GENETICS

Competence

Students are able to understand the mechanism, vehicle and visualization of property degradation

Competence Standard

Students are able to:

1. Explain the various characteristics of living things that are passed on to their offspring
2. Explain the description of the process of inheritance through crosses
3. Explain the meaning of homozygous, heterozygous, dominant, recessive, intermediate
4. Explain the structure of chromosomes
5. Explain the function of chromosomes in the inheritance of different traits
6. Describe the DNA molecule
7. Explain the process of DNA isolation and visualization
8. Explain the process of translating the information contained by DNA into protein

A. Different Traits Inherited From Parental To Descendants

Maybe you've heard or yourself commented on the physical differences or traits of your friends. For example, "Nita's hair is straight like she's rebonded" while "Farhan has curly hair like Edi Brokoli". Or "Rina has a sharp nose while Arik has flat nose". Or you notice another comment that you may often hear is: "That Nadia looks exactly like her mother." Or "How come that Nisa looks like an Arab huh?", "Oh, of course, her grandfather is an Arab", and so on. You may have also read or seen a farmer always chooses the best seeds from his plants to be used as seeds for the next planting.

Do you know what causes differences in the nature of living things? Why do some people have straight hair, while others have curly hair, why are some people grumpy while others are patient, why is one plant better (yielding a lot, big fruit, sweetness etc.) while the other is ugly? In order for you to understand this, in this material, you will learn about different traits and crosses of two individuals with one different trait or more than one different trait.

ACTIVITY 1

Differences and Similarities and the origin of the nature of an Individual

Basic Competence

Understanding the differences and similarities between two people and the origin of these traits.

Steps

Observe the physical characteristics of two of your friends. Also ask how the characteristics of both parents and or grandparents. Then, write the results in the following table:

No.	Characteristics	Student's name	Mother's name	Father's name	Participant's name	Mother's name	Father's name	Conclusion
1.	Ears							
2.	Hairs							
3.	Complexion							
4.	Cheek							
5.	Forehead							
6.	Nose							
7.	Face							
8.	Fingers							
9.	Tongue							
10.	Eyes							

After doing this activity, answer the following questions!

1. Do your two friends have the same characteristics? What are those characteristics?
2. Are there any differences between your two friends? What are those characteristics?
3. Did your two friends get these characteristics from their parents or grandparents?
4. What can you conclude about the different characteristics of one individual with another individual?
5. What can you conclude about the origin of different traits in each individual?

B. Crossing peas to understand the inheritance of different traits

Something passed on from parents or parents to their children causes the difference in living things. People used to believe that hereditary traits were carried down through the bloodline. However, this viewpoint is no longer valid. Sex cells pass on parental characteristics to their children (gametes). Genetics is the science that investigates inheritance.

You'll come across phrases that explain symbols for the following generation or generation while studying heredity. The terms are as follows:

1. Parent or parent indicated by parental (P);
2. The first descendant which is declared with filial one (F1)
3. The second offspring expressed by filial two (F2)
4. The third generation which is stated by filial three

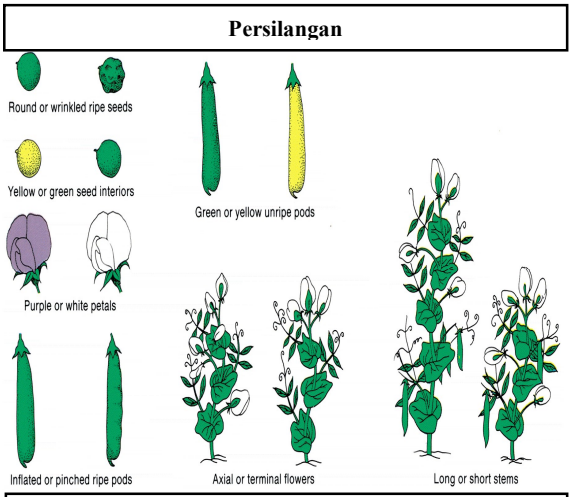
From the activities you did above, you can see that there is a decrease in traits that come from the parent to the filial (F_1, F_2, F_3, F_4) P is the parent of F_1, F_2 s the parent of F_2, and so on.

