**Module 9 Genetics**

North Carolina 2011 NISMEC

# Essential questions

***We are all humans, just look around. We are all different or vary in some way. Why?***

What traits are the most common in our classroom? Which traits are most dominant? What is the relevance of traits not seen as often?

Is there more to traits than just dominant and recessive?

Do all types of inheritance work in the same way?

What are the obvious and significant differences between various inheritance patterns?

Can we predict the outcome of a cross between two organisms?

We have all seen pedigrees, although we call them family trees. Can pedigrees be used to predict something about families or their genetic backgrounds?

How are traits passed from parents to offspring?

How do DNA and RNA control the structure and function of cells and of entire organisms?

# Instructional goals

Goal (Standard #).

Interpret and predict patterns of inheritance

 Dominant, recessive and intermediate traits.

 Punnett squares.

Interpret Punnett squares **(monohybrid only)** to determine genotypic and phenotypic ratios

 Understand that dominant alleles mask recessive alleles.

 Determine parental genotypes based on offspring ratios.

Recognize that some traits are controlled by more than one pair of genes and that this pattern of inheritance is identified by the presence of a wide range of phenotypes (skin, hair, and eye color).

Predict offspring ratios based on a variety of inheritance patterns (including dominance, codominance, incomplete dominance, multiple alleles, and sex-linked traits).

Explain the role of meiosis in sexual reproduction and genetic variation.

Infer the importance of the genes being on separate chromosomes as it relates to meiosis.

Explain how the process of meiosis leads to independent assortment and ultimately to greater genetic diversity.

Exemplify sources of genetic variation in sexually reproducing organisms including crossing over, random assortment of chromosomes, gene mutation, nondisjunction, and fertilization.

# Misconceptions

Daughters inherit most of their characteristics from their mothers.

Boys inherit most of their characteristics from their fathers.

Variation between species is a result of adaptation to environment instead of inheritance.

Transmitted characteristics are acquired during the life time of the animal.

Individuals can adapt to a changing environment. These adaptations are heritable.

Students do not understand the relationship between DNA, genes, and chromosomes

One parent contributes genes for some characteristics, while the other features come from the other parent.

Inherited traits are blended, but the male parent's characteristics are stronger in expression or always dominant.

Animals consciously plan their reproductive strategies.

If there are three alleles in a population, an individual may have three alleles.

Dominant alleles are generally the most frequently occurring alleles in a population.

If a trait is genetically controlled it can't be influenced by the environment. Dominant alleles are the most desirable ones.

# Essential vocabulary

Punnett square

Ratio

Probability

Phenotype

Genotype

monohybrid

dihybrid

heterozygous

homozygous

actual results

predicted results

pedigree

carrier

Sex linked

karyotype

autosome

sex chromosome

trisomy

Law of independent assortment

Law of segregation

Dominant

Recessive

Incomplete dominant

Codominant

Multiple allele

Polygenic

Codon

Start codon

Stop codon

Anticodon

mRNA

tRNA

rRNA

transcription

translation

mutation

substitution

deletion

insertion

frameshift mutation

# Sequence

1. Prequiz [.5 day]
2. Human Traits Survey [1 day]
3. Dominant vs. Recessive: What does it mean to you? [1 day]
4. Inheritance Patterns Vocabulary Puzzle Pieces [1 day]
5. Genetic Predictions [1 day]
6. Model: Spongebob Genetics Lab [1 day]
7. Model: Probability Pennies Lab [2 days]
8. Incomplete Dominance [1 day]
9. Model: Dihybrid Spongebob Genetics Lab [1 day]
10. Model: Codominant traits [1 day]
11. Model: Multiple Allelic Traits
12. Model: Polygenic Genes
13. Mendel Post-quiz [.5 day]
14. Pedigree Vocabulary Puzzle [.5 day]
15. Model: Thacker Family Pedigree [1 day]
16. Model: More pedigrees [1 day]
17. Reading: Hemophilia [1 day]
18. Model: Human Karyotypes [1 day]
19. Protein Synthesis Prequiz [.5 day]
20. Protein Synthesis Vocabulary Puzzle Pieces [.5 day]
21. Protein Researching [.5 day]
22. Lick Your Rat Simulation [1.5 days]
23. Transcription/Reverse Transcription Activity [.5 day]
24. Protein Synthesis Relay Activity [.5 day introduction, recurring periodically]
25. RNA Decoding Activity - words [1 day]
26. RNA decoding activity – letters [1-2 days]
27. Molecular Structure of Protein Synthesis [1-2 days]
28. Introduction to Mutations [.5 day]
29. Gene Mutations Activity [1 day]

