This Module for Interactive Teaching (MINT) may be found online at
https://ivv.rit.edu/dc-mint.php

Meiosis

- DNA sequence determines homology and the mechanism of homologous pairing. Ploidy is defined as the number of complete sets of unique genetic information in a cell.

Contents:

MINT Learning Objectives

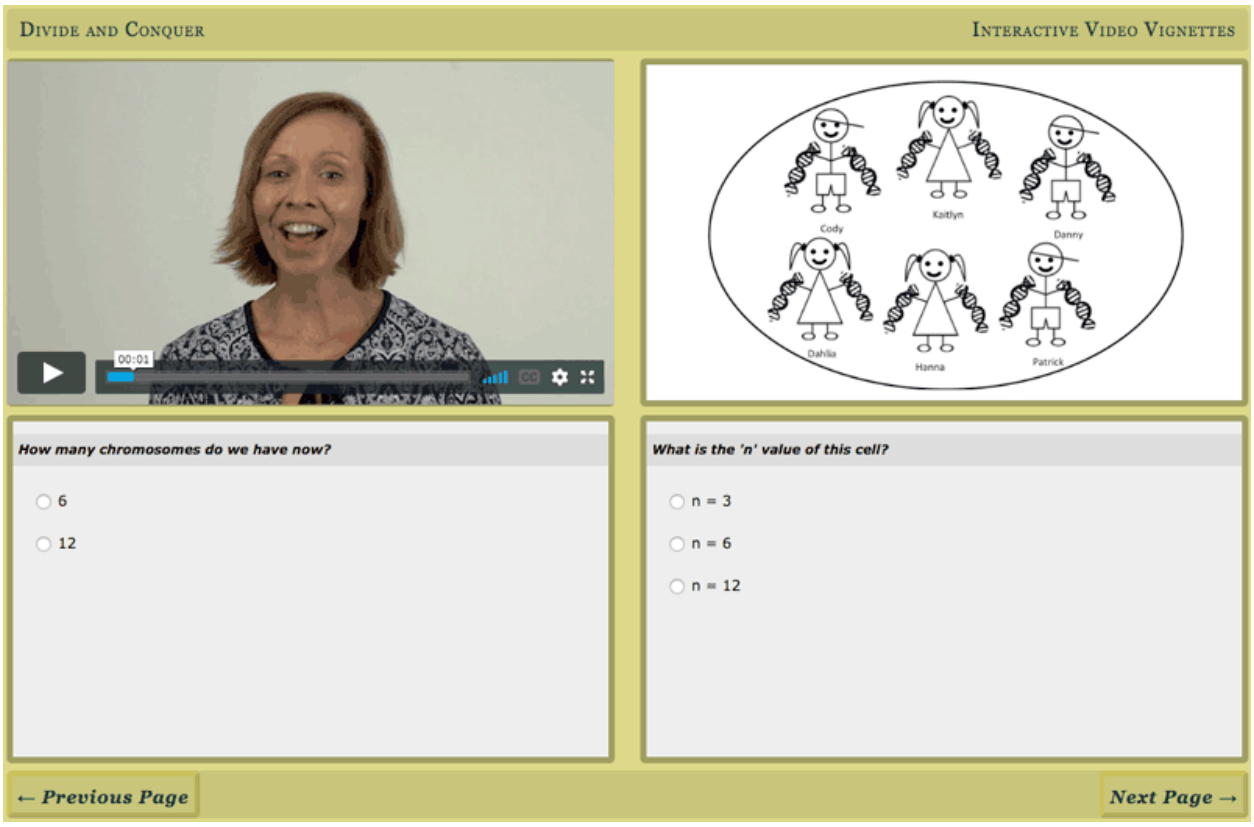
- Correctly draw the steps of meiosis; identify the differences between mitosis and meiosis
- Correctly identify the ploidy of a cell containing any configuration of chromosomes, replicated or not

This MINT aligns with and may be used to support learning related to the following national standards:

- Vision and Change Core Concepts and Competencies (http://visionandchange.org)
  - Core Concept:
    - Information Flow, Exchange, and Storage: The growth and behavior of organisms are activated through the expression of genetic information in context
  - Core Competencies:
    - Ability to use modeling and simulation: Biology focuses on the study of complex systems
    - Ability to use quantitative reasoning: Biology relies on applications of quantitative analysis and mathematical reasoning.
- Biocore Guide (Brownell et al., https://doi.org/10.1187/cbe.13-12-0233)
  - Evolution: Multiple molecular mechanisms, including DNA damage and errors in replication, lead to the generation of random mutations. These mutations create new alleles that can be inherited via mitosis, meiosis, or cell division.
  - S/F The structure of molecules or organisms may be similar due to common ancestry or selection for similar function.
- Next Gen Science Standards (http://www.nextgenscience.org/)

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)

Interactive Video Vignette Information



IVV Title: *Divide and Conquer*

IVV URL for students: https://ivv.rit.edu/DC/2/
Copy the URL to the Clipboard. Either paste it into an email to your students, or use it to create a link in your course management system.

IVV Description:
A college instructor is leading an interactive in-class demonstration to model the important aspects of the process of meiosis. Students volunteering for the demo and classroom members offer explanations to the various questions posed by the instructor. The user is asked to answer the questions posed to the student "audience" as well. At the end of the lesson the students in the class (as well as the IVV user) realize the importance of DNA sequence and genetic information to explain concepts of ploidy, homology and homologous pairing.

Novice Ideas and IVV Learning Goals

Novice Ideas

- "n" of an organism changes during the cell cycle due to DNA replication
- "n" of an organism is linked to number of chromatids
- Pairing does not involve physical interaction
- Homology is determined by superficial aspects of appearance of chromosomes
- Meiosis is just mitosis twice without DNA replication in between
- The cell only becomes haploid at the end of the process
- Meiosis and fertilization are linked in an individual
- Two-chromatid chromosomes contain a chromatid from each parent
- Ploidy is based on DNA quantity
- Meiosis can occur in any cell
- The purpose of meiosis is to halve the amount of DNA in preparation for fertilization.
- The purpose of crossing over is to create genetic diversity
- Maternal and paternal chromosomes of the same kind are very different from each other
- Chromosome pairing and lining up are the same thing and happen at the same time

Ideas addressed in the IVV

- "n" is constant for any member of a species in all phases of its life cycle
- "n" is determined by the amount of unique information; chromatids are exact copies of each other so they add no new information
- DNA sequence homology determines pairing, which is detectable by physical hybridization of strands
- Homology is determined by DNA sequence similarity, which has a side of effect of looking the same
- Meiosis I is different from meiosis II due to pairing of homologous chromosomes
- The cell becomes haploid after the first meiotic division.
- Meiosis is necessary for fertilization but fertilization does not always happen, and it requires another physical process to happen first!
- Two-chromatid chromosomes are the result of DNA replication; maternal and paternal contributions appear as homologous chromosomes
- Ploidy is based on information content
- Meiosis only occurs in precursor germ cells
- The purpose of meiosis is to prepare for fertilization by preserving one and only one copy of all information to be passed to the next generation.
- The purpose of crossing over is to allow for proper chromosomal pairing which then allows for proper segregation.
- Genetic diversity is an important side effect.

- Maternal and paternal chromosomes of the same kind are nearly identical at the DNA sequence level
- Pairing occurs due to sequence, lining up occurs later due to spindle fibers

Recommended In-class Curricular Material

Please see the MINT FAQ (https://ivv.rit.edu/FAQ.php) for general information on the use of MINTs and IVVs with your class. The following curricular materials are provided as examples of resources that may be used in class to further student learning towards IVV and MINT learning objectives.

- Newman DL, Wright LK. Meiosis: A Play in 3 Acts, Starring DNA Sequence. CourseSource: https://www.coursesource.org/courses/meiosis-a-play-in-three-acts-starring-dna-sequence
- Wright, R. Why Meiosis Matters: The case of the fatherless snake. *CourseSource*. 2014. https://doi.org/10.24918/cs.2014.1

Assessment Question Information:

The research team has developed multiple select questions for assessing IVV effectiveness. Please contact the research team (https://ivv.rit.edu/about.php) if you are interested in assessing IVV use in your course.

Acknowledgement

This material is based in part upon work supported by National Science Foundation (NSF) grants 1432286 and 1432303. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.