What caused this heredity? Male and female sex cells are responsible for passing on qualities to their progeny. That is, if there is no marriage between sex cells, the process of characteristic decline will not occur.

The first person to analyze heredity and put it into numbers was Mendel using peas. Although Mendel's research used plants, the basic principles of inheritance that he discovered can be applied to humans and animals because basically the mechanism of inheritance in all living things is the same. Mendel observed different traits in peas. Through crossing and selection of pea (Pisum sativum) plants over several generations, Mendel found that some of the traits shown by offspring were a combination (mix of) parental trait.

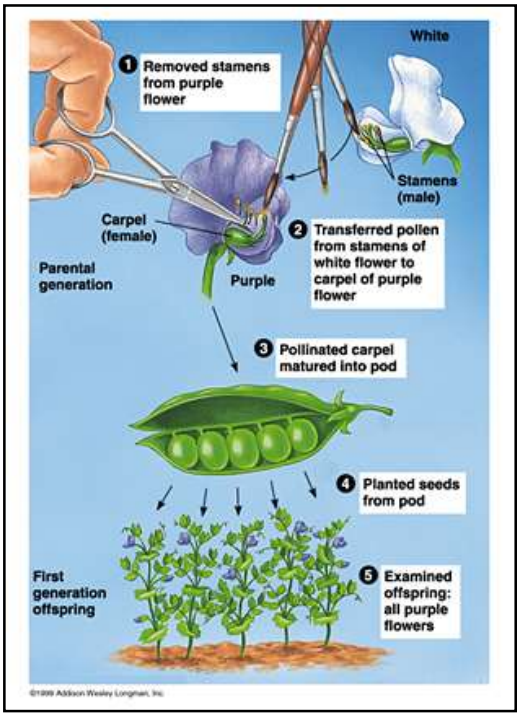
For example, the color of a pea flower is purple or white. When a purple-flowered pea plant is crossed (bred) with a white-flowered pea plant, the offspring are found to flower not between white and purple (for example, light purple), but instead purple. Mendel observed that there are seven properties that are easy to see and only easy to distinguish and each of them consists of two forms

