ATP & NAD

A Level

ATP and NAD both play important roles in respiration. Both compounds are modified nucleotides. **Figure 1** represents the molecular structures of ATP and NAD.

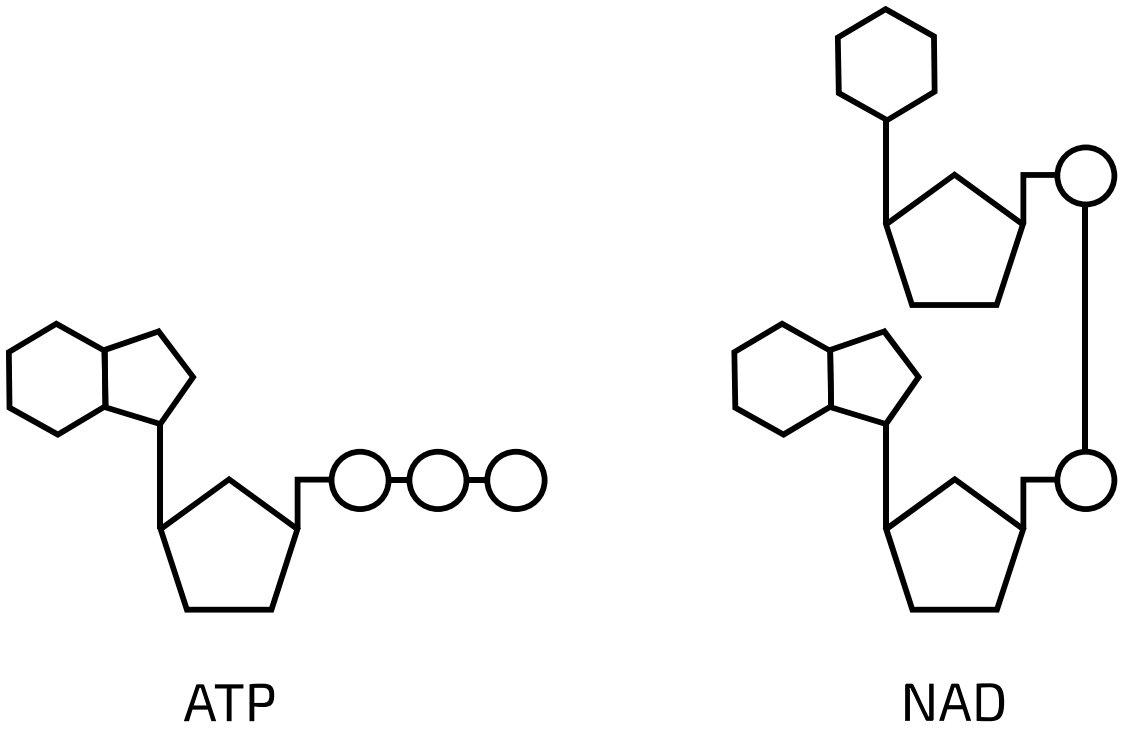

Figure 1: ATP and NAD.

Part A Structural similarities

Which of the following are structural **similarities** between ATP and NAD? Select all that apply.

- [ ] both contain ribose
- [ ] both contain phosphate groups
- [ ] both contain adenine
- [ ] both contain deoxyribose
- [ ] both contain a hexose sugar

Part B Structural differences

Which of the following are structural **differences** between ATP and NAD? Select all that apply.

- [ ] NAD contains two pentose sugars whereas ATP only contains one pentose sugar.
- [ ] ATP contains a purine base whereas NAD does not.
- [ ] ATP contains ribose whereas NAD does not.
- [ ] NAD contains nicotinamide whereas ATP does not.
- [ ] ATP contains three phosphate groups whereas NAD contains two phosphate groups.

Part C ATP synthesis

Name the type of chemical reaction by which ATP is made during the Krebs cycle.

Part D NAD functions

Which of the following are functions of NAD^+ in the **cytoplasm** of a eukaryotic cell? Select all that apply.

- [ ] accepts electrons from the electron transport chain
- [ ] donates electrons to the electron transport chain
- [ ] accepts electrons from other molecules
- [ ] phosphorylates other molecules

Adapted with permission from CIE A Level Biology, June 2016, Paper 4, Question 1

Beetle Biodiversity

A Level

The diversity of some beetle species that feed on animal dung (faeces) was investigated at two types of grassland site in North America. The first type of grassland site was grazed by cattle and the second type of site was not grazed.

Dung beetles were collected, identified and counted from two areas of the same total size. The results are shown in the table below.

Dung beetle species	Number of dung beetles on grassland grazed by cattle	Number of dung beetles on grassland not grazed
Onthophagus pennsylvanicus	4267	6641
Canthon ebenus	2005	774
Canthon pilularius	353	108
Onthophagus hecate	218	85
Total	6843	7608

Part A Genera and species

How many **genera** of beetles are shown in the table above?

