Life Sciences Learning Center

Risk taking behavior

Teacher Instructions-overview

Core Concepts:

- Genes and environment together influence human behavior
- Genes encode proteins that can affect brain development

Class time required:

Approximately 2 X40 minute class period (may take less for some)

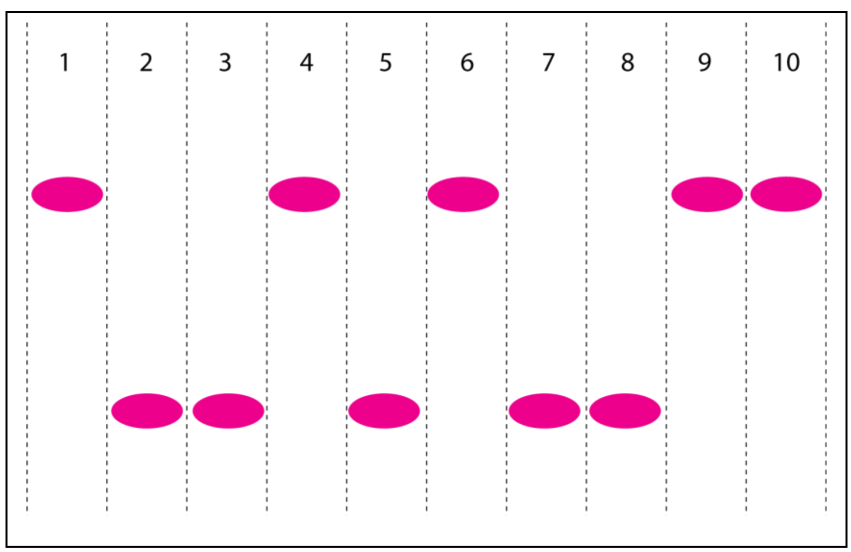
Teacher Provides

For ALL Parts:
For each student

- Copy of student risk survey
- Copy of student handout
- Metric ruler with mm markings—at least 24 cm long

For Part 5:
For each team of 2-4 students:

- Plastic plate or tray (needs to be large enough to fit simulated gel shown below.
- 2 ml tube labeled DNA Stain that is filled with washing soda
- Plastic stirrer
- Simulated gel. Use a cotton swab to spot with 2% phenolphthalein as shown on the right.



Suggested class procedure

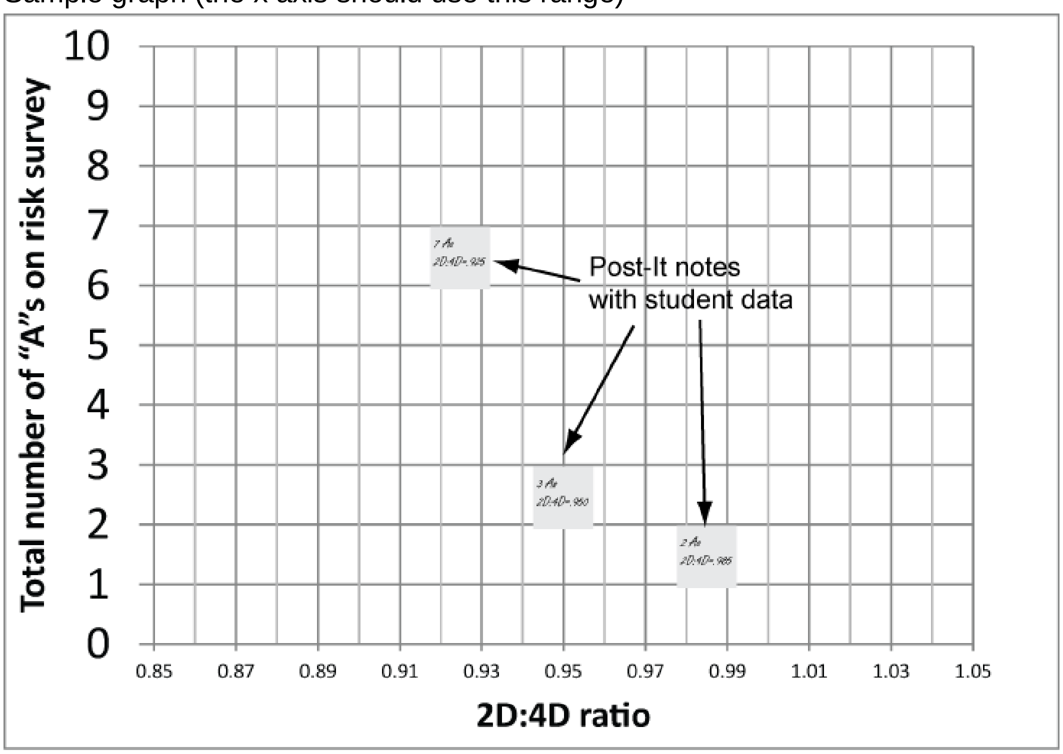
1. In Part 1 students read a short passage about a risk taker and answer questions relating to social and personal attitudes about risk. They also briefly review genetics (genotype and phenotype) and the central dogma of biology (DNA, RNA, protein, transcription and translation). This could be done as a group toward the end of class to introduce the next topic or as homework.

