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. Original classroom practice for IB SL; not an official IB paper.

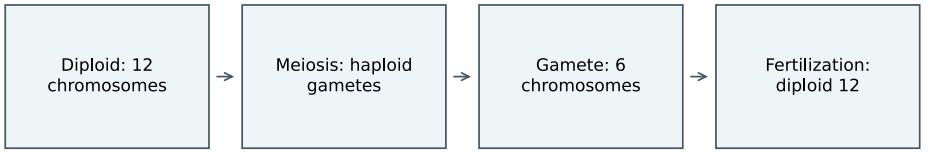
1 Key knowledge and worked examples

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.

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.

In the lab: 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

- 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.

Your turn: A model organism has diploid chromosome number 20. How many chromosomes are normally in a gamete?

■ **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.

Not true: DNA replication alone changes a diploid cell into a tetraploid cell. Replication doubles the DNA content but the chromosomes still count as one each (two sister chromatids); the cell remains diploid. Tetraploidy needs a failure of division, not replication.

Key:

- Meiosis reduces chromosome number when producing haploid cells from a diploid starting cell.
- Distinguish homologous chromosomes from sister chromatids, and chromosome number from DNA quantity.
- Watch for: A gamete is not made by halving the size of an ordinary cell.

■ **Write from a gamete with 23 chromosomes**

- A model organism has diploid chromosome number 46.
- A gamete normally has half that number. Replication alone does not turn a diploid cell into a tetraploid cell.

2 Practice

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

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

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 Exam-style questions

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]

Solutions

2.1 B Meiosis halves the chromosome number to make haploid gametes; fertilization fuses two gametes and restores the diploid number. Neither meiosis II alone nor DNA replication adds a second set.

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

2.3 False. Replication doubles the DNA content but the chromosomes still count as one each (two sister chromatids); the cell remains diploid. Tetraploidy needs a failure of division, not replication.

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

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.

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