How many **species** of beetles are shown in the table above?

Part B Simpson's Index of Diversity

Use the information in the table above to work out the Simpson's Index of Diversity (D) for the beetles on the grassland **not** grazed using the formula:

$$D = 1 - \sum \left(\frac{n}{N}\right)^2$$

where

- $n =$ the number of individuals of each species
- $N =$ the total number of individuals of all species

Give your answer to 3 significant figures.

Part C Comparing grassland sites

The Simpson's Index of Diversity for the beetles on the grassland grazed by cattle was calculated as 0.523 using the same formula as above.

Which of the following statements are correct? Select all that apply.

- [ ] there is greater species **richness** on grassland that is grazed than on grassland that is not grazed
- [ ] there is greater species **richness** on grassland that is **not** grazed than on grassland that is grazed
- [ ] there is greater species **evenness** on grassland that is grazed than on grassland that is not grazed
- [ ] there is greater species **evenness** on grassland that is **not** grazed than on grassland that is grazed
- [ ] the results suggest that grazing **increases** dung beetle species diversity
- [ ] the results suggest that grazing **decreases** dung beetle species diversity

---

Adapted with permission from CIE A Level Biology, June 2017, Paper 4, Question 8

Gameboard:
STEM SMART Biology Week 48

Zebra Finch Clutch Size

A Level

The number of eggs a bird lays in its nest is called the clutch size.

The variation in clutch size was investigated in the zebra finch over several years.

The data are shown in **Figure 1**.

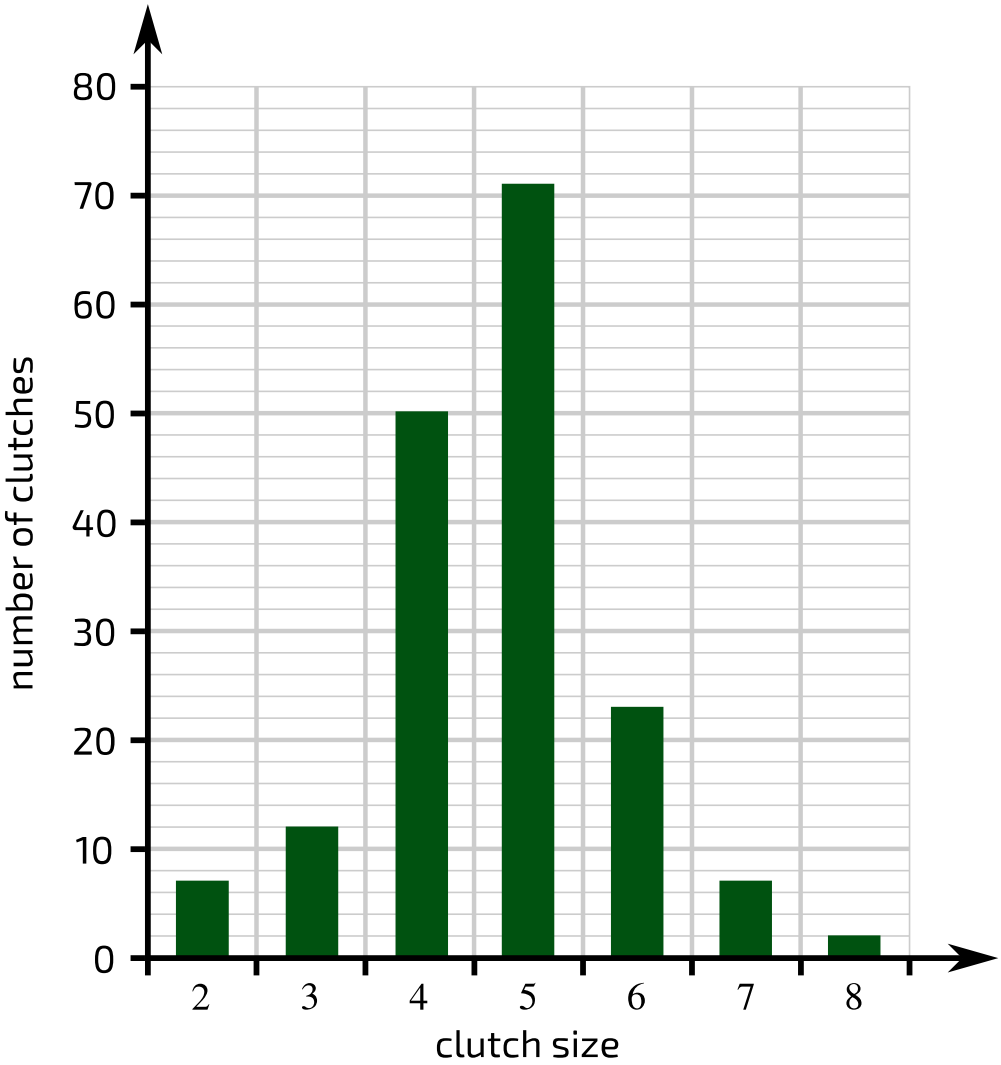

Figure 1: Zebra finch clutch size variation over several years.

