



AP[®] Biology (Operational) 2004 Sample Student Responses

The materials included in these files are intended for noncommercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the Advanced Placement Program[®]. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. This permission does not apply to any third-party copyrights contained herein. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here.

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 4,500 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 23,000 high schools, and 3,500 colleges through major programs and services in college admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT[®], the PSAT/NMSQT[®], and the Advanced Placement Program[®] (AP[®]). The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

For further information, visit www.collegeboard.com

Copyright © 2004 College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, AP Central, AP Vertical Teams, APCD, Pacesetter, Pre-AP, SAT, Student Search Service, and the acorn logo are registered trademarks of the College Entrance Examination Board. PSAT/NMSQT is a registered trademark of the College Entrance Examination Board and National Merit Scholarship Corporation. Educational Testing Service and ETS are registered trademarks of Educational Testing Service. Other products and services may be trademarks of their respective owners.

For the College Board's online home for AP professionals, visit AP Central at apcentral.collegeboard.com.

BIOLOGY
SECTION II

Time—1 hour and 30 minutes

1R1

Directions: Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in this booklet.

1. Meiosis reduces chromosome number and rearranges genetic information.

- Explain how the reduction and rearrangement are accomplished in meiosis.
- Several human disorders occur as a result of defects in the meiotic process. Identify ONE such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? Describe how this abnormality could result from a defect in meiosis.
- Production of offspring by parthenogenesis or cloning bypasses the typical meiotic process. Describe either parthenogenesis or cloning and compare the genomes of the offspring with those of the parents.

(a) Reduction is accomplished by two consecutive divisions without replication in between.

Following the replication of DNA the chromosomes move to the center and form tetrads in metaphase I. They separate in Anaphase I, then immediately go into metaphase II where they line up again and split apart during Anaphase II. So essentially the cell does this: $2N \rightarrow 4N \rightarrow 2N \rightarrow 1N$. Rearrangement occurs during meiosis when the chromosomes line up in homologous pairs during the metaphases. The chromosomes separate and each gamete receives one of each type of chromosome. Crossover while in the tetrad also results in more genetic variability.

(b) Down syndrome results from nondisjunction of the 21st chromosome during meiosis. This means it does not separate from its homologous partner during anaphase I or II resulting in two in one gamete. The person with down syndrome has ~~two~~ 3 21st chromosomes. People with down syndrome have enlarged tongues, heart problems, ~~and~~ learning disabilities, and lower IQ's.

GO ON TO THE NEXT PAGE.

© Cloning results from mitotic division, and the genome of the offspring are exactly the same as the parents. Cloning results in no variation in offspring. An example of cloning is the production of plantlets by the Kalenchoe. This plant is known as "The Mother of Thousands" because it produces many clones of the parent plant which are genetically identical. The spider plant is another example of reproduction by cloning, or asexual reproduction.

GO ON TO THE NEXT PAGE.

BIOLOGY

SECTION II

Time—1 hour and 30 minutes

Directions: Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in this booklet.

1. Meiosis reduces chromosome number and rearranges genetic information.

- (a) Explain how the reduction and rearrangement are accomplished in meiosis.
- (b) Several human disorders occur as a result of defects in the meiotic process. Identify ONE such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? Describe how this abnormality could result from a defect in meiosis.
- (c) Production of offspring by parthenogenesis or cloning bypasses the typical meiotic process. Describe either parthenogenesis or cloning and compare the genomes of the offspring with those of the parents.