# Instructional notes

## Prequiz [.5 day]

## Human Traits Survey [1 day]

### Apparatus

An inventory of my traits worksheet

### Pre-activity discussion

We are all humans, just look around. We are all different or vary in some way.

### Instructions

Have students get in groups.

Ask students the leading question.

Students should whiteboard their answers.

Hold a Board Meeting to discuss the answers given by students

### Post-activity discussion

Why are people different?

What causes these variations among individuals?

Are there similarities in individuals?

How do you think these similarities and differences relate to your families?

What do you think this next unit will focus on?

Can you make any connections to concepts we have learned earlier this year, or that you have learned in the past?

## Dominant vs. Recessive: What does it mean to you? [1 day]

### Apparatus

*Per Student:*  An Inventory of My Traits-Survey worksheet, An Inventory of My Traits- Data Table worksheet, An Inventory of My Traits-Graph worksheet, ruler, colored pencil

### Pre-activity discussion

What traits are the most common in our classroom? Which traits are most dominant? What is the relevance of traits not seen as often?

### Instructions

Have the students’ complete “An Inventory of My Traits” survey.

Students should then get in groups of four and share their data. They should complete “An Inventory of My Traits” data table.

Students should graph their data as a bar graph.

Bar graphs should be white boarded.

As a class discuss the bar graphs and trends.

Collect an overall class data list.

Create another bar graph of class data.

### Post-activity discussion

Do the same trends exist?

What traits do you think are dominant?

Discuss dominant versus recessive.

## Inheritance Patterns Vocabulary Puzzle Pieces [1 day]

### Apparatus

Inheritance Patterns Vocabulary Puzzle Pieces

### Pre-activity discussion

Is there more to traits than just dominant and recessive?

Do all types of inheritance work in the same way?

What are the obvious and significant differences between various inheritance patterns?

### Instructions

Pass out a puzzle piece to each pair.

Have the student pairs use the vocabulary to create a whiteboard containing the information listed above.

Students will then share this information in a board meeting.

Students will make corrections to the whiteboards during the board meeting.

After every group has presented, students will post their whiteboards around the classroom.

Each student will go to each whiteboard and copy the information from each whiteboard into their biology notebooks

### Post-activity discussion

How does this information change your thoughts on how traits are passed on?

Even though inheritance patterns differ, can this information still be predicted?

## Genetic Predictions [1 day]

### Apparatus

Punnett Square Worksheet

### Pre-activity discussion

Can we predict the outcome of a cross between two organisms?

### Instructions

Students should be given time to work through the Punnett Sqaure worksheet.

When students have completed the Punnett Sqaure worksheet, they should move to pairs or groups, depending on how you would like to structure white boarding of practice problems in your classroom.

Each pair/group should be given a Punnett Square problem. You may give two groups the same problem and have a dueling whiteboard session. Or you may give each group a problem and have a presentation session.

Following each whiteboard probing questions should be asked regarding the whiteboards.

### Post-activity discussion

Did you accurately predict the right outcomes?

If the crosses were done repeatedly in real life, would you see the same actual results 100% of the time?

## Model: Spongebob Genetics Lab [1 day]

### Apparatus

Bikini Bottom worksheet

### Pre-activity discussion

Remind students of the working vocabulary they already know:

Homozygous

Heterozygous

Genotype

Phenotype

Dominant

Recessive

Allele

Trait

Punnett square

### Instructions

Have students work in groups to complete the Bikini Bottom Genetics problems.

When they are almost done, assign each group a portion of the worksheet to whiteboard and present to the class.

### Post-activity discussion

Have students present the whiteboards.

Ask students what surprised them about Spongebob’s genetics.