2. In Part 2 students complete a short self-assessment of their risk taking behavior either as homework or in class.

3. For Part 3 students will measure their 2D:4D finger length ratio. They can then plot the class data using post-it notes on a graph with the finger length ratio on the x-axis and the # of "letter A" answers on the risk taking survey on the y-axis. For the 2D:4D ratio, a range from 0.89 to 1.01 should capture 98% of students if they have done the measurement and calculation correctly. You may wish to plot females and males separately or with different colored post-it notes to compare graphs.

   It is important to note that the results should be interpreted carefully because of the shortness of the risk survey, the small number of students in the study(less than 50 would be considered a small number), and the inexperience of the people doing the measurements (small mistakes can make a difference in the results). You may wish to include this point in your class discussion of the results.

   Sample graph (the x axis should use this range)



4. Part 4 includes a short passage which explains the connection between finger length and testosterone signaling which could be done either in class or assigned as homework after the finger length/risk graphing activity.

   It can be mentioned that there are multiple signals involved in finger development and testosterone is one of many such signaling pathways.

   This section also explains the sexual dimorphism that is generally observed between males and females. While female students 2D:4D finger length ratio may not be as low as male students it still tends to be the case that females with lower than average 2D:4D ratios (compared to other females) tend to exhibit more risk taking behavior.

5. In Part 5 students read about the long and short versions of the testosterone receptor gene. They model translation of the two different version using the mRNA sequence and a codon table. Finally the students read a short passage which explains the functional differences between the short and long version of the testosterone receptor and why the short version is better at responding to testosterone signaling.

6. In Part 6 students read a passage about the connection between testosterone and the brain. They learn about the differences in testosterone receptor genes which can affect testosterone signaling and the development of regions of the brain involved in risk taking behavior. Students then perform simulated DNA tests using paper DNA gels to compare the testosterone receptor gene allele with risk taking behavior for 10 individuals.

7. Finally, in Part 7 students read two short passages describing experiments which point to age-related and environmental factors that can influence risk taking behavior. These passages are optional and could be assigned as homework after the hands-on component.

Further Information
A short article describing a number of the links made between finger length ratio and behaviors, physical/intellectual abilities, and disease rates.

- http://discovermagazine.com/2013/may/04-finger-length-ratio-can-predict-aggressive-behavior-and-risk-of-disease

An excellent resource describing the science of the adolescent brain in relation to learning and risk taking behavior.

- http://www.dana.org/news/cerebrum/detail.aspx?id=19620

An interesting article about the male-female scoring gap on the SATs and how this may be connected to underlying differences in risk taking behavioral tendencies.

- http://blogs.edweek.org/edweek/reimagining/2013/07/The_SATs_Gender_Gap.html?override=web

For Part 6

1 Doug, age 32, is an auto mechanic and a big sports fan. He loves watching football, hockey, wrestling, and soccer.	2 Mark, age 32, is a neurobiologist who moved to Utah so that he could spend his summers rock climbing and whitewater rafting. He spends his winters ski jumping and ice climbing.
3 You never knew what Michael, age 32, would do next. He changed his job and his interests every few years. He has been a circus performer, an actor, a construction worker, and a chef. He quit his last job and enlisted in the Marines.	4 Fred, age 31, is an engineer and jazz musician. He began playing in a jazz band when he was a teenager and enjoys playing with local jazz groups on the weekends.
5 Cesar, age 33, and his brother own a barber shop and a Laundromat. On their days off, they enjoy fishing and watching baseball games.	6 Mark, age 34, works two jobs to support his family. He is an elementary school teacher. On the weekends and in the evenings, he works for a local landscaping company.
7 Jose's parents are upset because he decided to take a year off before he starts medical school. Jose, age 32, plans to spend the year volunteering in camps for refugees in war-torn Somalia.	8 In high school, Ray, age 31, was the "class clown" known for his crazy pranks. Ray moved to Las Vegas and now enjoys a career as a professional poker player.
9 Gary, age 34, still lives and works in the small town where he was born. He manages the town's only restaurant and enjoys volunteering at a local nursing home.	10 Like his father, Ramil is a race car driver on the semi-pro circuit. Ramil, age 31, also occasionally works as a stunt car driver.

For Part 6

Print on card stock or thick paper

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

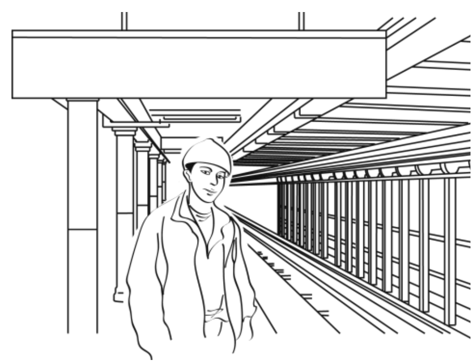
Optional Extension or Engagement Graphic before **Part 3**

Do believe these claims?

Part 1—Neuroscience of Risk

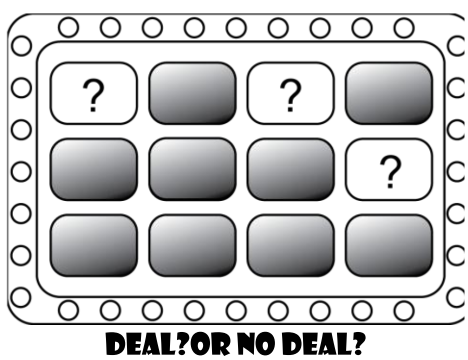
Biology Brief: Biology of Behavior

The term **phenotype** refers to the observable traits of an organism. It is the organism's phenotype which directly determines its chances of surviving and passing on its genes to the next generation. Some of the most familiar examples of phenotype include physical traits like eye and hair color, height, and blood type. However, traits may also include things that are less obvious like behaviors. One example of a behavioral trait is risk taking behavior illustrated in the story below.