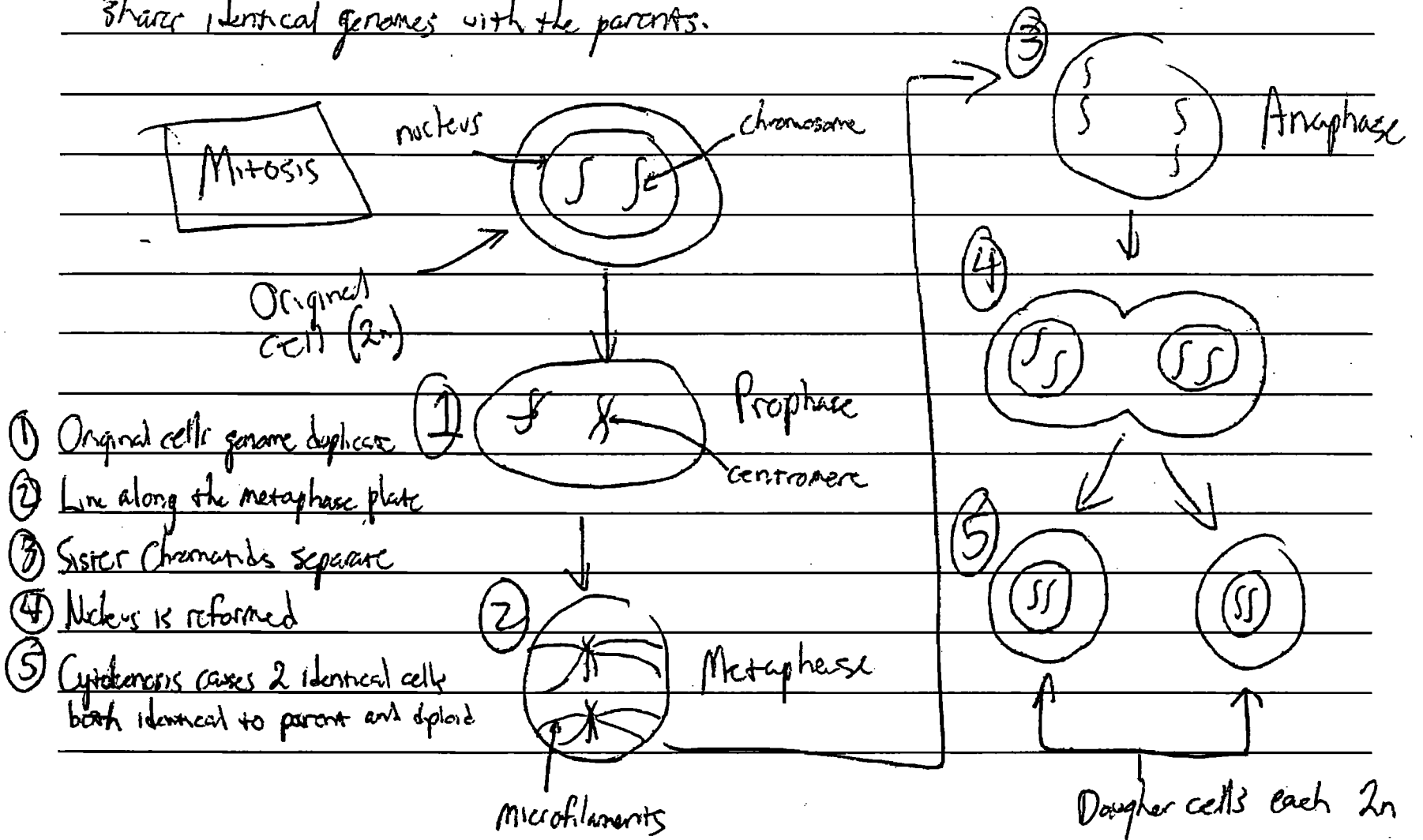
(a) ~~During~~ ^{During} Interphase, the cell makes copies of its DNA ~~in~~ ⁱⁿ G₂. This is the last phase of Interphase. Once the chromosomes condense to form Chromatin, Meiosis occurs. Starting with Prophase I, the chromosomes duplicate themselves, forming sister chromatids. They are joined together at centromeres. ~~During~~ ^{During} This ~~phase~~ ^{phase} an important theme known as crossing over occurs. Double chromosomes cross over to their sister chromatid and exchange genetic information. This is how the majority of rearrangement occurs. Next in Metaphase I, Homologous chromosomes pair at the center of the cell. During Anaphase I, microfilaments extend to the centromeres and attach to the kinetochores and pull homologous chromosomes apart. Telophase and cytokinesis occur ~~at~~ resulting in ~~2~~ ² diploid new cells. Then begins Prophase II which resembles Prophase I except there is no crossing over. Metaphase II resembles Metaphase I. Anaphase II separates sister chromatids as opposed to homologous chromosomes as in Anaphase I. Telophase II and cytokinesis occurs resulting in 4 haploid gametes. The original diploid cell has been reduced to 4 haploid cells.

GO ON TO THE NEXT PAGE.