Refer back to the misconceptions and ask leading questions to help students discover the error in the misconception. For example, “Why is blue always recessive?” “When Squidward gets married, whose genes will get expressed in their offpring, and why?”

### Extension to evolution

Through a mutation which causes a different phenotype, one of Spongebob and Susie’s offspring, SpongeLarry, has the ability to get oxygen from air in addition to from the water. Let A = non-air breathing and a = air-breathing. Some possible prompts for whiteboarding:

* + Explain how SpongeLarry got his phenotype.
	+ If SpongeLarry finds a sweetheart who is aa, explain the advantage they would have by moving away from Bikini Bottom to live on Bikini Beach.

## Model: Probability Pennies Lab [2 days]

### Apparatus

Probability in Genetics lab (possibly for reference only)

### Pre-activity discussion

Remind students of vocabulary they know:

* + Dominant
	+ Recessive
	+ Allele
	+ Trait
	+ Actual results
	+ Predicted results

### Instructions

For the monohybrid cross, students flip 2 properly marked pennies 100 times each, with one side of each coin representing T and the other representing t. They record their results in the data table. For the dihybrid cross, students flip four properly marked pennies 100 times each, recording their results in the data table. (entire instructions explained on lab handout)

### Post-activity discussion

Have students whiteboard the answers to the questions at the end of both pages of the Probability in Genetics Lab.

## Incomplete Dominance [1 day]

### Apparatus

Photograph of red, pink, and white snapdragons (find your own pictures)

### Pre-activity discussion

Remind students about dominant and recessive inheritance patterns. Is life always simple?

### Instructions

Give students the photograph and have them whiteboard the following:

Explain in terms of genetics what this picture shows. They must include a Punnett square.

### Post-activity discussion

Hold a board meeting and discuss. Introduce students to the correct notation method for incomplete dominance.

## Model: Dihybrid Spongebob Genetics Lab [1 day]

### Apparatus

Bikini Bottom – Dihybrid Crosses worksheet from lessonplansinc.com

### Pre-activity discussion

Suggest that all organisms have more than one trait. We can show that on a Punnett square.

### Instructions

Have students work in groups to complete the Bikini Bottom – Dihybrid Crosses Genetics problems.

When they are almost done, assign each group a portion of the worksheet to whiteboard and present to the class.

### Post-activity discussion

Was there any combination of traits that did not show up together? Which ones appeared more often? Discuss ratios.

## Model: Codominant traits [1 day]

### Apparatus

Photograph of white, black, and Barred Rock chickens (find your own pictures).

### Pre-activity discussion

Remind students about dominant and recessive inheritance patterns and incomplete dominance. Define incomplete dominance in terms of having a “medium” trait (so that when they see the codominant, it will be noticeably different).

### Instructions

Give students the photograph and have them whiteboard the following:

Explain in terms of genetics what this picture shows. They must include a Punnett square.

### Post-activity discussion

Hold a board meeting and discuss. Introduce students to the correct notation method for incomplete dominance.

## Model: Multiple Allelic Traits

This component is not yet completed.

## Model: Polygenic Genes

This component is not yet completed.

## Mendel Post-quiz [.5 day]

## Pedigree Vocabulary Puzzle

### Apparatus

Genetic Disorders Vocabulary Puzzle Pieces

### Pre-activity discussion

Remind students that they have heard of these words.

### Instructions

Assign one word or figure to each group. Have them whiteboard their understanding of the word or figure. Students must use multiple representations on their boards.

### Post-activity discussion

Students present their whiteboards. Each group asks a question of each presenting group. Students write the definitions in their notebooks.

## Model: Thacker Family Pedigree

### Apparatus

“The Thacker Family: Constructing a Pedigree” reading

### Pre-activity discussion

Discuss pedigree symbols and the basics of constructing a pedigree.

Remind students of some key vocabulary terms.

### Instructions

Have students read the family history and, in groups, whiteboard the questions at the end.

### Post-activity discussion

Have a board meeting and encourage students to discuss their understanding of pedigrees.