Wesley Autrey, a New York City construction worker, was a national hero. He jumped in front of an oncoming subway train to save a fellow passenger. "I had to make a split-second decision," he told The New York Times the next day. "I just saw someone who needed help. I didn't really think about it. I just did what I felt was right."

Four months later, Wesley was a contestant on the hit NBC game show, Deal or No Deal. The show was essentially a guessing game. For each round of the game, contestants open several cases containing amounts of money ranging from one cent to one million dollars, removing those prizes from play.



Wesley, played fearlessly, and fared much better than most contestants. With only three cases remaining—$25, $10,000, and $1,000,000—he was offered a whopping $305,000 to walk away. When the host leaned in and whispered the show's pivotal question, "Deal … or no deal," Autrey answered: "No deal!" Instead, he called to eliminate case number 14. The amount inside: one million dollars! The audience groaned. Once again, Autrey was offered a buy-out—$5,000. But again he declined with a "No deal." When the next case he chose was removed it contained $10,000. The case he won contained only $25.

Adapted from "Let it Ride: The Neuroscience of Risk" by John Pearsonhttp://dukemagazine.duke.edu/dukemag/issues/111208/risk1.html

1. What are some advantages of having the risk taking phenotype? Or in what situations might it be beneficial to be a risk taker?

    ____

    ____

2. What are some disadvantages of having the risk taking phenotype? Or in what situations might it be dangerous to be a risk taker?

    ____

    ____

Biology Brief: Biology of Behavior (continued)

You may already know that genes, specific stretches of DNA that encode proteins, play a big role in determining physical traits like eye color and blood type. For example, a gene is *transcribed* into RNA, which is then *translated* into a protein involved in melanin (pigment) formation, which gives rise to a phenotype of black hair color (Figure 1).

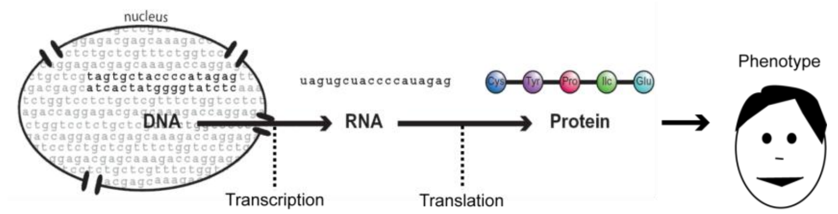


Figure 1: Physical traits like hair color are influenced by an organism's genotype. But what about behaviors? Are they also affected by genes?

What about behavioral traits like risk taking though? Are behaviors determined just by your genotype (an organism's particular set of genes) or are there other things that influence behavioral traits?

Questions

3. List two things other than genetics that might influence behavioral traits.

 _Drugs, Peer Pressure, Stress, Age_______________

 ____

4. Jeff has freckles and two copies (one from each parent) of the freckles gene (homozygous). Isaiah has freckles and one copy of the freckles gene and one copy of the non-freckles gene (heterozygous).

 These individuals have the same (*circle one*) genotype / phenotype

 but different (*circle one*) genotypes / phenotypes.

5. The process of making an RNA copy of a DNA code is called (*circle one)*

 a) Transcription
 b) Translation

6. The process of making protein based on an RNA code is called (*circle one*)

 a) Transcription
 b) Translation

Part 2: Personal Risk Taking Phenotype--Measurement 1

Complete the survey below. *(Circle the letter of the choice that best represents you)*

1. You often arrive:
    a. At the last minute or a little late
    b. Early

2. Do you like to ride roller coasters?
    a. Yes
    b. No

3. You think gambling and games of chance are:
    a. Fun
    b. Too risky

4. Would you like to travel to an underdeveloped country?
    a. Yes
    b. Not really

5. Would you like to ride a motorcycle, go whitewater rafting, bungee jumping, snowboarding, or scuba diving?
    a. Yes
    b. No

6. Getting lost in an unfamiliar place is:
    a. No big deal
    b. Scary

7. Your interests:
    a. Change every few months
    b. Are the same interests you've had for years

8. Do you do crazy things just for the fun of them?
    a. Yes
    b. No

9. Driving towards a stop light as it turns yellow you would:
    a. Speed up
    b. Slow Down

10. Would you say that you would try anything once?
    a. Sure
    b. No, not anything

Record the number of times you selected answer a or b below

# of times you answered “a”	# of times you answered “b”

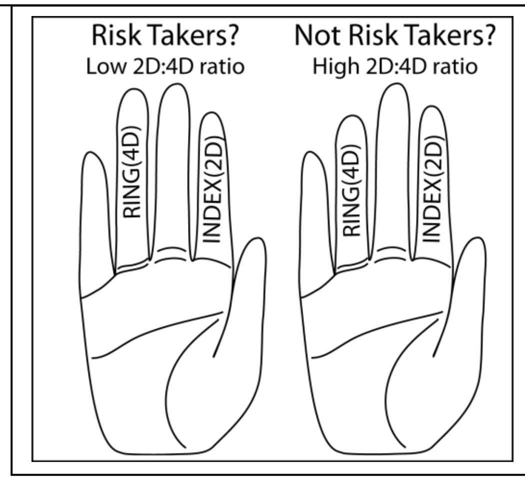
The more times you selected choice “a” the more likely you are a risk taker.

