

Exercise walk-through

29.1

Sexual reproduction: meiosis and fertilization have different roles

International Baccalaureate · IB Diploma · Biology · SL

29.1 Sexual reproduction: meiosis and fertilization have different roles

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS fertilization • haploid

Objective

Sexual reproduction: meiosis and fertilization have different roles. Supported SL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

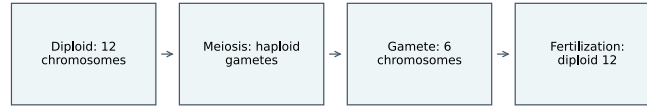
■ What would explain this observation?

- Gametes normally contain one set of chromosomes, while **fertilization** joins two sets. Maintaining chromosome number across generations requires both processes.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Meiosis reduces chromosome number when producing **haploid** cells from a diploid starting cell. Homologous chromosomes separate in meiosis I, while sister chromatids separate in meiosis II. Fertilization combines haploid gamete nuclei to form a diploid zygote. Sexual reproduction can create new combinations of existing alleles.
- haploid: Having one chromosome set in the stated life cycle; fertilization: Fusion of

gamete nuclei to form a zygote.



■ Choose evidence that can test it

- Distinguish homologous chromosomes from sister chromatids, and chromosome number from DNA quantity. Replication before meiosis copies DNA without doubling the number of chromosome sets. Crossing over and independent assortment contribute to genetic variation, while random fertilization further changes combinations. These processes do not make every offspring genetically distinct under every conceivable condition.
- Use a labelled model organism with a stated chromosome number. Track chromosome sets through replication, meiosis I, meiosis II and fertilization. Use anonymous model data rather than personal family or reproductive-health information. Compare organism life cycles carefully; flowering-plant and animal reproductive structures require their own additional teaching.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a model organism has diploid chromosome number $2n=12$. A gamete has $n=6$. After fertilization, the zygote has 12 chromosomes. With six independently assorting chromosome pairs and ignoring crossing over, there are $2^6=64$ possible maternal/paternal chromosome combinations in a gamete. This is a model count, not a probability of an individual phenotype.

Example:

A model organism has diploid chromosome number 20. How many chromosomes are normally in a gamete? Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ **Check the conclusion and its limits**

- A gamete is not made by halving the size of an ordinary cell. Independent assortment counts assume distinct homologous alternatives and do not include crossing-over outcomes. Human and plant reproduction cannot be fully replaced by a monohybrid Punnett grid.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

DNA replication alone changes a diploid cell into a tetraploid cell. This claim is false: A gamete is not made by halving the size of an ordinary cell. Independent assortment counts assume distinct homologous alternatives and do not include crossing-over outcomes. Human and plant reproduction cannot be fully replaced by a monohybrid Punnett grid.

Key:

Sexual reproduction: meiosis and fertilization have different roles: Distinguish homologous chromosomes from sister chromatids, and chromosome number from DNA quantity. Replication before meiosis copies DNA without doubling the number of chromosome sets. Crossing over and independent assortment contribute to genetic variation, while random fertilization further changes combinations. These processes do not make every offspring genetically distinct under every conceivable condition.

Exercises 2.1·2.2

2.1 Which process restores diploid chromosome number in this model? Choose one answer.

- **A** Fertilization
- **B** Meiosis II alone
- **C** DNA replication alone

[1]

2.2 A model organism has diploid chromosome number 20. How many chromosomes are normally in a gamete? Show the relation, substitution and units.

[2]

Exercises 2.1-2.2

2.1 Which process restores diploid chromosome number in this model? Choose one answer.

- **A** Fertilization
- **B** Meiosis II alone
- **C** DNA replication alone

[1]

2.1 A Distinguish homologous chromosomes from sister chromatids, and chromosome number from DNA quantity. Replication before meiosis copies DNA without doubling the number of chromosome sets. Crossing over and independent assortment contribute to genetic variation, while random fertilization further changes combinations. These processes do not make every offspring genetically distinct under every conceivable condition.

2.2 A model organism has diploid chromosome number 20. How many chromosomes are normally in a gamete? Show the relation, substitution and units. [2]

2.2 Gametes are haploid: $n=20/2=10$ chromosomes.

Exercises 2.3-3.1

2.3 Decide whether this claim is true and justify: DNA replication alone changes a diploid cell into a tetraploid cell. [2]

2.4 Having one chromosome set in the stated life cycle: write the technical term. [1]

3.1 A model organism has $2n=8$. Ignoring crossing over, how many chromosome combinations can a gamete receive? Does this count predict a phenotype ratio? [4]

Exercises 2.3-3.1

2.3 Decide whether this claim is true and justify: DNA replication alone changes a diploid cell into a tetraploid cell. [2]

2.3 False. A gamete is not made by halving the size of an ordinary cell. Independent assortment counts assume distinct homologous alternatives and do not include crossing-over outcomes. Human and plant reproduction cannot be fully replaced by a monohybrid Punnett grid.

2.4 Having one chromosome set in the stated life cycle: write the technical term. [1]

2.4 haploid. haploid means Having one chromosome set in the stated life cycle.

3.1 A model organism has $2n=8$. Ignoring crossing over, how many chromosome combinations can a gamete receive? Does this count predict a phenotype ratio? [4]

3.1 Four pairs give $2^4=16$ combinations under independent assortment. Phenotype probabilities also need loci, dominance and linkage information; combinations are not phenotype categories.