of nerve fibres running down the 'back'; connects brain with lateral muscles and other organs • notochord: cartilaginous rod running underneath nerve cord • post-anal tail 3) Closed circulatory system with blood transported in arteries, veins and capillaries 4) Bilaterally symmetrical

Understanding

2 Echidnas are a marsupial and a mammal. All mammals are endothermic because they can generate heat using metabolic activity. This allows them to regulate their internal body temperature.

Applying

3 A bat is a mammal because it produces milk for its young from mammary glands and gives birth to live young, whereas birds lay eggs.

Question set 2.7

Remembering

1

Phylum	Three distinguishing features
Bryophytes	No true leaves, stems or roots No vascular tissue Reproduce via spores
Pteridophytes/Ferns	Leaves, roots, stems present Vascular tissue present Reproduce using spores Leaves arranged in pairs on opposite sides of stem
Gymnosperms	Leaves, roots, stems present Vascular tissue present Reproduce using seeds in cones
Angiosperms	Leaves, roots, stems present Vascular tissue present Reproduce using seeds in fruits Sex organs in flower

Understanding

2 Angiosperms, or flowering plants, are classified further into monocotyledons and dicotyledons. Features of the two groups differ from the embryo stage to the adult stage. In the embroyonic stage, monocotyledons have one cotyledon (embryonic leaf), whereas dicotyledons have two. Other differences include parallel venation of leaves in monocotyledons, whereas dicotyledons have a network of veins in their leaves. The root system also differs, with monocotyledons having a 'tap root' system whereas dicotyledons have a fibrous root system. Monocotyledons have petals in multiples of three, whereas dicotyledons have petals in multiples of four or five. Examples of monocotyledons include grains (wheat and corn), grasses, sugar and daffodils. Examples of dicotyledons include legumes (peas and beans), tomatoes and daisies.

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Question set 2.8

Remembering

1 Physical characteristics, reproductive methods and molecular sequences

2 Dichotomous keys are tools used to identify organisms. They involve choosing between a series of two options until an organism is identified.

Understanding

3 The more similar the amino acid sequences in a given protein are between organisms, the more closely related the organisms are. If the amino acid sequences are the same, the organisms are likely to belong to the same classification group or taxa.

Applying

4 **a** *Streptococcus pneumonia*, *Staphylococcus aureus*, *Neisseria* spp.

b *Clostridium difficile*

c *Neisseria* spp. In this case, spp. means 'members of the genus *Neisseria*'.

Question set 2.9

Remembering

1 Phylogenetic trees follow a branching pattern that shows the evolutionary history of groups of organisms (called taxa, singular taxon). The common ancestor is at the base and as populations evolve, branches form to show that the group or taxon has diversified from the original ancestor. A point where a taxon diverges from its ancestor is shown as a branch point. Taxa that are closely related have their branches closer together, whereas taxa that are not closely related have a common ancestor or branching points further away.

2 Three assumptions that are used to construct cladograms include:

a the more characteristics that are shared between organisms, the more they are closely related.

b some of the characteristics shared by a group will not be shared with more distantly related groups.

c a shared feature between taxa is more likely to have evolved from a common ancestor than independently for each taxa.

3 When a cladogram represents taxa on a branch that descended from a common ancestor, the group on that branch is referred to as a clade with the taxa referred to as monophyletic.

Understanding

4 Some taxonomists have recommended that the taxa containing birds and reptiles should be reclassified as new evidence shows that birds also evolved from dinosaurs and therefore share a common ancestor with crocodiles and alligators. Currently they are organised into separate classes as classification occurred before this evolutionary evidence was discovered.

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Chapter review questions

Remembering

1 A hybrid is a result of mating (sexual reproduction) between two individuals from different species. Hybrids are usually sterile.

2 Domain, kingdom, phylum, class, order, family, genus and species

3 A common ancestor is an organism from which two species evolved.

Understanding

4 The binomial system is the scientific method used to name species. Two names, genus and species, together form the scientific name of each species.

5 Organisms are classified into groups to organise information about them and to observe patterns and trends between them. This information can then be analysed and communicated to other scientists.

6 The biological classification system is hierarchical in that the higher taxonomic levels are larger groupings and show more diversity between individuals. Further down the hierarchy of classification, the groupings are smaller and less diverse.

7 **a** Paraphyletic

b The circle will encompass the top half of the cladogram, intersecting the line below baboons and above marmosets.

c Chimpanzees

8 More

9 When organisms inhabit similar niches in different parts of the world, they often evolve similar physical characteristics to suit their surroundings. Because of this, other characteristics are used to determine if their similarity is due to their ancestral relatedness or the environment they live in. In the case of the marsupial mole and African golden mole, their reproductive method is different enough to classify them separately.

Applying

10 Biodiversity is the variety of species that inhabit a certain ecosystem or region. Biodiversity can be broken down to three levels: all genes within a species' gene pool, all the species within an ecosystem and finally all of the ecosystems in the biosphere. Biodiversity is important for the survival of species. Populations of species are intricately balanced, and a change in one population in turn affects another population. Examples of this include interactions between populations such as competition and predation, which maintain population numbers and diversity.

11 **a** Physical characteristics, such as size and type of venomous sting; reproductive characteristics and molecular sequences

b Domain Eukarya, Kingdom Animalia, Genus Carukia

Analysing

12 a Presence of a backbone, no fur or feathers, no fins, no scales, colour of skin

b Amphibia

c There may be related species that are very similar to corroboree frogs and there may be hybrids that are not endangered. It is important to identify the members of the endangered species only so that they can be bred to produce offspring.

Evaluating

13 All cells of members of Eukarya contain DNA within a nucleus and membrane-bound organelles. All cells of Bacteria and Archaea do not contain a nucleus or membrane-bound organelles.

14 This will depend on students' response. A binomial name is useful in describing organisms for the scientific community and common names are beneficial when general populations are describing living things.

Creating

15

	Lamprey (Order Petromyzontiformes)	Shark (Class Chondrichthyes)	Lobe-Finned Fish (Class Sarcopterygii)	Ray Finned Fish (Class Actinopterygii)
Jaw	–	+	+	+
Fins attached to body on a fleshy stalk	–	–	+	–
Skeleton made of bone	–	–	+	+

Practice exam questions

1 C

2 A

3 Order Hymenoptera (1 mark)

Any of the following three (1 mark each):

- hind and front wings linked by a row of hooks
- front of abdomen narrowed to form a 'waist'
- wings and body completely covered by fine scales or hairs
- all wings membranous. May be hair or scale covered
- with two pairs of wings
- wings present.

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4 Any of the following four (1 mark each):

- each species has two names
- each species has a genus name and a species name
- genus name written with first letter captialised
- italics used when typewritten
- latin is used
- species name is often descriptive
- underlined when hand written.

5 Ecosystem biodiversity – the range of different ecosystems in the biosphere (1 mark)

Any 3 marks for rationale relating to ecosystem biodiversity:

- maintains matter cycles (nitrogen, carbon, water)
- maintenance of water/food as a resource
- maintenance of climate patterns
- soil conservation (needed for farming)/ prevents wind and water erosion
- recreation and tourism.

Species diversity – the range of all the different species in an ecosystem (1 mark)

Any 2 marks for rationale relating to species biodiversity:

- food web maintenance – maintains species diversity
- new food species
- medicines
- oxygen
- not having monocultures – ensures overall biodiversity of species in an area.

Gene biodiversity – All the genes in a species (1 mark)

Any 2 marks for rationale relating to gene biodiversity:

- more likely to survive a changing environment
- more suitable genes in a changing environment
- variation.