Part 3: Personal Risk Taking Phenotype--Measurement 2

Biology Brief: Pointing To Risk Taking

Some scientists claim that the length of the index finger (2nd digit or 2D) when compared to the ring finger (4th digit or 4D) correlates with risk taking behavior.

- If a person's 2D:4D ratio is low, (4D longer than 2D) they are more likely to be a risk taker.
- If a person's 2D:4D ratio is high, (4D equal to or shorter than 2D) they are less likely to be a risk taker.



Your class will collect data to test this claim. Each member of the class will determine his/her 2D:4D ratio. Then the class will create a scatter plot graph to determine if there is a correlation between their finger length ratio and their score on the risk taking survey.

To calculate the 2D:4D ratio you need to measure the length of the index finger (2D) in millimeters then divide this by the length of the ring finger (4D).

Shown below are two sample calculations:

$$\frac{73.6 \text{ mm (2D)}}{79.1 \text{ mm (4D)}} = 0.93 \qquad \frac{69.9 \text{ mm (2D)}}{71.3 \text{ mm (4D)}} = 0.98$$

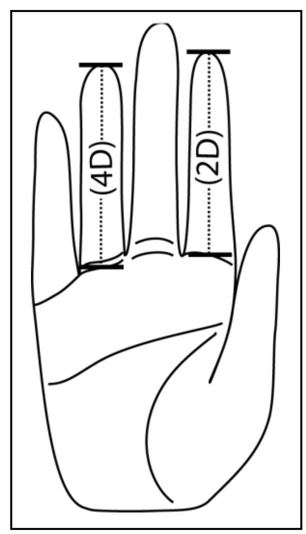
Low 2D:4D High 2D:4D

- Measure your 2D and 4D finger lengths.
  - **a)** Straighten the fingers on your right hand and look at the palm of your hand.
  - **b)** There are creases at the base of your index and ring finger. Your index finger is likely to have one crease. Your ring finger may have a band of creases.
  - **c)** Select the crease closest to the palm on your 2D (index finger)
  - **d)** Use a pen to mark a spot that is in the middle of the crease.
  - **e)** Use a ruler to measure the distance from the spot to the tip of your index finger. Record your 2D measurement in millimeters.

    ____

  - **f)** Repeat steps c) through e) using your 4D (ring) finger. Record your 4D measurement in millimeters.

    ____



- Calculate your 2D:4D ratio by dividing the length of your index finger (2D) by the length of your ring finger (4D). Record your 2D:4D ratio on the line below.

  $$\text{2D:4D ratio} = \frac{\text{2D measurement}}{\text{4D measurement}} = \_\_\_\_\_\_\_\_\_\_\_\_\_$$

- Write your 2D:4D ratio and your score on the Risk Taking Survey (number of a's) on a Post-It note.

- Place your Post-It note in the appropriate position on one of the graphs (male or female) that your teacher has provided in the classroom.

Questions

1. Observe both of the class Post-It note graphs. Summarize your observations of both graphs using complete sentences.

   Student answers will vary. They may note that there are differences between male and female digit ratios. They may also note a correlation with risk scores and digit ratios but the small sample size and/or inexact measurements may not reveal this.

   ____

2. Does the data on the graphs support the scientists' claim that there is a correlation between low 2D:4D ratio and high risk taking behavior? Why or why not?

   Student answers will vary. They may note a correlation with high risk taking scores and low digit ratios but the small sample of students (less than 50) and inexact measurements should make students cautious about making firm conclusions. Also there will likely be exceptions (high 2D:4D ratio/low risk individuals and vice versa) to this that should be noted and discussed

Part 4: Testosterone Signaling in Finger Development

Biology Brief: Testosterone Signaling Basics

Scientists have proposed that the 2D:4D ratio is determined during **prenatal** (before birth) development. The 2D:4D ratio results from interactions between:

- Levels of prenatal testosterone
- Testosterone receptors on the ring finger and index finger.

Testosterone is a hormone that is secreted by endocrine glands in the body. In the developing hand, testosterone acts as one of multiple different signals that cause cells to divide (**Figure 1**). It does this by binding to the testosterone receptors located in cells within the developing fingers. The testosterone receptors can then enter the nucleus and activate other genes that encode proteins which promote mitosis.

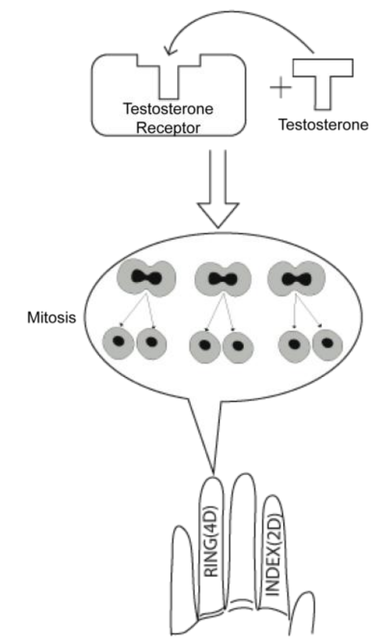


Figure 1: Testosterone binding to testosterone receptors in finger cells can promote cell division.

The more testosterone receptors a cell has, the more likely it is to respond to testosterone. Interestingly…there are usually more testosterone receptors in the ring finger than there are in the index finger, which helps explain the fact that the ring finger is typically longer than the index finger (**Figure 2**).