Kapri



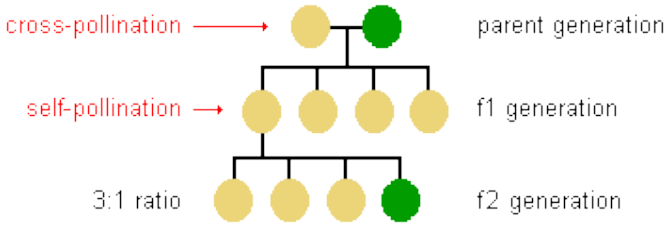
Persilangan

Sifat-sifat beda yang diamati oleh Mendel

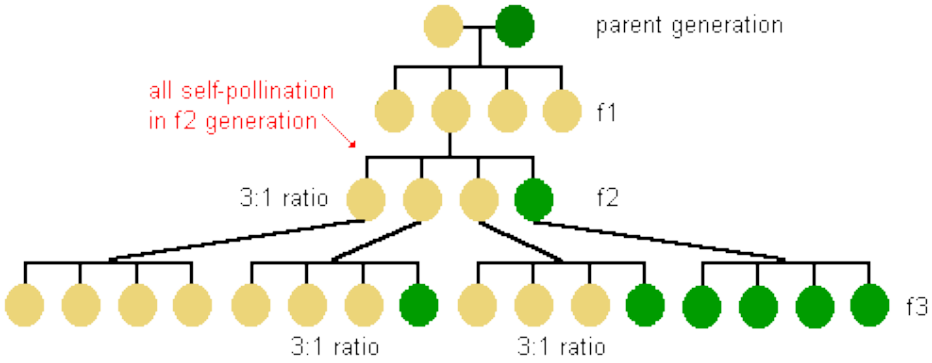


Based on the results of these observations Mendel hypothesized that there are factors of inheritance that produce certain traits. These factors are now referred to as genes. For certain properties consist of a pair of alternatives. Mendel decided that there should be an alternative gene for height and an alternative gene for short. The alternative form of a gene is called an allele. For each trait of an organism controlled by a pair of alleles, one allele from the male parent, and one allele from the female parent.

Mendel also discovered that plants with purple flowers always produced purple flowers. This plant has a pair of purple flower color alleles derived from male and female parents. Mendel called these plants homozygous. Mendel wondered what the offspring would be when a purple flowered parent was crossed with a white flowered parent. It turned out that the cross resulted in purple flowering plants. This plant received a purple allele from one parent and a white allele from the other parent. However, even though it has a purple allele and a white allele, the plant has purple flowers. These plant-like organisms were referred to by Mendel as heterozygous. In this heterozygous plant, only the purple allele is expressed, the white allele is hidden. Mendel called these alleles that are always expressed dominant, while those that are hidden are recessive. In crossing plants that produce yellow seeds with plants with green seeds, Mendel found that the F1 generation is always yellow. However, the F2 generation always produces a 3:1 ratio for yellow to green.



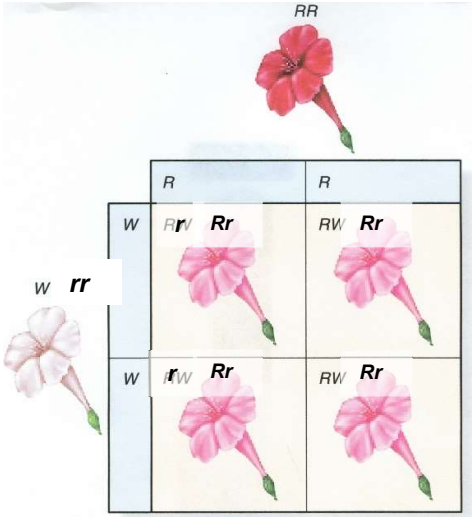
Perbandingan 3:1 ini juga terdeteksi pada generasi-generasi berikutnya:



Finally, Mendel concluded 3 important things that:

1. The inheritance of a trait is determined by a unit or factor that is passed on to its offspring without changing it. These units are called genes.
2. Each individual inherits one such unit from each parent
3. A different trait may not appear in one individual but can still be passed on to the next generation

If Mendel's research using peas was never found to have F1 which has combined properties of the two parents, something different was found in the decrease in the color properties of Mirabilis Jalapa flowers.



Two allele:

- R - purple
- r – white

purple RR Plant
white r plant

Cross: RR x rr
Rr plants are pink!

In Mirabilis, it is seen that there is a combination of parental traits in offspring that get different alleles from each parent. So that the heterozygous offspring has intermediate traits between white and purple. This means that both alleles are equally strong so that the phenotype of the offspring becomes light purple in color. The color is obtained from a combination of purple and white alleles.

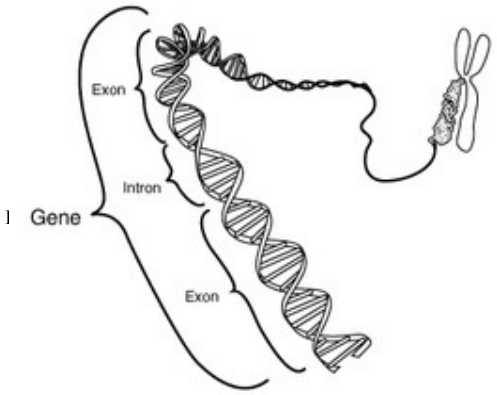
CONCEPT MASTERY TEST

1. The unit/factor that determines the different properties is called .....
2. A pea plant that has two alleles for purple flowers is called .....
3. Heterozygous purple flowered plants have one allele of purple flower and one allele of ....
4. Alleles that are always expressed are called…….. allele
5. The recessive allele for the plant height gene is .....
6. What combinations of alleles might a purple-flowered plant have?
7. Can white-flowered plants be heterozygous? Explain your answer.

