Variations on a Human Face

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Topic

Genetics

Time

60 to 90 minutes

Safety

Please click on the safety icon to view the safety precautions.

Materials

two coins
drawing paper
pencil
colored pencils or crayons
scissors
glue

Procedure

1. Choose a partner for this experiment. You and your partner will flip a coin to determine the facial characteristics of one of your "offspring." One of you will represent the father, and the other will represent the mother. In each coin toss, heads represents a dominant gene and tails represents a recessive gene. In some cases, a hybrid result will look like a mixture of the two traits. This is called *incomplete dominance.*

Note: Some of the traits are known to be inherited in a manner to be explained. The other traits were created to illustrate what might be happening. In actuality, inherited characteristics of the face are not as simple as will be demonstrated here. Several sets of genes may work together to produce a certain trait. Traits may be inherited separately or linked to one another.

2. First flip to determine the sex of the offspring. Only the father flips, as the father determines the child's sex. Heads will be a boy. Tails will be a girl. Record your results on the data table.

DATA TABLE

Child's Name _____ Sex _____

Date of Birth _____

Phenotypic characteristic	Father's gene	Mother's gene	Phenotypic characteristic	Father's gene	Mother's gene
Face shape			Eyelashes		
Chin shape (1)			Mouth size		
Chin shape (2)			Lip size		
Cleft chin			Hapsburg lip		
Widow's peak			Dimples		
Hair texture			Nose size		
Hair color (4 letters)			Nose shape		
Eyebrows (1)			Nostril shape		
Eyebrows (2)			Nose tip		
Color of eyebrows			Ear and nose size		
Eye distance			Earlobes		
Eye size			Darwin's ear point		
Eye shape			Hairy ears		
Eye position			Freckles		
Eye color (4 letters)					

3. Now flip for each of the facial characteristics that follow. Heads gives a capital letter, tails a small letter. See the illustrations section for the letters to use for each characteristic. For example, the first flip is for face shape. If your coin comes up heads, write R in the proper column next to face shape on the data table. If your partner's flip comes up tails, write r in his or her column on the data table. Then look at the illustrations. You will see that RR or Rr will produce a round face, while rr will produce a square face. Since your tosses resulted in Rr, this offspring will have a round face. Circle round in the Face shape section of the Checklist for Phenotypes. Continue in this way until you have flipped for all of the facial characteristics.
4. Now look at your completed Checklist for Phenotypes. Draw a picture of the offspring as he or she might look. You may also cut out the various parts of the face from the illustrations and assemble your face on a sheet of paper.

5. If your whole class did this experiment, compare your drawings. How much variation is there in the offspring? Are you surprised by the amount of variation? Why?
6. Research Mendelian and population genetics in your biology textbook or an encyclopedia. Explain in what ways your random coin tosses approximate the actual chances of a child's being born with given facial characteristics. Explain in what ways the experiment does not accurately reflect the chances of receiving given characteristics and what factors it failed to take into account.

CHECKLIST FOR PHENOTYPES (CIRCLE YOUR COIN FLIP RESULTS)

Sex
- male
- female

Face shape
- round
- square

Chin shape (1)
- very prominent
- less prominent

Chin shape (2)
- round
- square

Cleft chin
- absent
- present

Hair texture
- curly
- wavy
- straight

Widow's peak
- present
- absent

Hair color
- black
- brown
- red
- blonde
- dark blonde
- pale blonde

Eyebrows (1)
- bushy
- fine

Eyebrows (2)
- not connected
- connected

Color of eyebrows
- darker than hair
- same as hair
- lighter than hair

Eye distance
- close together
- average
- far apart

Eye size
- large
- medium
- small

Eye shape
- almond
- round

Eye position
- horizontal
- upward slant

Eye color
- dark brown
- brown
- green
- brown/green flecks
- gray blue
- dark blue
- light blue

Eyelashes
- long
- short

Freckles
- present
- absent

Mouth
- long
- average
- small

Lips
- thick
- thin

Hapsburg lip
- present (very protruding)
- present (slightly protruding)
- absent

Dimples
- present
- absent

Nose
- big
- medium
- small

Nose shape
- rounded
- pointed

Nostril shape
- rounded
- flared

Ear and nose size
- large ear, wide nose
- small ear, narrow nose

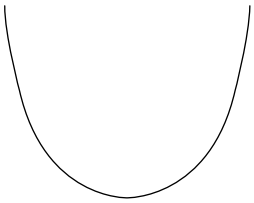
Earlobes
- free
- attached

Darwin's ear point
- present
- absent

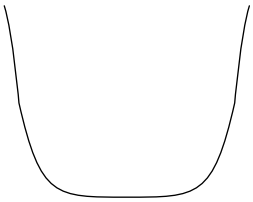
Hairy ears (males only)
- present
- absent