Because females tend to produce less testosterone during prenatal development compared to males, females' ring finger length is typically closer to their index finger leading to a higher 2D:4D ratio (**Figure 2**).

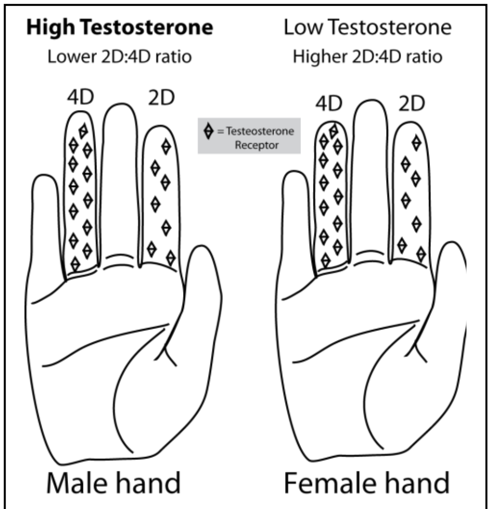


Figure 2: The 4D has more testosterone receptors than the 2D. Males have more testosterone than females. The combination of hormone level and receptor level leads to differences in 2D:4D ratio between males and females

NOTE: Prenatal testosterone levels are not related to adolescent or adult levels of testosterone.

Questions

1. Why do females typically have a higher 2D:4D ratio than males?

Females generally experience prenatal exposure to lower levels of testosterone.___________________

____

2. What are two possible explanations for why different males might have different 2D:4D ratios.

They were exposed to different levels of testosterone during prenatal development or they have different_ numbers of testosterone receptors.________________

Part 5: Testosterone Receptor Genetics

Biology Brief: More about Testosterone Receptors

The testosterone receptor gene is located on the X chromosome. There are actually longer and shorter versions of the testosterone receptor gene (**Figure 1**). These longer and shorter genes encode longer and shorter versions of the Testosterone Receptor protein.

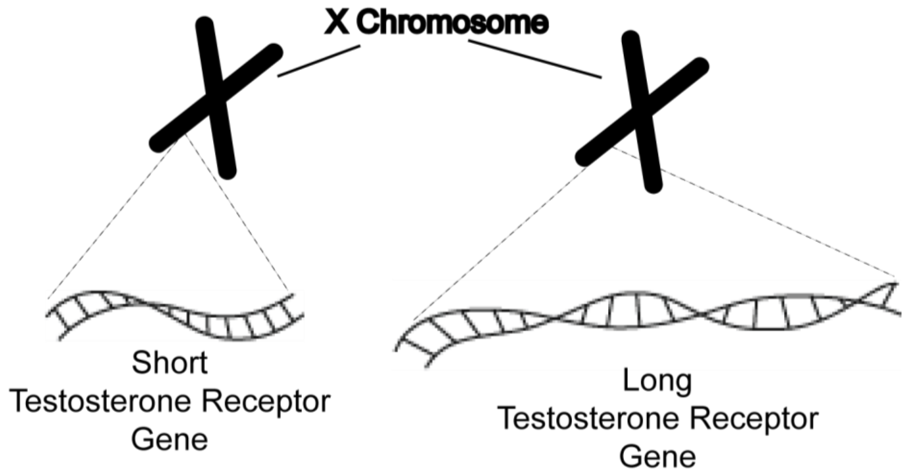


Figure 1: Individuals may inherit a shorter or longer version of the testosterone receptor gene.

For the information in the gene to be used, it needs to be transcribed into RNA and then the RNA must be translated into protein. Each group of three RNA nucleotides (which include A, U, C, or G) is called a codon. Codons specify which amino acids will be added next during protein synthesis (Figure 2). Amino acids are the building blocks of proteins.

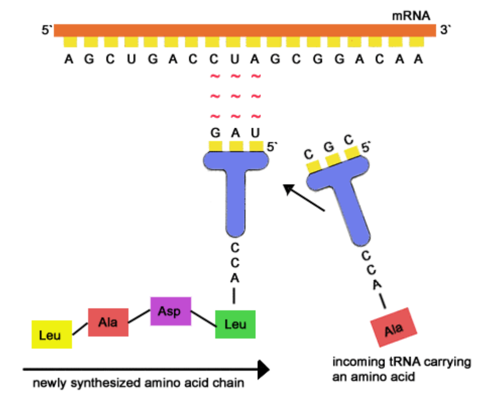


Figure 2: The amino acids (ex. Leu, Ala) are assembled into proteins by following the code contained in the RNA.

Activity--Crack the Code

- Examine the two testosterone receptor RNA sequences on the next page.
- Use Table 1 to determine the amino acid sequence of the proteins encoded by the two sequences. For instance, if the first codon (set of three RNA nucleotides) is UUU this would encode Phenylalanine (Phe).
- Wherever you see a “STOP” that means that no more amino acids are added.

Table 1: The Genetic Code.