8. A pea plant is homozygous for yellow seed color, another plant is homozygous for green seed color. Yellow is the dominant color for seeds. What is the color of the seed of the offspring from a cross between the two?
9. 'Hetero' means different. What is the relationship between this meaning and the term heterozygous?

C. Chromosomes, vehicle for inheritance

After understanding how a trait is passed down through an understanding of the crossing process, you may be wondering how the parental trait is passed on to the offspring? What vehicle is used to carry this trait so that it can be transmitted to the offspring?
The vehicle is a chromosome. Chromosomes are located in the nucleus of the cell. Chromosomes are composed of genes, which are DNA molecules that regulate heredity.



For example, there are genes that regulate or determine the characteristics of curly hair, sharp nose or if in plants, resistance to disease, egg shape, plant height, flowers, color, leaf shape, and fruit taste.
Chromosomes discovered in the early 19th century are thread-like structures in the nucleus of a cell that appear when a cell begins to divide. Chromosomes are composed of chromatin formed by DNA. Each part of the X-shaped chromosome above is called a chromatid.

The shape and number of chromosomes in each species is different. For example, humans have 46 chromosomes, purple onions have 16, and cows have 60 chromosomes. Here is the number of chromosomes in some living things.

No.	Living things	Number of Chromosomes (2n)
1.	Human	46
2.	Crocodile	32
3.	Cat	32
4.	Cow	60
5.	Dog	78
6.	Horse	64
7.	koi carp	94
8.	house fly	12
9.	Hydra	32
10.	dove	80
11.	Corn	20
12.	Rose	14
13.	Tobacco	48

Based on the table, there are 46 chromosomes in humans (23 pairs) consisting of 23 chromosomes from the mother and 23 from the father. Cells that carry chromosomes from the father and mother are called sex cells. So, in the human egg and sperm there are 23 chromosomes each. The formation of sex cells is carried out through the process of meiosis. Furthermore, through the fusion of sperm and egg cells that produce a zygote containing 46 chromosomes which is a combination of both parents. Therefore, the result of fertilization is called a diploid cell, while a cell containing 23 chromosomes is called a haploid cell. Thus, sex cells contain half of the number of body cells.

22 pairs of body chromosomes (autosomes) and 1 pair of sex chromosomes make up the 23 chromosomal pairs. The female sex chromosome is XX, while the male sex chromosome is XY.

CONCEPT MASTERY TEST

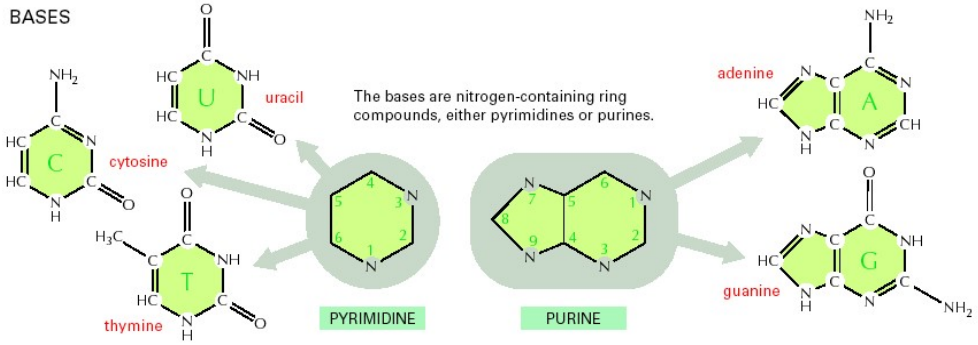
1. Where are the chromosomes located?
2. What are the chromosomes made of?
3. Where are the genes located?
4. Why do chromosomes always pair up?
5. What is the relationship between chromosome pairs and alleles?