Part A Mean clutch size

Calculate the mean clutch size to 2 significant figures.

Part B Selection

The data shown in **Figure 1** were collected over 60 years ago.

Scientists carried out a similar investigation recently and obtained very similar results (i.e. a similar mean clutch size and a similar spread of data).

What is the name given to the type of selection that is acting on clutch size in zebra finches?

Which of the following statements could explain why this form of selection is occurring?

- [ ] birds with small clutches (2 to 3 eggs) don't produce as many offspring as birds with intermediate clutches (4 to 6 eggs)
- [ ] birds with small clutches (2 to 3 eggs) are more likely to survive to the next mating season
- [ ] birds with intermediate clutches (4 to 6 eggs) struggle to feed all of their chicks, and so chicks from intermediate clutches have a lower survival rate than chicks from small clutches (2 to 3 eggs)
- [ ] birds with intermediate clutches (4 to 6 eggs) don't produce as many offspring as birds with large clutches (7 to 8 eggs)
- [ ] birds with large clutches (7 to 8 eggs) struggle to feed all of their chicks, and so chicks from large clutches have a lower survival rate than chicks from intermediate clutches (4 to 6 eggs)
- [ ] birds with large clutches (7 to 8 eggs) produce the largest number of offspring

Adapted with permission from CIE A Level Biology, June 2018, Paper 4, Question 2

Gameboard:
STEM SMART Biology Week 48

Squash Plant Genetics

A Level

The patty pan squash plant, *Cucurbita pepo*, produces edible fruits that vary in colour.

The colour of the fruits is controlled by two genes, **A/a** and **B/b**, that occur on different chromosomes.

- Allele **A** produces a white colour.
- Allele **a** does not produce a colour by itself but allows the colours coded by gene **B/b** to show in the phenotype.
- Allele **B** produces a yellow fruit colour.
- Allele **b** produces a green fruit colour.

In a dihybrid cross, an **AABB** plant was crossed with an **aabb** plant. All the resulting F1 plants produced white fruits.

The F1 plants were then crossed with each other to obtain the F2 generation.

Part A F2 ratios

State the expected ratio in the F2 generation of **white** fruit plants to **yellow** fruit plants to **green** fruit plants.

Express your answer as a ratio in its simplest form (e.g. 1 : 2 : 3).

Part B Test crosses

Test crosses were carried out on two white-fruited plants, **P** and **Q**, from the F2 generation. Each of these plants had its female flowers pollinated with pollen from a green-fruited plant.

For plant **P**, half of the offspring were white and half were yellow.

For plant **Q**, half of the offspring were white and half were green.

State the genotype of plant **P**.

State the genotype of plant **Q**.

Part C Genetic variation

Plants **P** and **Q** show genetic variation with respect to fruit colour alleles.

Name the process that occurred during meiosis in the F1 parents that produced this variation.

During which phase of meiosis does this process occur?

Adapted with permission from CIE A Level Biology, June 2020, Paper 4, Question 2a

Gameboard:
STEM SMART Biology Week 48

Organelle Descriptions

A Level

Each of the statements below describes a structure or organelle that is found in eukaryotic cells.

Identify the structure/organelle that is described in each statement below.

Part A Organelle A

An organelle that contains 70S ribosomes.

Part B Structure B

A thread-like structure composed of DNA and histone proteins.

Part C Organelle C

The organelle that modifies and packages proteins for secretion.

Part D Structure D

The structure that synthesises rRNA and combines it with proteins.

Part E Organelle E

An organelle that contains digestive enzymes and is surrounded by a single membrane.

Part F Structure F

A microtubule-based extension of a cell that is used to propel that cell through the surrounding fluid.

Adapted with permission from CIE AS Level Biology, June 2017, Paper 2, Question 1

Gameboard:
STEM SMART Biology Week 48

Animal Cells, Tissues, and Organs

A Level

Name the cell/tissue/organ that is described in each of the following statements.

Part A **Blood vessel A**

The blood vessel that transports deoxygenated blood from the heart.

Part B **Cell B**

The cell that ingests and digests cell debris and bacteria in the lungs.

Part C **Cell C**

The cell that secretes antibodies.

Part D **Cell D**

The epithelial cell that secretes mucus in the trachea.

Part E Tissue E

The tissue that prevents the collapse of the trachea during inhalation.

Part F Organ F

The accessory organ of digestion that regulates blood glucose levels.

Adapted with permission from CIE AS Level Biology, June 2012, Paper 2, Question 1