(b) Trisomy 21

During Anaphase, sister chromatids are not separated properly. Instead of an equal division of chromosomes, there is an unbalance where one cell has an extra chromosome while the other cell lacks that chromosome. If the gamete with the extra chromosome should fuse with a normal gamete, the result would be an individual with the chromosomal abnormality known as Down Syndrome. This often results with the individual having pale skin, high forehead, large eyes, mental retardation, and sometimes sterility.

(c) Cloning is where an identical copy of a cell is reproduced. This occurs during asexual reproduction which uses Mitosis instead of Meiosis. Mitosis is analogous to Meiosis II. However instead of ending with 4 haploid gametes, the endgame of Mitosis is two daughter cells, each diploid, and each containing the same genetic information as the other and as the original. Therefore the offspring share identical genomes with the parents.



- ① Original cell's genome duplicates
- ② Line along the metaphase plate
- ③ Sister Chromatids separate
- ④ Nucleus is reformed
- ⑤ Cytokinesis causes 2 identical cells both identical to parent and diploid

GO ON TO THE NEXT PAGE.

IT₁

BIOLOGY
SECTION II

Time—1 hour and 30 minutes

Directions: Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in this booklet.

1. Meiosis reduces chromosome number and rearranges genetic information.

(a) **Explain** how the reduction and rearrangement are accomplished in meiosis.

(b) Several human disorders occur as a result of defects in the meiotic process. **Identify ONE** such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? **Describe** how this abnormality could result from a defect in meiosis.

(c) Production of offspring by parthenogenesis or cloning bypasses the typical meiotic process. **Describe** either parthenogenesis or cloning and **compare** the genomes of the offspring with those of the parents.

(a) Meiosis is the process of getting four haploid cells from one diploid cell. There are 5 phases of meiosis. Interphase, Prophase, Metaphase, Anaphase & Telophase. After those 5 phases happen, they happen again. That's how the number of gametes being made are reduced. During the first IPMAT of meiosis, two daughter cells are made from the parent cells. During IPMAT II, two more cells are made totalling four gametes. Interphase is when the DNA gets replicated, Prophase is when the chromosomes start to move toward the center of the cell. Metaphase is when the chromosomes (homologous chromosomes) line up in the center. Homologous means they are the same chromosome (same size, contain same genes, etc.) During Anaphase, the spindle fibers pull the homologous pairs of chromosomes apart.

GO ON TO THE NEXT PAGE.

to the ends of the cell. Telophase is when the cleavage furrow forms and the cell divides. When the cytoplasm divides, it's called cytokinesis. During Interphase II, the same things happen: enzymes get made, DNA does not get replicated, chemicals get made, etc. During ~~pro~~ prophase II, metaphase II, and anaphase II, the same things basically happen. But synapsis can occur, which is also called crossing over. It's when a piece of a chromosome from one homologous pair switches with another piece from the other chromosome. This doesn't happen as rarely as you'd think. This is the cause of much mutations and variations in genotype + phenotype. It happens during prophase II. After the second "IPMAT" happens, there are a total of four cells from one. (b) Down's-syndrome is an example of one chromosomal disorder. This is when an individual has an extra ~~21st~~^{21st} chromosome. Instead of two chromosomes, it has three. The phenotypic qualities of an individual with down's-syndrome includes: droopy eyes, underbites, obesity, difficulty speaking, etc. There are also behavioral problems included in one who has this disorder. They tend to be slower in school, have more difficulty with everyday tasks, They also have an early death rate. This can be caused by a defect in

GO ON TO THE NEXT PAGE.

the splitting of the chromosomes during Anaphase or Metaphase of meiosis. ~~the splitting of the chromosomes during Anaphase or Metaphase of meiosis.~~

An extra chromosome could have mistakenly been copied and grouped in one of the daughter cells.

(c) With cloning, exact duplicates are made from others. The same DNA is in two different organisms. The same exact nucleotide sequences are present in each. The genomes of the offspring would have $\frac{1}{2}$ the DNA of the male parent and $\frac{1}{2}$ the DNA of the female parent. The offspring's clone would have the same exact DNA as the offspring. In this case, parents and offspring wouldn't share the same exact DNA -- only half.

GO ON TO THE NEXT PAGE.