1st letter	Second Letter: U		C		A		G		3rd letter
U	UUU	Phe	UCU		UAU	Tyr	UGU	Cys	U
	UUC		UCC	Ser	UAC		UGC		C
	UUA	Leu	UCA		UAA	Stop	UGA	Stop	A
	UUG		UCG		UAG	Stop	UGG	Trp	G
C	CUU		CCU		CAU	His	CGU		U
	CUC	Leu	CCC	Pro	CAC		CGC	Arg	C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU		ACU		AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met	ACG		AAG		AGG		G
G	GUU		GCU		GAU	Asp	GGU		U
	GUC	Val	GCC	Ala	GAC		GGC	Gly	C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

Testosterone Receptor Gene 1- **mRNA**
… … AUG UUC CGU GGU GAG CAG CAG CAA CAG CAA UAA GAA … …

Amino acid sequence encoded by Testosterone Receptor Gene 1:
(*write the sequence here*)

Met-Phe-Arg-Gly-Glu-Gln-Gln-Gln-Gln-Gln

Testosterone Receptor Gene 2- **mRNA**
… … AUG UUC CGU GGU GAG CAG CAG UAA GAA CCC GCA CGA … …

Amino acid sequence encoded by Testosterone Receptor Gene 2:
(*write the sequence here*)

Met-Phe-Arg-Gly-Glu-Gln-Gln

Questions

1. How are the two testosterone proteins' amino acid sequences the same or different?

   The second protein has the same sequence as the first but it is shorter by three Gln amino acids.

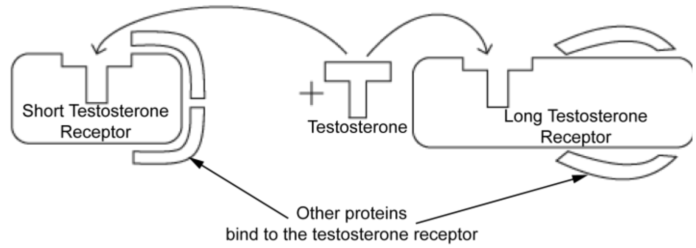
2. How many copies of the testosterone receptor gene would a male have?

   Males have 1 copy of the testosterone receptor gene on the X chromosome.

Biology Brief: More about Testosterone Receptors

You found out that the two different testosterone receptor genes code for short and long testosterone receptor proteins. A shorter or longer amino acid sequence can have big consequences for a protein's shape. And the shape is what determines the function(s) of the protein.

Figure 3: The short testosterone receptor can interact better with other proteins in the cell.



Scientists have found that the shorter version of the receptor protein is better able to interact with other proteins in the cell (**Figure 3**). By interacting better with other proteins, the short testosterone receptor is better able to trigger the cell's responses to testosterone signaling.

Questions

3. What factor(s) can affect how a protein functions?

   Student answers will vary. The amino acid sequence length and the particular order of the amino acids can affect protein shape and the shape can affect how the protein functions.

4. Devon and David are both taking equal amounts of testosterone to treat a medical condition of low testosterone. Devon is responding better and more quickly than David to the testosterone treatment. Genetic tests were done of Devon and David to examine their testosterone receptor genes.

   Predict whether Devon most likely has the long or short version of the testosterone receptor gene and explain your answer.

   Devon is more likely to have the shorter testosterone receptor gene because this version encodes a short receptor that is better at responding to testosterone and he is responding better to the treatment.

Part 6: From Protein Function to Behavioral Trait

Biology Brief: The Long and Short of Risk Taking

The parts of the brain involved in risk taking behavior may develop differently in people who have different length testosterone receptors. Risk taking is controlled by the reward system of the brain. The reward system of the brain includes the limbic system which controls emotions like happiness and the frontal cortex which controls decision making. In the brain, testosterone signaling can lead to increased connections between the limbic system and frontal cortex by promoting growth and mitosis of neurons connecting these regions (**Figure 1**).

Scientists have found that those who have shorter testosterone receptor proteins respond more strongly to testosterone while those with longer testosterone receptor proteins respond more weakly to testosterone (**Figure 1**). This means that people with the shorter, more active testosterone receptors are more likely to develop strong neural connections and increased activity in the brain's reward pathway.

Strong connections in the reward pathway may provide individuals with more positive feelings following a reward and increase their willingness to take risks to activate this region of the brain. Consistent with this idea scientists have used live brain imaging techniques to show that people with more active reward systems are more likely to take risks.

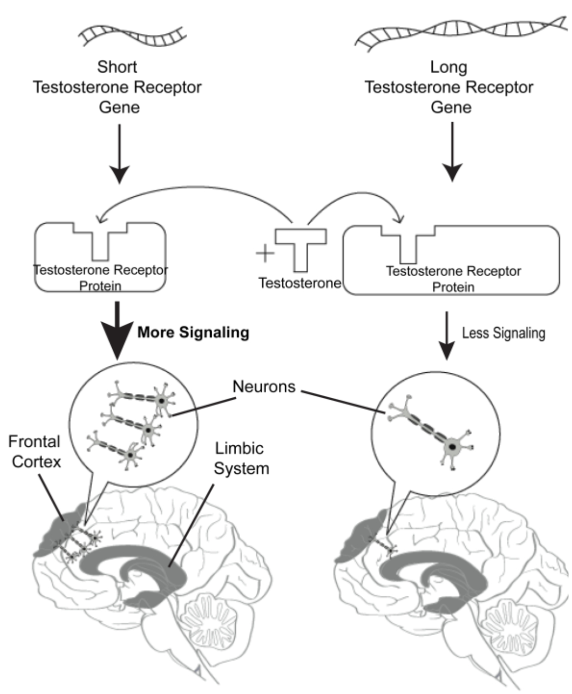


Figure 1: The short testosterone receptor, encoded by the shorter gene, sends a stronger signal in response to testosterone binding compared to the long testosterone receptor. More signaling leads to more connections in the limbic system and frontal cortex which form the reward system of the brain.