Face shape:

Round (RR, Rr)

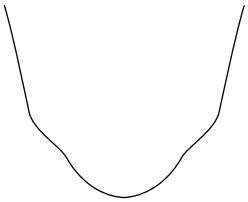


Square (rr)

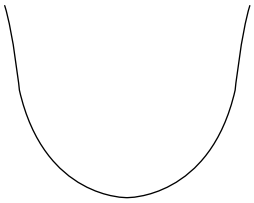


Chin shape (1):

Very prominent (VV, Vv)



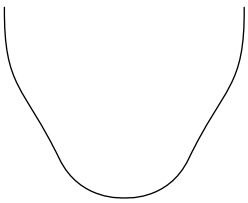
Less prominent (vv)



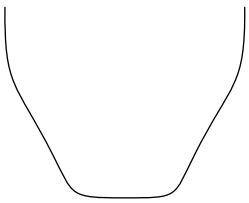
Chin shape (2):

Note: Flip coins for this trait only if chin shape (1) was VV or Vv

Round (RR, Rr)

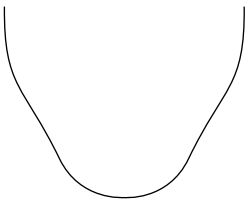


Square (rr)

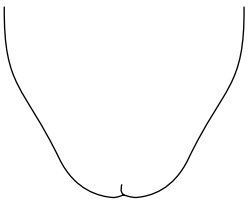


Cleft chin:

Absent (AA, Aa)

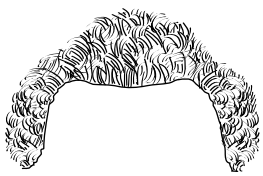


Present (aa)



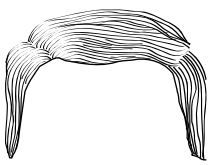
Hair body:

Curly (CC)



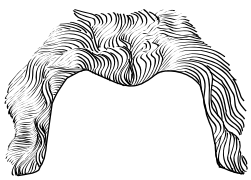
Wavy (Cc)

Straight (cc)

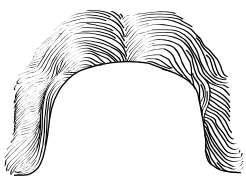


Widow's peak:

Present (WW, Ww)