## Model: More pedigrees

### Apparatus

Pedigree Scenarios, cut into slips for each group

### Pre-activity discussion

Review the Thacker Family pedigree. Ask leading questions to help students realize what patterns of heredity helped them determine that polydactyly was a dominant trait. Also, get them to conclude what patterns would indicate a recessive or sex-linked trait.

### Instructions

Assign groups of students to read and complete the different pedigrees. Have them present their pedigrees on whiteboards, labeling only as Scenario I, II, etc. without the names of the disorder. Teacher circulates and asks leading questions to be sure that students are coming to the correct conclusion of the inheritance pattern represented by their scenario.

Have students display their whiteboards and then have students identify the inheritance pattern represented by each whiteboard.

### Post-activity discussion

After students have identified inheritance patterns, discuss the similarities and differences between the inheritance patterns. Each group should share the correct answer to their scenario to be sure that the class was correct.

## Reading: Hemophilia

### Apparatus

“Hemophilia: The Royal Disease” handout from North Carolina Modeling or “Recovering the Romanoffs” - <http://www.dnai.org/d/index.html>

Extension: Extended Hemophilia Pedigree

### Pre-activity discussion

None, in the context of preceding activities.

### Instructions

Have students read and answer questions, then whiteboard answers.

### Post-activity discussion

Hold a board meeting to discuss sex-linked pedigrees.

### Extension to evolution

Show the extended pedigree of the English royal family and discuss how the surviving portion of the family is not affected by the disorder. Tie this in to natural selection, and talk about a deleterious mutation can cause an individual to contribute less to the gene pool.



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## Model: Human Karyotypes

### Apparatus

Karyotype cut-and-paste pages from Human Karyotyping Activity

Blank paper

Scissors

Glue/tape

### Pre-activity discussion

Background: Occasionally chromosomal material is lost or rearranged during the formation of gametes or during cell division of the early embryo. Such changes, primarily the result of nondisjunction or translocation, are so severe that the pregnancy ends in miscarriage – or fertilization does not occur at all. It is estimated that one in 156 live births have some kind of chromosomal abnormality.

### Instructions

It is recommended to use only the Chromosomes “Set A,B,C,D” pages, or else to copy them off with the “Normal” label obscured. It also may be beneficial to obscure the “Y” label on any of the pages.

Give the students the cut-and-paste page and have them cut out and organize the chromosomes by homologous pairs on the blank page. Label the sex chromosomes.

### Post-activity discussion

Have students whiteboard the answers to these discussion questions:

1. Is your person male or female? How did you know?
2. Describe any abnormalities.
3. In your opinion, is karyotyping ethical? Justify your answer.

Hold a board meeting to share and discuss answers.

## Protein Synthesis Prequiz [.5 day]

## Protein Synthesis Vocabulary Puzzle Pieces [.5 day]

### Apparatus

Protein Synthesis vocabulary puzzle pieces

### Pre-activity discussion

Emphasize to students that these words are new to them.

### Instructions

Assign one word or figure to each group. Have them whiteboard their understanding of the word or figure. Students must use multiple representations on their boards. Direct them to use multiple resources to formulate definitions that are specific to biology.

### Post-activity discussion

Students present their whiteboards. Each group asks a question of each presenting group. Students write the definitions in their notebooks.

## Protein Researching [.5 day]

### Apparatus

Computers

### Pre-activity discussion

Discuss how proteins do all the jobs inside cells. Explain that there are a huge number of different kinds of proteins.

### Instructions

Using the internet and/or texts research 10 proteins and their functions. Choose proteins that students can relate to and find information about. For example, myosin, actin, DNA helicase, etc.

Have students report their findings on a powerpoint or whiteboard. Preferably, powerpoints can be revisited during the following activity.

### Post-activity discussion

What are proteins made of? Where did the cell get the raw materials? How did the materials get to the cell? Where are they assembled?

## Lick Your Rat Simulation [1.5 days]

### Apparatus

<http://learn.genetics.utah.edu/content/epigenetics/rats/>

### Pre-activity discussion

Remind students of what they know about proteins and how proteins cause traits.

### Instructions

Day 1: Using the lick your rat simulation, guide students to come to the conclusion that uncoiled DNA leads to more proteins and results in calmer rats.

