SCOPE, SEQUENCE, and COORDINATION

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SCOPE, SEQUENCE, and COORDINATION

Student Materials

Learning Sequence Item:

1004

The Human Genotype

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Contents

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Science as Inquiry

Karyotyping Human Chromosomes

How can we diagnose genetic abnormalities?

Overview:

A karotype is a way to organize a set of chromosomes from the nucleus of a cell. Is your karyotype that of a normal person or a person with a genetic disorder? Is it that of a male or female? These questions will be answered in this activity.

Procedure:

Cut out the chromosomes from Plate 1 (provided by your teacher) and arrange them in pairs, in descending order by pair, length of "arms," and by position on the centromere, using Diagram 1 as a guide. Then tape (or glue) the pairs to a sheet of paper. Repeat the process, but this time using the chromosomes from Plate 2.

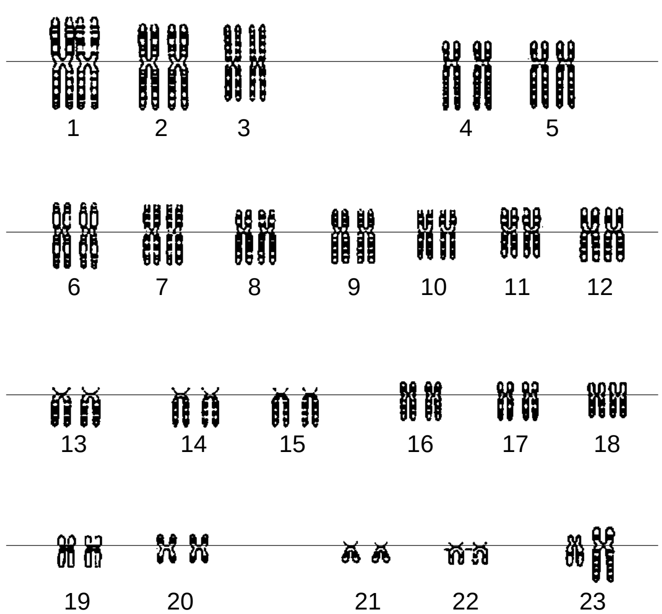


Diagram 1

Questions:

1. Observe the karyotype in Diagram 1. Notice that the two sex chromosomes (pair 23) do not look alike. They are different because this karyotype is of a male, and a male has an X and a Y chromosome. How many sex chromosomes are present in your karyotype?

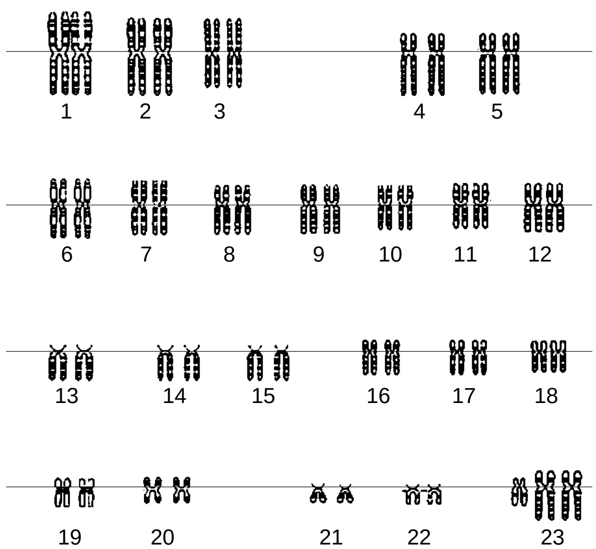


Diagram 2

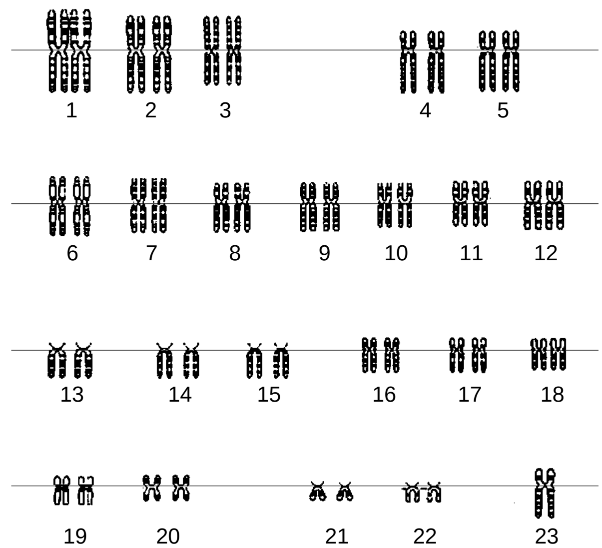


Diagram 3

2. How does the karyotype in Diagram 2 differ from the karyotype in Diagram 1? Do you think this is a significant difference?