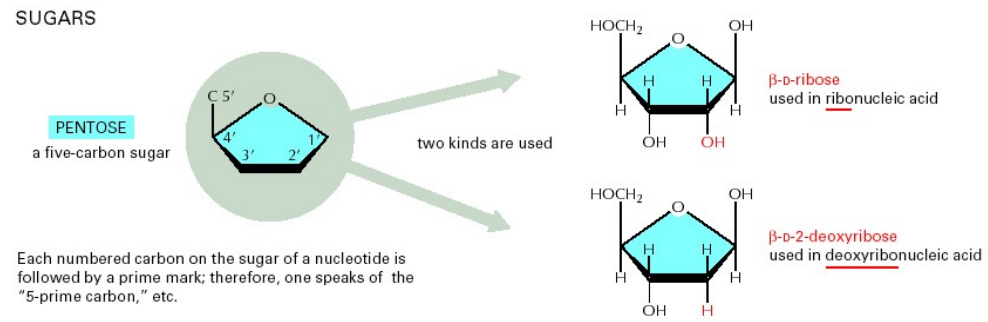
D. DNA Structure, DNA Replication AND Protein Synthesis

1. DNA Structure

Scientists questioned what the chemicals that make up chromosomes were after discovering that they hold genetic information. Chromosomes are made up of a huge molecule called DNA, which was identified later (deoxyribonuleic acid).

In 1953, James Watson and Francis Crick discovered the structure of the DNA molecule. DNA is shaped like a ladder, where the left and right skeletons are the backbone of DNA composed of deoxyribose sugars and phosphates, and the steps are a pair of nitrogenous bases linked by hydrogen bonds. Nitrogenous bases consist of two groups, namely purines and pyrimidines. Purine bases consist of guanine and adenine, while pririmidine bases consist of cytosine and thymine. Purines always pair with pyrimidines (A-T, G-C).





The structure of pyrimidine bases (cytosine, thymine and uracil), purines (adenine, guanine), pentose sugars, RNA and DNA

