# Chromosome Count

Trace how meiosis and fertilization shape a new generation

**BIO.3A** "Students will develop and use models to explain the role of meiosis in the production of haploid gametes required for sexual reproduction..."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline each place where a chromosome number changes or stays the same. Circle the processes that cause those results so you can trace the chromosome count across a generation.

### From Frog Cells to New Frogs

1. At a wildlife clinic, a biologist studies a species of frog with 24 chromosomes in each body cell. These chromosomes form 12 homologous pairs, with one chromosome of each pair inherited from each parent. To make sex cells, a frog uses meiosis. First, its DNA is copied. Then homologous chromosomes pair up and may exchange matching pieces in crossing over. The pairs separate during the first division; sister chromatids separate during the second. The result is four haploid cells, each with 12 chromosomes. Different combinations of chromosomes and crossing over make the cells' DNA different from the original cell's DNA.

2. Suppose two frogs each produce a gamete with 12 chromosomes. At fertilization, an egg and a sperm join, producing a zygote with 24 chromosomes, arranged in 12 pairs. That zygote can grow through mitosis: one body cell divides into two body cells with the same chromosome number and, barring copying errors, the same DNA sequence. Meiosis, unlike mitosis, halves the chromosome number and produces genetically varied sex cells for sexual reproduction. Because meiosis halves the number before fertilization restores it, the species does not double its chromosome number every generation. The new frog inherits a mix of DNA from both parents.

3. Meiosis does not always sort chromosomes correctly. In nondisjunction, a pair of homologous chromosomes or a pair of sister chromatids fails to separate, so some gametes receive an extra chromosome and others receive one too few. If such a gamete joins a typical gamete, the zygote can have an unusual chromosome number. A karyotype displays a person's chromosomes organized by type, making extra or missing chromosomes visible. Down syndrome usually results from three copies of chromosome 21. Turner syndrome usually involves one X chromosome and no second sex chromosome; Klinefelter syndrome usually involves XXY sex chromosomes.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. Trace the frog's chromosome count from a body cell to a gamete to a zygote. Name the process between each stage.

2. Why can two gametes made by the same frog have different DNA from each other and from the original body cell?

3. Compare what mitosis and meiosis produce. How does each process affect chromosome number, and what is its role?

4. A human karyotype shows three copies of chromosome 21. Name the condition and explain how an error during meiosis could lead to this result.

## 3 YOUR TURN

Your own words

In three panels, model sexual reproduction in an invented species with eight chromosomes per body cell: show two parent body cells, one gamete from each parent, and their zygote. Label the chromosome counts and the meiosis and fertilization steps, then write one sentence explaining why the zygote has eight chromosomes but DNA different from either parent.

ANSWER KEY

# Chromosome Count

HIGH SCHOOL · BIO.3A

## PART 1 · READ AND MARK

Underline each place where a chromosome number changes or stays the same. Circle the processes that cause those results so you can trace the chromosome count across a generation. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | Trace the frog's chromosome count from a body cell to a gamete to a zygote. Name the process between each stage. | **A body cell has 24 chromosomes. Meiosis produces a gamete with 12; fertilization joins two gametes to produce a zygote with 24.** |
| 2 | Why can two gametes made by the same frog have different DNA from each other and from the original body cell? | **Meiosis gives gametes different combinations of chromosomes, and crossing over can exchange pieces between homologous chromosomes.** |
| 3 | Compare what mitosis and meiosis produce. How does each process affect chromosome number, and what is its role? | **Mitosis produces body cells with the same chromosome number for growth. Meiosis halves the chromosome number to produce genetically varied sex cells for sexual reproduction.** |
| 4 | A human karyotype shows three copies of chromosome 21. Name the condition and explain how an error during meiosis could lead to this result. | **This is Down syndrome. Nondisjunction can produce a gamete with an extra chromosome 21; joining a typical gamete then produces a zygote with three copies.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: Parent 1 has chromosome pairs 1a/1b, 2a/2b, 3a/3b, and 4a/4b; Parent 2 has pairs 1c/1d, 2c/2d, 3c/3d, and 4c/4d. Each body cell has eight chromosomes. A meiosis arrow leads to Panel 2: Parent 1's gamete has 1a, 2b, 3a, and 4b; Parent 2's gamete has 1c, 2d, 3c, and 4d. Each gamete has four chromosomes. A fertilization arrow leads to Panel 3: The zygote has pairs 1a/1c, 2b/2d, 3a/3c, and 4b/4d, for eight chromosomes. Meiosis makes four-chromosome gametes, and fertilization restores eight chromosomes by combining DNA from both parents in a new combination.

Accept any clear three-stage model with eight chromosomes in each parent body cell, four in each gamete, and eight in the zygote. Chromosome labels may vary, but the zygote must receive one set from each parent.