3. How does the karyotype in Diagram 3 differ from the karyotype in Diagram 1? Explain how you think this difference might affect the individual who has this genotype.

4. Summarize the genetic conditions you found in the two karyotypes you constructed.

5. What problems did you encounter composing your karotypes?

Science in Personal and
Social Perspectives

The Right to Know and Not to Know

What is your family's profile?

Overview:

In this activity, you will observe a variety of human traits and use your observations to read and interpret a pedigree. Think about what traits make each person unique. Where do these traits come from?

Procedure:

Using the list below, conduct research with your nearby family members. Set up a data table to record your observations.

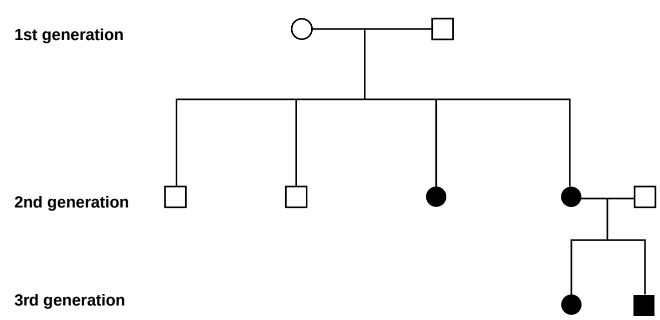
Ear lobe shape Record whether the subject has "free" ear lobes or attached ear lobes.

Dimples. Record whether the subject has dimples.

Freckles. Record whether the subject has freckles.

PTC tasting. The ability to taste a harmless chemical (PTC) is a genetic trait. Give subject a piece of PTC paper (provided), and tell your subjects to put it in their mouths and chew for a few seconds. Record whether or not the subject notices a distinct bitter taste.

Eye color. Although eye color is controlled by several genes, a single pair is responsible for blue eye color (recessive trait). All non-blue eyes result from the dominant B gene. Record subject's eye color.



Sample Pedigree Chart

Symbol	Meaning
○	female without trait
●	female with trait
□	male without trait
■	male with trait

After you have gathered your data, compare with your classmates' data. Calculate the percentage of the class that exhibits each trait. Based on your information, record possible genotypes and create your own pedigree chart.

Questions:

1. Do you have any recessive traits? How do you know?

2. How does the information you collected and studied indicate that dominant traits are the most common?

Science as Inquiry

Little Left-handed Finger

What causes variation and why is variation important?

Overview:

Did you know that you and your classmates belong to the same species? Do you notice some traits and not others? You can see examples of almost countless variations everyday. For example, when your cat has kittens, they will probably not be the same size—and that's just one variation!

Procedure:

Make a list of 10 differences you can easily see among your classmates—such as skin color, height, weight, eye color, etc. What about subtle differences? Let's investigate a difference you may not observe—the length of the first finger. Using a metric ruler, measure the length of the first finger (in centimeters) of your left hand and the members of your lab group. Next, record how many of each finger length (total fingers) occurs in your group. Now, record the group results on the chalkboard and compare with other groups. Using the data from the chalkboard, record the frequency for the entire class and create a bar graph.

Questions:

1. How would you describe the shape of your graph?

2. According to your graph, what finger length occurred most often?

3. What was the length of the shortest first-finger in your class? The longest?

4. What was the range of the length of the first finger?

5. How could finger-length be an advantage?

Science as Inquiry

Heads or Tails?

How do we know if things occur just by chance?

Overview:

Based upon your understanding of meiosis, you can make predictions about outcomes of simple breeding examples dealing with specific traits. Of course, the outcomes of sexual reproduction do not always turn out exactly as predicted. These differences in expected characteristics may be due to just chance. This activity will show you how to see if this is true.

Procedure:

Your teacher will lead you through an example of how to use the Chi-square test to find out if a set of data is within acceptable range (statistically significant) as compared to results that are expected under ideal conditions.

Study the data and information below. Your task is to determine if the outcomes of random breeding events of soybean plants produced the types and numbers of offspring that you would expect.