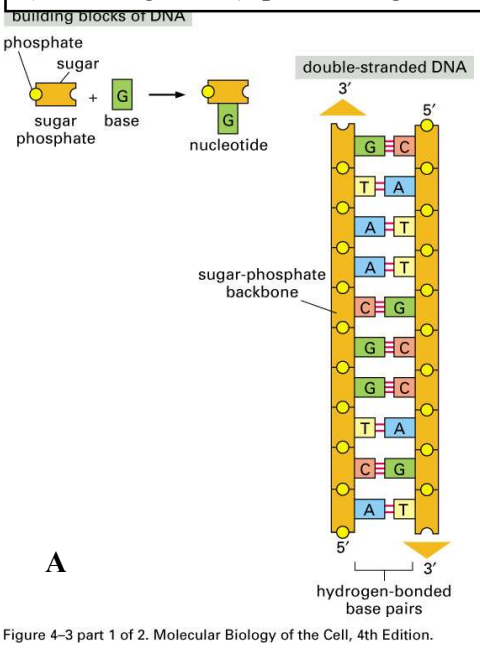


Figure 4–3 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

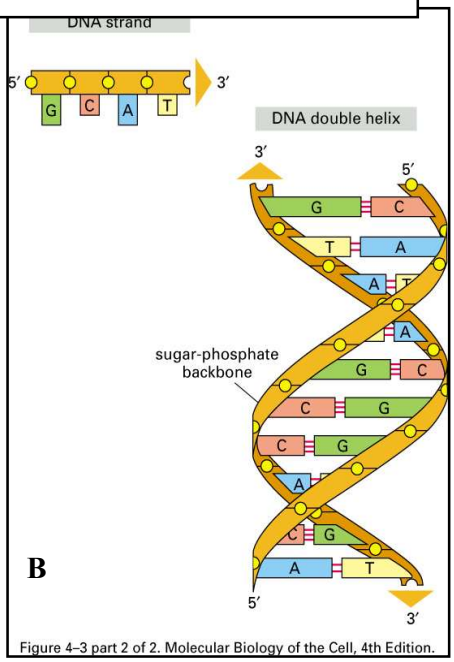
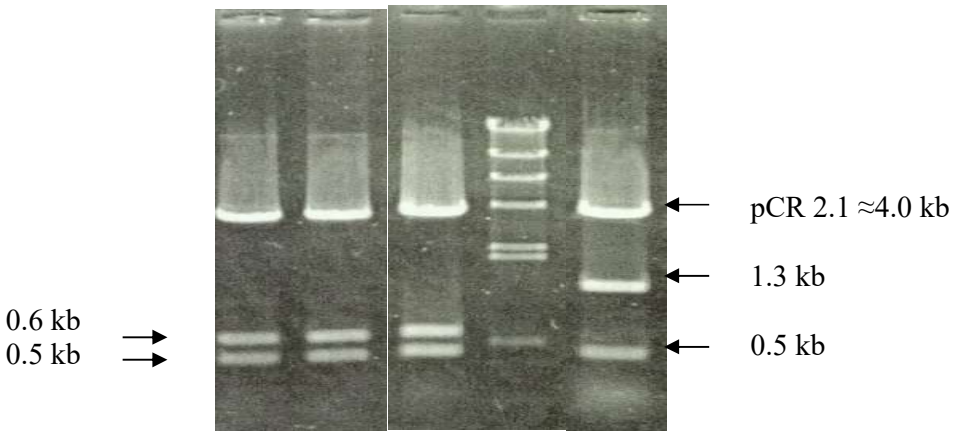


Figure 4–3 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

Formation of DNA structure from sugar, phosphate and nitrogenous base (A). DNA double helix structure

Based on what you have learned above, organisms with different traits will have different genes. While molecular genes are in the form of DNA molecules that make up chromosomes. Thus, when the DNA of different organisms is removed from the cell nucleus and exposed through certain media, it will be possible to see the difference.

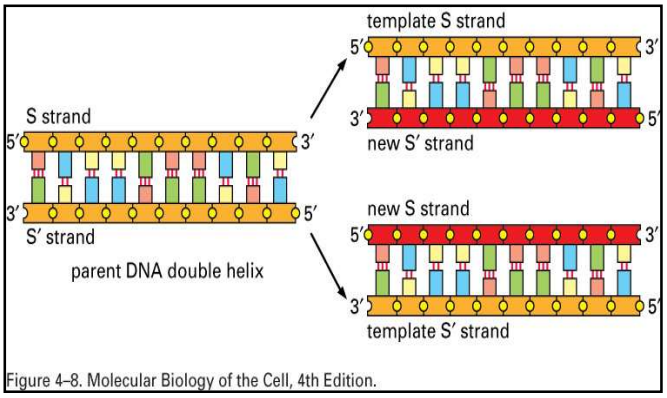


Visualization of DNA fragments of different sizes by agarose electrophoresis

With today's biomolecular technology, we can extract DNA from inside the cell nucleus, separate it from other cell components and visualize it using agarose gel electrophoresis technique. Agarose gel electrophoresis works on the 'sieve' principle. The smaller the concentration of agarose used, the larger the filter holes, so that DNA or DNA fragments of different sizes can be separated. Smaller fragments will move farther/faster than larger fragments.