Day 2: Give the whiteboard prompt, “Using proper terminology, explain the relationship between DNA and protein.” Have them use diagrams and words. Hold a board meeting and discuss.

Revisit the protein research activity. Show powerpoints if possible. Discuss or whiteboard the relationship between these proteins and the previous whiteboarding activity.

### Post-activity discussion

Alert students that the following activity will show how the cell uses DNA to produce a protein.

Possible extension to evolution: Discuss the relationship of environment on the DNA in terms of the reading on whether anxious behavior can be an advantage on the lick your rat web page.

## Transcription/Reverse Transcription Activity [.5 day]

### Apparatus

Transcription/Reverse Transcription worksheet

### Pre-activity discussion

Remind students of the preceding activities and of the need for proteins in cellular activities. Explain how to use an mRNA codon chart.

### Instructions

Give students the worksheet and have them whiteboard the answers.

### Post-activity discussion

Hold a board meeting to discuss the answers. Talk about why all the answers to #1 and #2 are the same, but #3 has some different answers. Introduce the idea that not all changes in the genetic code are important.

## Protein Synthesis Relay Activity [.5 day introduction, recurring periodically]

### Apparatus

Protein Synthesis Relay Cards

### Pre-activity discussion

Explain that transcription/translation is a teamwork activity, so students must work together just like the molecules in a cell do.

### Instructions

In groups of 3, students are assigned the following roles: DNA, mRNA, and Ribosome. They must use the cards to demonstrate transcription and translation with a given sequence of DNA. The first group to complete the sequence correctly wins.

### Post-activity discussion

Why is it necessary for the process to be so complicated?

Think about a teamwork activity you do in your everyday life. How is transcription/translation similar to that activity?

## RNA Decoding Activity - words [1 day]

### Apparatus

 Protein synthesis Sentence Activity from Lesson Plans inc

### Pre Activity discussion

Remind students of what they have just learned in the relay activity.

### Instructions

Have students complete the activity as directed in the lesson plan.

### Post-activity discussion

Have students report on whiteboards the sentences they have decoded, and hold a board meeting to compare answers.

## RNA decoding activity – letters [1-2 days]

### Apparatus

Slips with RNA messages

RNA message key for code

RNA message Excel decoder

### Pre-activity discussion

Remind students of how the genetic information is encoded in the DNA sequence.

### Instructions

Give students a secret message to decode. Let them puzzle over it for a while before telling them there is a key to break the code. Then show them how the key works.

### Post-activity discussion

On whiteboards, have students compare the method of decoding the messages to the actual cell process of protein synthesis. Present the whiteboards.

### Optional extension

Have students write secret messages back to the teacher. These can be decoded by typing them into a new column on Sheet 2, starting at Column E.

## Molecular Structure of Protein Synthesis [1-2 days]

### Apparatus

Cut-out pictures of DNA, mRNA, ribosome, tRNA, Amino acids with double-sided tape on back.

### Pre-activity discussion

Remind students of the process they have been learning. Introduce the appearance of the structures by showing pictures.

### Instructions

Have students produce a “movie” by moving the pieces around on their whiteboards.

### Post-activity discussion

Present and discuss. Guide students to correct misconceptions.

## Introduction to Mutations [.5 day]

### Apparatus

none

### Pre-activity discussion

Write a sequence of DNA bases on the board. Discuss what would happen if somehow the sequence got changed somehow. Define *mutation*.

### Instructions

Have students come up with as many different ways to change the DNA as possible and whiteboard their results. Hold a board meeting.

### Post-activity discussion

Guide the students to agree about categories of mutations (substitution, deletion, insertion). Highlight the similarity of deletion and insertion mutations as both being able to cause a frameshift.

## Gene Mutations Activity [1 day]

### Apparatus

Gene mutations worksheet from lessonplansinc.com

### Pre-activity discussion

Review mutation vocabulary.

### Instructions

Have students complete the worksheet in groups and whiteboard the following prompt: “Explain the types of mutations. Which would cause the biggest change? Justify your answer.”

### Post-activity discussion

Hold a board meeting. Have students explain and discuss the types of mutations and how traits change from those mutations.