Sexual reproduction requires fertilization, the union of two cells from two individual organisms. If those two cells each contain one set of chromosomes, then the resulting cell contains two sets of chromosomes. Haploid cells contain one set of chromosomes. Cells containing two sets of chromosomes are called diploid. The number of sets of chromosomes in a cell is called its ploidy level.

**Review Questions**

Meiosis produces ________ daughter cells.

1. two haploid
2. two diploid
3. four haploid
4. four diploid

C

What structure is most important in forming the tetrads?

1. centromere
2. synaptonemal complex
3. chiasma
4. kinetochore
B

At which stage of meiosis are sister chromatids separated from each other?

1. prophase I
2. prophase II
3. anaphase I
4. anaphase II

D

At metaphase I, homologous chromosomes are connected only at what structures?

1. chiasmata
2. recombination nodules
3. microtubules
4. kinetochores

A

Which of the following is not true in regard to crossover?

1. Spindle microtubules guide the transfer of DNA across the synaptonemal complex.
2. Non-sister chromatids exchange genetic material.
3. Chiasmata are formed.
4. Recombination nodules mark the crossover point.

C

What phase of mitotic interphase is missing from meiotic interkinesis?

1. G₀ phase
2. G₁ phase
3. S phase
4. G₂ phase

C

The part of meiosis that is similar to mitosis is ________.

1. meiosis I
2. anaphase I
3. meiosis II
4. interkinesis
If a muscle cell of a typical organism has 32 chromosomes, how many chromosomes will be in a gamete of that same organism?

1. 8
2. 16
3. 32
4. 64

B

**Free Response**

Describe the process that results in the formation of a tetrad.

During the meiotic interphase, each chromosome is duplicated. The sister chromatids that are formed during synthesis are held together at the centromere region by cohesin proteins. All chromosomes are attached to the nuclear envelope by their tips. As the cell enters prophase I, the nuclear envelope begins to fragment, and the proteins holding homologous chromosomes locate each other. The four sister chromatids align lengthwise, and a protein lattice called the synaptonemal complex is formed between them to bind them together. The synaptonemal complex facilitates crossover between non-sister chromatids, which is observed as chiasmata along the length of the chromosome. As prophase I progresses, the synaptonemal complex breaks down and the sister chromatids become free, except where they are attached by chiasmata. At this stage, the four chromatids are visible in each homologous pairing and are called a tetrad.

Explain how the random alignment of homologous chromosomes during metaphase I contributes to the variation in gametes produced by meiosis.

Random alignment leads to new combinations of traits. The chromosomes that were originally inherited by the gamete-producing individual came equally from the egg and the sperm. In metaphase I, the duplicated copies of these maternal and paternal homologous chromosomes line up across the center of the cell. The orientation of each tetrad is random. There is an equal chance that the maternally derived chromosomes will be facing either pole. The same is true of the paternally derived chromosomes. The alignment should occur differently in almost every meiosis. As the homologous chromosomes are pulled apart in anaphase I, any combination of maternal and paternal chromosomes will move toward each pole. The gametes formed from these two groups of chromosomes will have a mixture of traits from the individual's parents. Each gamete is unique.

What is the function of the fused kinetochore found on sister chromatids in prometaphase I?

In metaphase I, the homologous chromosomes line up at the metaphase plate. In anaphase I, the homologous chromosomes are pulled apart and move to opposite poles. Sister chromatids are not separated until meiosis II. The fused kinetochore formed during meiosis I ensures that each spindle microtubule that binds to the tetrad will attach to both sister chromatids.

In a comparison of the stages of meiosis to the stages of mitosis, which stages are unique to meiosis and which stages have the same events in both meiosis and mitosis?
All of the stages of meiosis I, except possibly telophase I, are unique because homologous chromosomes are separated, not sister chromatids. In some species, the chromosomes do not decondense and the nuclear envelopes do not form in telophase I. All of the stages of meiosis II have the same events as the stages of mitosis, with the possible exception of prophase II. In some species, the chromosomes are still condensed and there is no nuclear envelope. Other than this, all processes are the same.

11.2: Sexual Reproduction

Sexual reproduction was an early evolutionary innovation after the appearance of eukaryotic cells. It appears to have been very successful because most eukaryotes are able to reproduce sexually, and in many animals, it is the only mode of reproduction. And yet, scientists recognize some real disadvantages to sexual reproduction. On the surface, creating offspring that are genetic clones of the parent appears to be a better system.

Review Questions

What is a likely evolutionary advantage of sexual reproduction over asexual reproduction?

1. Sexual reproduction involves fewer steps.
2. There is a lower chance of using up the resources in a given environment.
3. Sexual reproduction results in variation in the offspring.
4. Sexual reproduction is more cost-effective.

C

Which type of life cycle has both a haploid and diploid multicellular stage?

1. asexual
2. diploid-dominant
3. haploid-dominant
4. alternation of generations

D

Fungi typically display which type of life cycle?

1. diploid-dominant
2. haploid-dominant
3. alternation of generations
4. asexual

B

A diploid, multicellular life-cycle stage that gives rise to haploid cells by meiosis is called a ________.

1. sporophyte
2. gametophyte
3. spore
4. gamete

A

Free Response

List and briefly describe the three processes that lead to variation in offspring with the same parents.

a. Crossover occurs in prophase I between non-sister homologous chromosomes. Segments of DNA are exchanged between maternally derived and paternally derived chromosomes, and new gene combinations are formed. b. Random alignment during metaphase I leads to gametes that have a mixture of maternal and paternal chromosomes. c. Fertilization is random, in that any two gametes can fuse.

Compare the three main types of life cycles in multicellular organisms and give an example of an organism that employs each.

a. In the haploid-dominant life cycle, the multicellular stage is haploid. The diploid stage is a spore that undergoes meiosis to produce cells that will divide mitotically to produce new multicellular organisms. Fungi have a haploid-dominant life cycle. b. In the diploid-dominant life cycle, the most visible or largest multicellular stage is diploid. The haploid stage is usually reduced to a single cell type, such as a gamete or spore. Animals, such as humans, have a diploid-dominant life cycle. c. In the alternation of generations life cycle, there are both haploid and diploid multicellular stages, although the haploid stage may be completely retained by the diploid stage. Plants have a life cycle with alternation of generations.