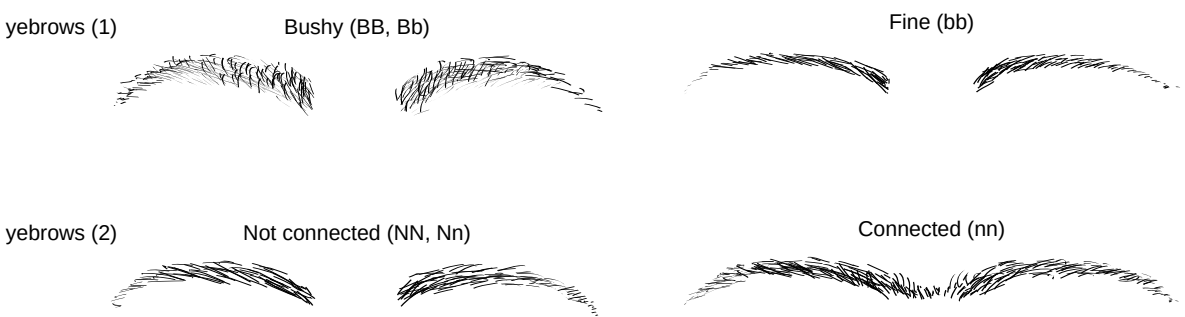


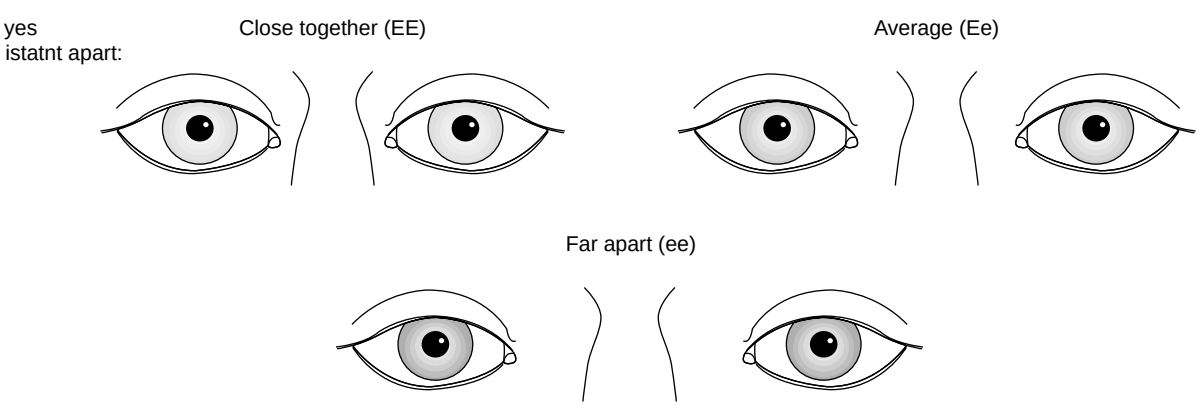
Absent (ww)

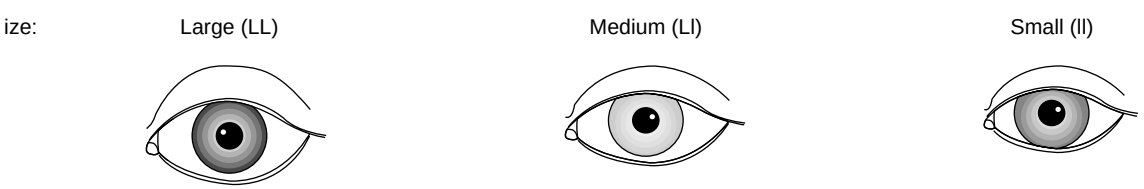


Hair color: Dark hair is dominant over light. To determine the color of the offspring's hair, assume that there are two gene pairs involved. There are probably more. Flip your coin first to determine the genotype of the first pair of genes (AA, Aa, aa). Now flip your coins again to determine the genotype of the second pair of alleles (BB, Bb, bb). Then match the genotype with the corresponding hair color by looking at the following chart:

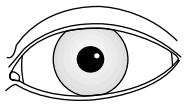
If the genotype is:	Then the hair color is:
AABB	black
AABb	black
AAbb	red
AaBB	brown
Aabb	regular blonde
AaBb	brown
aaBB	dark blonde
aaBb	regular blonde
aabb	pale yellow blonde

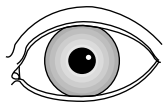






hape: Almond (wide) (AA, Aa) Round (narrow) (aa)



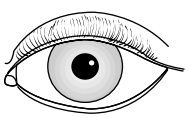


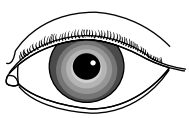
lantedness (position): Horizontal (HH, Hh) Upward slant (hh)

Eye color: Dark eyes are dominant over light. To determine the color of the offspring's eyes, assume that there are two gene pairs involved, one that codes for depositing pigment in the front of the iris and one that codes for depositing pigment in the back of the iris. Determine the genotype of the first pair (AA, Aa, aa). Then flip again to determine the second pair of genes (BB, Bb, bb).

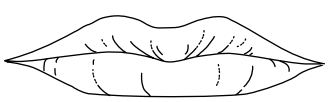
If the genotype is:	Then the eye color is:
AABB	dark brown
AABb	dark brown
AAbb	brown
AaBB	brown/green fleck
AaBb	brown
Aabb	gray-blue
aaBB	green
aaBb	dark blue
aabb	light blue (hazel)

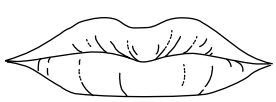
ye lashes: Long (LL, Ll) Short (ll)



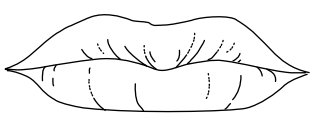


outh: Long (MM) Average (Mm) Small (mm)

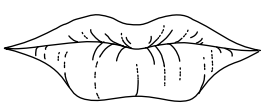


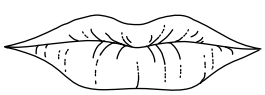


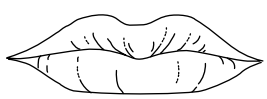
ips: Thick (TT, Tt) Thin (tt)



apsburg Lip: Very Protruding (HH) Slightly Protruding (Hh) Absent (hh)

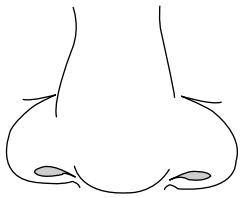


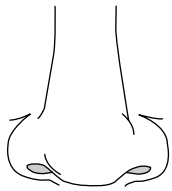


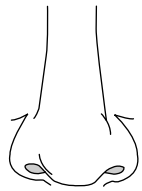


Dimples: Present (DD, Dd) Absent (dd)