Questions

1. What is the function of the testosterone receptor gene? (Refer to **Figure 1**)

<u>It carries coded information for how to</u>

<u>make the testosterone receptor.</u>______

____

2. What is the function of the testosterone receptor protein?

<u>It binds to testosterone and signals___</u>

<u>changes in the development of cells in</u>

<u>different parts of the body.___________</u>

3. What regions of the brain are involved in the reward pathway which is influenced by testosterone signaling?

<u>The limbic system and the frontal cortex</u>

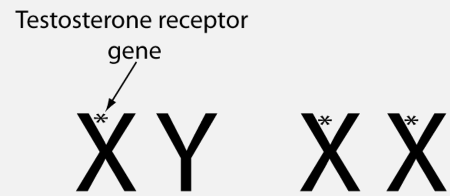
4. Hypothesize---Which gene (long or short) is more likely to result in an increased tendency for risk taking behavior?

<u>The short gene is more likely to result in increased risk taking.</u>___________________

Activity--Test Your Hypothesis

Your lab kit contains a series of cards describing 10 male research subjects.

- Sort the cards into two piles—5 subjects who have a greater tendency for risk taking and 5 subjects that have lower tendency for risk taking.



Note: Male subjects (XY) were selected because the gene for testosterone receptor protein is on the X chromosome. That means that males only have one gene for the testosterone receptor protein.

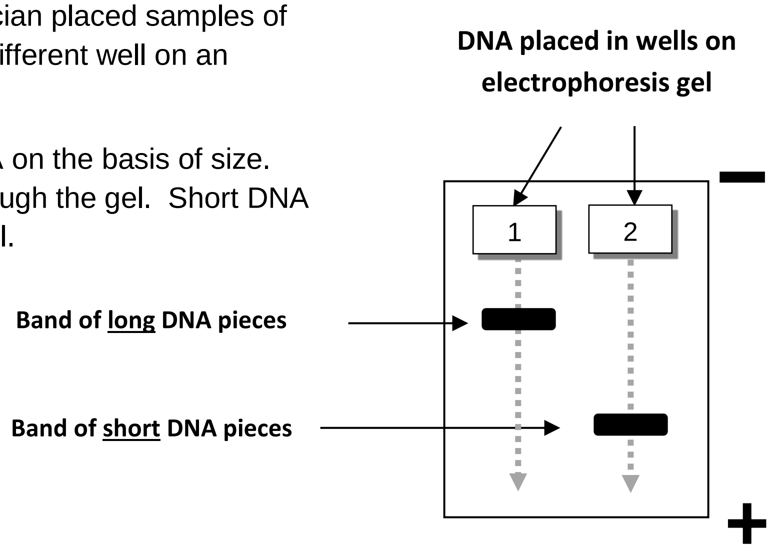
Question

6. The cards have numbers in the upper left-hand corner. Circle the numbers below that are in your "high risk taking" pile.

1 2 3 4 5 6 7 8 9 10

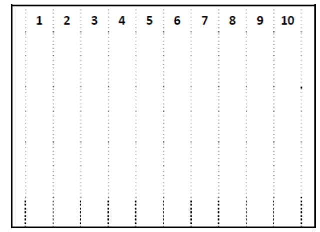
To test the receptor protein gene (DNA) samples for the ten research subjects, a lab technician placed samples of the DNA from each subject into a different well on an electrophoresis gel.

Gel electrophoresis separates DNA on the basis of size. Long DNA pieces move slowly through the gel. Short DNA pieces move rapidly through the gel.



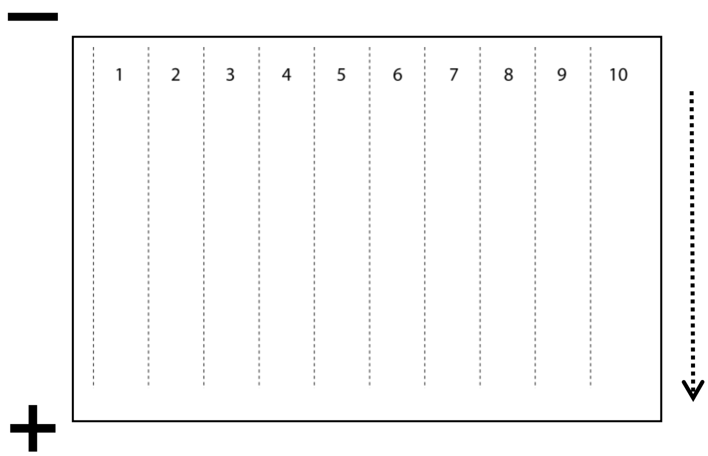
7. Which pattern of bands (1 or 2 in the graphic above) would represent a male with a short gene associated with risk taking behavior? ________**2**_______

Your lab kit contains a simulated paper electrophoresis gel that the lab technician made for the research subjects.



You can't see the DNA pieces on this gel because DNA is colorless. **To see the gene pieces, you need to add a DNA stain to the gel**. This stain will attach to the genes on the gel and turn them pink.

- Add enough water to the plastic tray to completely cover the bottom with approximately 3 millimeters of water.
- Pour the entire contents of the tube of DNA stain into the water in the plastic tray.
- Use the stirrer to mix the DNA stain until it dissolves.
- Soak the simulated gel in the DNA stain in the tray for approximately 30 seconds.
- Observe the pink DNA bands on the gel. **Record the banding pattern on the diagram of the electrophoresis gel below**.