2. DNA Replication

At the time of cell division, both mitosis and meiosis, there are stages of doubling of chromosomes to form sister chromatids. Molecularly this process is preceded by the formation of DNA copies. Double helix DNA can be copied precisely because each strand contains a nucleotide sequence that is exactly complementary to the sequence of the other strand. Each strand can serve as a template for the synthesis of a new complement strand that is identical to its initial pair.



DNA Replication

3. Protein Synthesis

To translate DNA into different traits as you have observed in humans or Mendel observed in peas, a protein synthesis process is carried out. This protein will then play a role in shaping certain morphology and metabolism in the organism's body so that we can finally observe it as a different trait. The process of protein synthesis is divided into transcription and translation. When the transcription process is running, it is preceded by a signal from the outside of the need for a protein or other molecule needed for the process of growth, development, metabolism, and other functions at the cellular and tissue level.

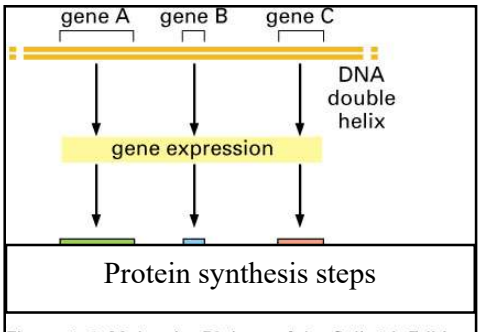


Figure 4–6. Molecular Biology of the Cell, 4th Edition.

CONCEPT MASTERY TEST

1. What are the basic molecules of chromosomes?
2. What are the stages of protein synthesis?
3. With what nitrogenous base does guanine pair?
4. By what process does DNA replicate itself?
5. Why are the chromosomes of different organisms generally different?

WORKSHEET
GENETICS

Objectives

1. Understand dominant and recessive traits
2. Prove Mendel's Law I

Introduction

Genes are traits that carry information from parents to their offspring. One of the genes that will be discussed in this activity is the gene that carries the nature of hair texture in humans, namely: straight genes and curly genes. Between these two genes, some are dominant (defeat), and some are recessive (defeated).

Tools and Materials

1. Family photo
2. Red and white genetic buttons 12 pieces each (6 pairs)

Steps of Activity I

1. Observe your family photo! Observe the hair texture on each family member, then fill in the mating chart fields below with the genotype symbols: “A” for straight and “a” for curly.

Grandmother
Grandfather
Grandmother
Grandfather
Mother
Father
Me
Older brother or sister
Younger brother or sister

2. Take a look at the marriage chart that you have filled in, then compare it with other group charts!

3. Answer the questions below!
   a. If curly is married to curly, can it produce children with straight hair?
   b. If straight is married to straight, can it produce children with curly hair?
   c. If straight is married to curly or vice versa, what will the result be?
   d. Based on this activity, draw conclusions about the nature of human hair! (which one is dominant and which one is recessive)

Steps of Activity II

1. Prepare 12 red genetic buttons (denoted by "M"), then place them in box A.
2. Prepare 12 white genetic buttons (denoted by "m"), then place them in box B.

3. Take one button from box A and one button from box B, then attach it. Repeat this for the other buttons until all the buttons are paired.
4. Are all buttons in red and white pairs now?
5. Put 6 pairs of red and white buttons in box A, and another 6 pairs in box B.
6. Remove all buttons from the partner
7. After all the buttons are released, take one button from box A and one button from box B. Do this repeatedly without looking at the contents of boxes A and B. Record the results in the following table!

Pick-up	Picked Button Color	Genotype Symbol
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

1. If 'M' is dominant which determines the 'straight hair' phenotype, while 'm' is recessive which determines the 'curly hair' phenotype, make a mating chart!

P1 : X

2. What can you conclude from this activity?

Gamet P1	:	X
F1	:	
P2	:	X
Gamet P2	:	
F2	:	

Yogyakarta, …….

Practitioner,

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