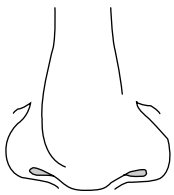
Nose size: Big (NN) Medium (Nn) Small (nn)



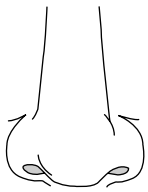


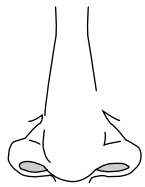


Nose shape: Rounded (RR, Rr) Pointed (rr)



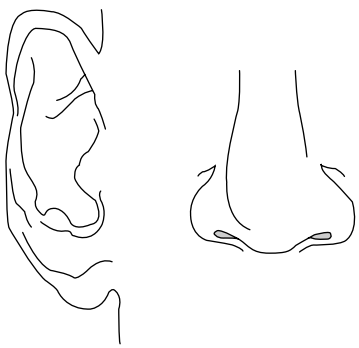
Nostril shape: Rounded (RR, Rr) Flared (rr)

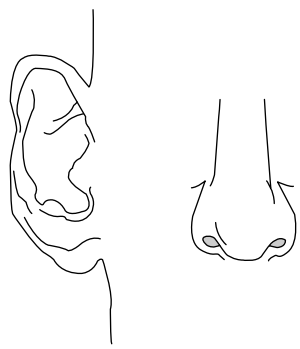




Note: Nose tip thickness and size of ears are almost always inherited together. In other words, thick nose tip and large ears are usually inherited together, but not always.

Flip coin first: (XX, Xx) large ears, thick nose (xx) small ears, narrow nose

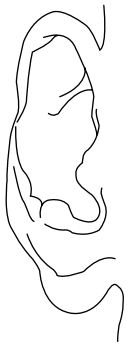




To see if the traits have stayed together, flip again. If both tails come up and the results of the first flip called for big ears, make the ears small. If the results called for small ears, make them big.

Ear lobes:

free (FF, Ff)



attached (ff)

Darwin's ear points:

present (DD, Dd)

absent (dd)

Hairy ears:

absent (EE, Ee)

present (ee)

Freckles:

present (FF, Ff)

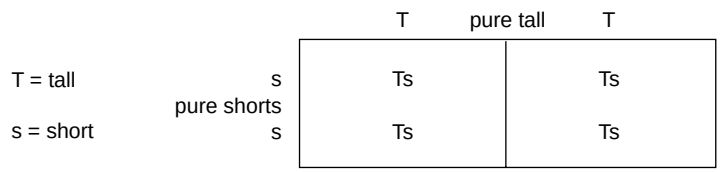
absent (ff)

What's Going On

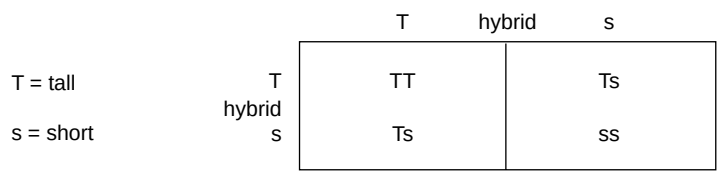
Even though this demonstration is carried out using the most simple laws of heredity and with only a few characteristics being examined, an amazing amount of variety will be seen from offspring to offspring. Because in reality many more factors of heredity and many more characteristics are involved, the possibilities for variety are actually much greater.

Connections

The Austrian monk Gregor Mendel determined the basic laws of genetics, the rules governing how traits are handed down from parent to offspring. A trait is passed down through *genes,* the basic unit of genetic information, with at least two genes, one from each parent, controlling its inheritance. Some traits are *dominant;* that is, they prevent other traits from appearing. Some are *recessive;* these do not appear when a dominant gene is present. For example, let us say that "tallness" is a dominant trait and "shortness" recessive. The following diagram, called a Punnett square, shows what might happen when a plant with two tall genes (a pure tall) is crossed with a plant with two short genes (a pure short).



All the offspring would be *hybrids,* that is, contain both a dominant and a recessive gene. Since we have determined that tallness is dominant, all offspring would look tall. But if we crossed these hybrids, we could get more varied results in the third generation as the following Punnett square shows.



It is important to note that the diagram holds true only when large numbers of offspring are represented. In this demonstration, we discovered what an offspring might look like if each parent is a hybrid for each characteristic, and we examined the possible variations that may result.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES