Activity Guide: Double-Double-Double Activity

Introduction

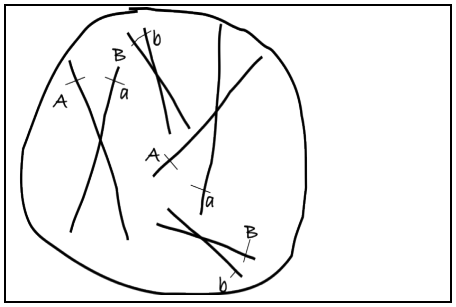
The basis for this activity is the observation that students often demonstrate confusion when moving among various representations of chromosomes and DNA, and this is in part a result of the multiple pairs or "doubles" involved:

1. DNA is a double helix.
2. Most familiar eukaryotic cells are diploid (2*n*).
3. DNA is replicated prior to cell division.

Finally, the most common depictions of chromosomes show them as replicated, and in their condensed, prophase, state. It seems that the 2 chromatids of each chromosome get mentally assigned as the 2 strands of the double helix by a significant proportion of students. This activity, composed of a short sequence of clicker questions, can quickly bring 90%+ of students to a correct understanding of the relationships between the 3 doubles.

We also find that correcting this conceptual difficulty could significantly assist in solving a common problem in genetics. This problem is illustrated by the following assessment question and the incorrect response that is often encountered:

> Q: *"Draw a nucleus with 2n=4 chromosomes as it might appear during late prophase of mitosis. Label with alleles for the double heterozygote (unlinked): AaBb."*



Note how this student has incorrectly assigned the heterozygous alleles to sister chromatids. A student who rigorously applied their knowledge of DNA replication and the meanings of these types of representations would be less likely to make this mistake. The "double" that is the diploid condition would be less likely confused with the "double" that results from replication.

Learning Objective

Students should be able to use a detailed knowledge of the cell cycle, including replication, mitosis, and meiosis, to reason about hereditary processes.

Context and Connections: Chapters 11 and 12

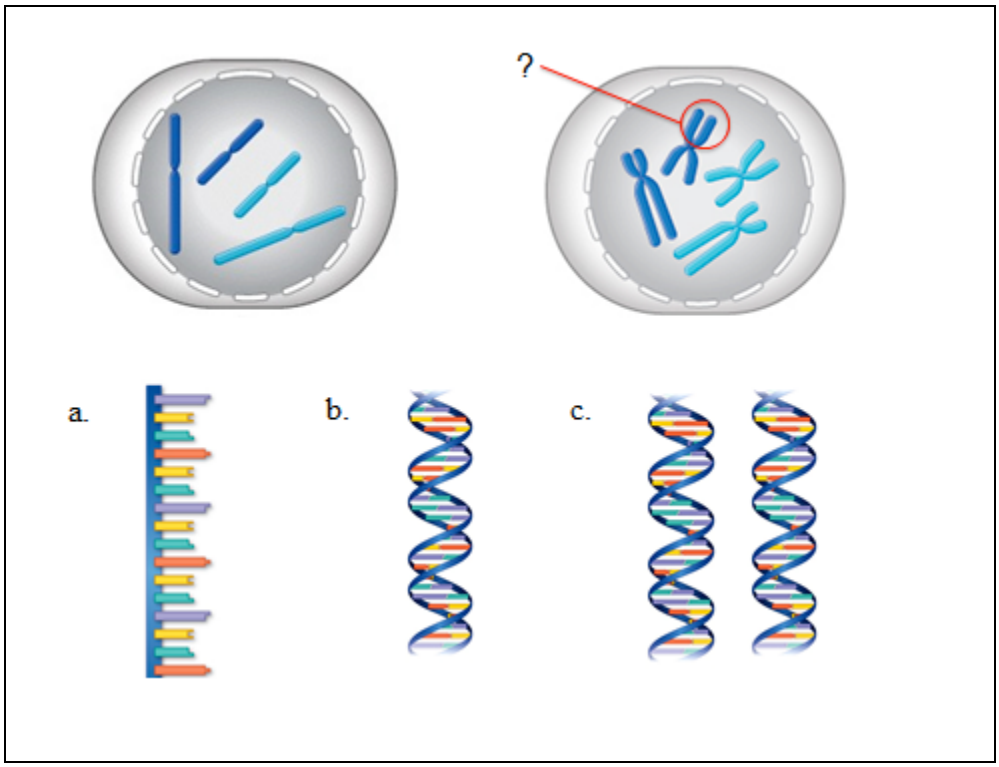
This exercise can be employed almost any time during the cell cycle chapters (Ch. 11, 12). Since students generally enter our courses with some background in thinking about chromosomes and their behavior during cell divisions, this sequence could be used as a lead-in to the topics. Alternatively, it could be inserted at the beginning of Chapter 12 (DNA Replication).

List of Materials

1. Activity Guide (file name: 1 Activity Guide Ch11 Double Double Double)
2. In-class Presentation (file name: 2 In-class Presentation Ch11 Double Double Double)
3. Exam Questions (file name: 3 Exam Qs Ch11 Double Double Double)

Description

Students are asked to identify corresponding depictions of chromosomes and DNA pre- and post-replication. The questions take the form shown in this sample, in which students must select one of the DNA representations that most closely depicts the chromosome labeled with the question mark.



The first clicker question, showing only the mitosis figures, will verify that the students recognize these image types. This might be skipped if the activity comes soon after covering mitosis.

This sequence works very well if students are encouraged to discuss the questions with each other, but with essentially no other instructor guidance or input. Furthermore, clicker results are **not** shown until the final clicker is completed.

Class size and timing

This activity can be used in essentially any class size since it is based on clicker questions. It can be quite brief, 5-10 minutes, even with summary discussion.

Connection to Vision and Change:

This activity is aimed at the Core Concept 3. Information Flow, Exchange, and Storage.