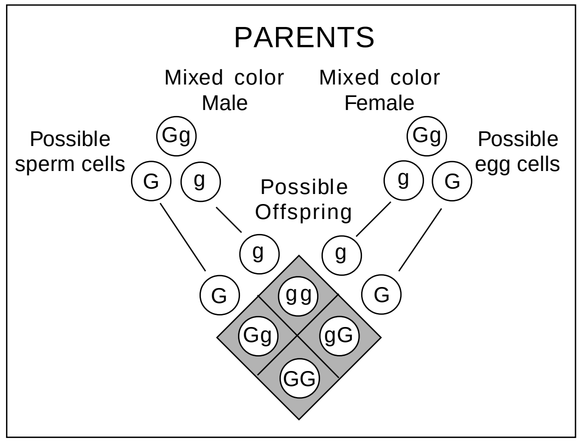
The color of soybean plants can vary. They can be either green, yellow, or mixed-color depending on their genetic makeup. Remember that all individuals have two homologous chromosomes which have genetic instructions for the same trait(s), in this case plant color. Let's represent the gene for soybean plant color with the letter "G." Capitol G codes for the color green, and small g codes for yellow. If an individual plant has two homologous chromosomes both with capitol letter G (GG), then the plant is green; if it happens to have Gg, then it is mixed-color; if it happens to have gg, then it is yellow. This is a case discontinuous variation due to incomplete dominance.

Chi-square Values

freedom	P = 0.99	0.95	0.80	0.50	0.20	0.05	0.01
1	0.0000157	0.00393	0.0642	0.455	1.642	3.841	6.635
2	0.0201	0.103	0.446	1.386	3.219	5.991	9.210
3	0.115	0.352	1.005	2.366	4.642	7.815	11.341
4	0.297	0.711	1.649	3.357	5.989	9.488	13.277
5	0.554	1.145	2.343	4.351	7.289	11.070	15.086
6	0.872	1.635	3.070	5.348	8.558	12.592	16.812
7	1.239	2.167	3.822	6.346	9.830	14.067	18.475
8	1.646	2.733	4.594	7.344	11.030	15.507	20.090
9	2.088	3.325	5.380	8.343	12.242	16.919	21.666
10	2.558	3.940	6.179	9.342	13.442	18.307	23.209

Questions:

1. From your study of meiosis, you know that the parents can produce gametes. Based upon the illustration, what is the expected ratio of each color of soybean offspring, yellow : mixed : green? What would be the expected ratio for a set of 100 soybean seedlings bred from the same two parents (as in the illustration)?



2. Use the chi-square test to determine if the following observed count of 100 soybean seedlings is within acceptable range as compared to results that are expected under ideal conditions.

Count:
20 Green
53 Mixed-color
27 Yellow

chi-square = Ý [d^2/exp.]

or, in another form:

X^2 = sum of (difference^2/expected ratio)

Science in Personal and Social Perspectives

Good Cells, Bad Cells

How do normal and sickled erythocytes compare?

Overview:

Are all red blood cells alike? Do they have the same shape? What does the cell membrane and the cytoplasm look like? What does the color say about the cell? Do the cells have nuclei? After completing this activity, you should be able to answer these questions.

Procedure:

Observe a normal red blood cell (slides provided) under low power, then under high power. Using the red pencil, create a line drawing of what you see. Label the cell parts, i.e., cell membrane, cytoplasm. Shade in the parts of the cell in which hemoglobin is found.

Next, observe a slide of a sickled red blood cell. Diagram your observations as before.

Questions:

1. Describe the shape of normal cells.

2. Describe the shape of sickled cells.

3. Which type of cell, normal or sickled, contains more hemoglobin? Why?

4. Describe how a pedigree might help demonstrate whether the sickled erythocyte condition is genetically caused.

5. How could you determine whether this trait is sex-linked?

Science in Personal and Social Perspectives

Hemophilia vs. Color Blindness

How are traits inherited?

Overview:

Sex chromosomes are important! They, of course, determine whether we are male or female, but the X chromosome contains a great deal more information. If your mother has a particular trait, what are your chances of having it?

Procedure:

Part A. You will test chances for inheriting hemophilia. Tape and label both sides of the coins as shown in the diagrams. The labels (letters) represent the results that might appear in offspring of these parents. Placing two coins (in the combinations listed) in your cupped hands, shake, then drop the coins on a table top. Set up a data table and record the results of the toss. Repeat the process for a total of 40 throws, first for Family 1 (normal, mother is heterozygous), then for Family 2, (father is hemophiliac, mother is heterozygous).

FAMILY 1

	front	back
Coin 1. Male	X^H	Y
Coin 2. Female	X^H	X^h

FAMILY 2

	front	back
Coin 3. Male	X^h	Y
Coin 4. Female	X^H	X^h

FAMILY 3

	front	back
Coin 5. Male	X^b	Y
Coin 6. Female	X^B	X^B

FAMILY 4

	front	back
Coin 7. Male	X^B	Y
Coin 8. Female	X^B	X^b

Part B. Repeat the process as above, except that the test is for color blindness in Family 3 (father is color blind, mother has two dominant genes); and for Family 4 (normal, mother is heterozygous).

Questions:

1. If two parents have these genes for hemophilia ($X^H X^h$ and $X^h y$), what types of blood will their children have?

2. It is often said that there is less of a chance of a female being colorblind. How can this statement be true?