8. Circle the wells which contained DNA (genes) for the short testosterone receptor gene?

1 2 3 4 5 6 7 8 9 10

9. Based on the results of DNA electrophoresis gel, can you conclude that the short testosterone receptor gene results in risk taking behavior? Support your answer with evidence from the gel. *Hint: Compare your answer for question 8 with your answer for question 6.*

The results of this test do not allow one to conclude that the short risk taking gene leads to risk taking behavior. While more people in the "high risk" group had the short testosterone gene there was one person in the "low risk" group who had the short testosterone gene and one in the high risk group with the long gene version.

Part 7: Are there other factors that affect risk taking behavior?

Biology Brief: The Age of Risk Taking

Age is one factor that may affect risk taking behavior. Teenagers and adults were placed into a Magnetic Resonance Imager (MRI), which can measure activity in specific regions of the brain. Their brain activity was then measured while playing a gambling game which paid them small rewards for correct guesses. When the adults and teens won, the researchers recorded the activity in the right and left sides of the cerebral cortex, the highly folded outermost part of the brain involved in higher thinking and decision making (Figure 1).

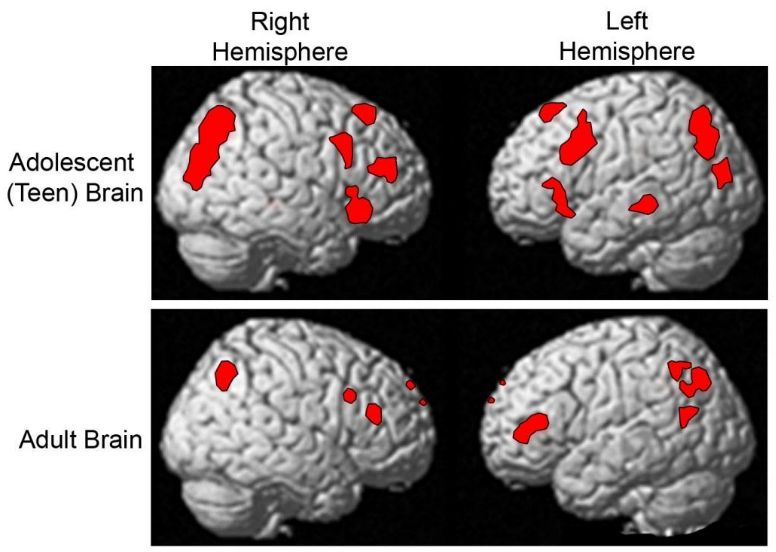


Figure 1: Post reward imaging of adult and teen brain activity (stripped regions).

Questions:

1. Describe any similarities or differences you observe in the images above.

   __**Answers will vary but they should see more activity overall in the adolescent brain**__

2. What is the name of the outermost brain region involved in decision making?

   __**Cerebral cortex**__

3. Researchers believe that higher brain activity in some of these regions indicates more intense feelings of satisfaction. Knowing this how do you think this would affect teens' or adults' risk taking tendencies?

   __**The increased feelings of satisfaction might lead teens to take more risks.**__

Biology Brief: Environmental Factors and Risk Taking

Doing experiments in humans related to risk taking behavior is difficult for many reasons but a major challenge is that most individuals have different genetic backgrounds and experiences (environmental factors) that can be difficult or impossible to control. To avoid the complications of human studies, scientists often use other model animals. One species being used to study the genetic and environmental factors that affect risk taking is the stickleback fish (Figure 1).

Figure 1: Stickleback fish are small freshwater fish that can be used to study animal behaviors like risk taking.
Image courtesy of http://fish.dnr.cornell.edu/nyfish/Gasterosteidae/stickleback.html

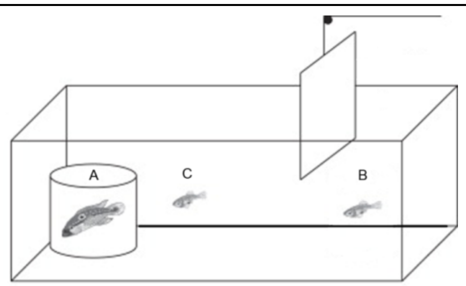


Figure 2: The test fish (C) will inspect the predator (A) more often when in the presence of another larger stickleback (B).

One example of risk taking behavior in sticklebacks is approaching and inspecting a predator decoy (an object shaped like a predator). When alone in a tank, small sticklebacks rarely take the risk of inspecting the predator model. However, when these same fish are paired with another larger stickleback they show much greater risk taking behavior (Figure 2). Interestingly, they do not inspect the predator as often when paired with another small stickleback.

Scientists believe that these studies may provide a model to understand how humans behave when acting alone or in groups.

1. Why might scientists use model animals, instead of humans, for research on risk taking behavior?
   Easier to control the environmental and genetic factors that might affect behavior

2. What is one factor that increases stickleback risk taking behavior?
   Pairing with another larger fish.

3. What are two examples of experiences or environmental factors that might affect human risk taking behavior?
   Peer pressure. Drugs. Stress….

Optional short essay or class discussion question

Using information from this activity, which of the following do you think might explain people's risk-taking tendencies? Explain your answer.

- Genetic (inherited) differences
- Age-related changes in the brain
- Environmental influences