

Extracting DNA from Bananas

As discussed in the program, for something to be called living or alive, it must be able to reproduce. Cells are the functional units of living things. They reproduce, in part, by making and passing deoxyribonucleic acid (DNA) from the parent cell to the offspring cell. All DNA is made up of the same chemical bases, adenine, thymine, guanine, and cytosine. The order of the bases determines the proteins the cell makes and the functions the cell performs.

In this activity, students extract DNA (and also some RNA) from bananas. They see that:

- DNA is a component of living and once-living things.
- DNA can be extracted and observed.

Materials:

- *Extracting DNA from Bananas* student handout
- 1 large banana
- 3/4 cups distilled water
- 1 teaspoon clear, colorless (i.e., not cloudy) shampoo or liquid soap containing EDTA
- 1/4 teaspoon table salt
- 15 ml 91% isopropyl (i.e., rubbing alcohol) in 25 ml or 50 ml sealed test tube; chill the alcohol by placing the test tube in a beaker containing ice cubes and some water
- Blender or smoothie maker
- 3 16-ounce plastic cups
- tape (optional)
- 2 plastic spoons
- 1 set of measuring spoons and a measuring cup with 1/2-cup markings
- 1 #4 cone paper coffee filter
- 250 ml beaker
- 1 plastic pipette or medicine dropper
- 1 thin glass rod

Key Terms

- **DNA:** Deoxyribonucleic acid, which is the hereditary material in cells that contains the instructions for producing the cell and enabling it to function
- **Extraction:** A procedure to obtain a substance by chemical or mechanical action
- **Filtrate:** The material collected after a solution or mixture passes through a filter
- **Precipitate:** Solid material that comes out of solution as a result of a chemical or physical change

National Science Education Standards Connection

Science Standard C: Life Science

- Grades 5–8: Reproduction and Heredity
- Grades 9–12: The Cell; The Molecular Basis of Heredity

Video is not required for this activity.

Artificial Life Viewing Activity || Teacher Notes (cont.)

Procedure

1. Review the procedure with students, discussing key terms and responding to any questions. Explain that crushing the bananas separates its cells and exposes them to the soap and salt. The soap helps break down cell membranes and release DNA. The salt helps bring the DNA together, and the cold alcohol helps the DNA precipitate and come out of solution so it can be collected.
2. Demonstrate the following:
 - Show what it means to stir gently so as not to cause the solution to froth or foam.
 - Demonstrate how to place the coffee filter in the cup so that the solution can pass through the filter and be collected in the cup. Leave about one to two inches between the bottom of the cup and the bottom of the filter. (Taping the filter to the cup is optional.)
 - Remind students to get their test tubes with alcohol only when they are ready to use them.
 - Remind students of the importance of following the procedure carefully.
3. Divide the class into teams. Have students gather their materials and begin their extraction. Consider keeping the blenders, the beaker with the alcohol test tubes, a gallon of distilled water, the soap, and the salt in one general area. You may also want to prepare a batch of blended bananas for the entire class and distribute the mixture to teams. Make sure students know to answer the questions at the bottom of the student sheet after finishing the extraction.

Answers to questions on student handout:

1. Describe the appearance of the DNA you extracted.

The DNA will appear white and will form a clump made of string-like strands that wrap onto the glass rod.

2. Summarize the main steps involved in extracting DNA from bananas.

Possible answer—We crushed the bananas to help release the DNA. We made a solution—water, soap, and salt—to free the DNA from other components. The soap breaks apart the cellular and nuclear membranes, and it releases the DNA. The salt helps the DNA strands come together. We used coffee filters to remove large particles, and we used alcohol to precipitate the DNA. DNA is not soluble in alcohol. Last, we observed our product, the DNA, on a glass rod.

3. Do you think your results would be different if you were to use a fruit or vegetable other than bananas? Explain.

Since DNA is in the cells of every living organism, students could use this technique to extract DNA from any fruit or vegetable.

©2005 WGBH Educational Foundation. NOVA and NOVA scienceNOW are trademarks of the WGBH Educational Foundation.

NOVA and NOVA scienceNOW are produced by the WGBH Boston Science Unit. Major funding for NOVA is provided by Google. Additional funding is provided by the Corporation for Public Broadcasting and public television viewers. Major funding for NOVA scienceNOW is provided by the National Science Foundation and the Howard Hughes Medical Institute with additional funding provided by Alfred P. Sloan Foundation and The Kavli Foundation. NOVA scienceNOW is closed captioned and described for viewers who are hearing or visually impaired by the Media Access Group at WGBH. This material is based upon work supported by the National Science Foundation under Grant No. 0229297. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Extracting DNA from Bananas

For something to be considered living, it must be able to reproduce. Cells reproduce in part by passing deoxyribonucleic acid (DNA) from parent cells to offspring cells. DNA provides a blueprint for an organism's growth and development. Studying DNA is one way scientists learn about what is necessary for life. In this activity, you will extract and observe DNA from bananas.

Procedure

1. Put 1/2 cup of distilled water and one banana into the blender. Blend for 25 seconds, making sure the banana is completely pulverized. Pour the mixture into a beaker.
2. Mix 1 teaspoon of soap with 1/4 teaspoon of salt in a plastic cup. Add 2 tablespoons of distilled water. Stir gently to avoid creating a foam. Continue for a few minutes until the soap and salt are dissolved.
3. Add 2 tablespoons of the banana mixture to the cup containing the soap solution. Use a spoon to stir the mixture for at least 10 minutes.
4. Insert a filter into a clean plastic cup so it does not touch the bottom of the cup. If necessary, tape the sides of the filter to the cup.
5. Pour the mixture from step 3 into the filter. After 10 minutes, some liquid, called the filtrate, should have collected in the bottom of the cup. Gently stir the mixture in the filter and let it sit for another minute. Remove the filter and set it aside.
6. Get a test tube of cold alcohol. Use a pipette or eyedropper to collect your filtrate. Add it to the alcohol.
7. Place the test tube with the alcohol and filtrate in a beaker or test tube holder. Let it sit undisturbed for about four minutes. Do not shake. The white material coming out of solution as a precipitate is DNA.
8. Dip the glass rod into the tube, slowly rotating it to spool out the banana's DNA.

Questions

1. Describe the appearance of the DNA you extracted. _____

2. Summarize the main steps involved in extracting DNA from bananas. _____

3. Do you think your results would be different if you were to use a fruit or vegetable other than bananas? Explain. _____

©2005 WGBH Educational Foundation. NOVA and NOVA scienceNOW are trademarks of the WGBH Educational Foundation.

NOVA and NOVA scienceNOW are produced by the WGBH Boston Science Unit. Major funding for NOVA is provided by Google. Additional funding is provided by the Corporation for Public Broadcasting and public television viewers. Major funding for NOVA scienceNOW is provided by the National Science Foundation and the Howard Hughes Medical Institute with additional funding provided by Alfred P. Sloan Foundation and The Kavli Foundation. NOVA scienceNOW is closed captioned and described for viewers who are hearing or visually impaired by the Media Access Group at WGBH. This material is based upon work supported by the National Science Foundation under Grant No. 0229297. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

The word *texture* describes the roughness or smoothness of an object. Soil texture is determined by feeling the soil.

- **Soil texture** is the proportion of sand, silt, and clay in the soil.
- **Soil texture** is considered by most soil scientists to be the single most important soil property.
- **Soil texture** affects many land uses and cannot be changed without great cost and effort.

Sand, the largest particle of the soil, is visible to the eye. It is gritty, holds little water, and is not slick or sticky when wet. Sand particles are between 2 and 0.05 millimeters in diameter.

Medium-sized soil particles are called **silt**. Silt feels like flour or talcum powder. It holds moderate amounts of water and has a somewhat sticky feel when wet. Silt particles are between 0.05 and 0.002 millimeters in diameter.

The smallest particles of soil are called **clay**. Most individual clay particles can only be seen with a powerful microscope. Clay feels sticky when wet, and hard when dry. Clay is more chemically active than sand and silt. Clay particles are less than 0.002 millimeters in diameter.

How to determine soil texture by feel

Laboratory analyses of soil texture are costly and take time, while feeling soil texture by hand is quick, free, and, with practice, highly accurate. The two basic steps in the texture by feel method are shown in figures 1 and 2.

After completing these two steps, and following the flow chart diagram, determine the soil textural class for your soil sample. The textural triangle organizes the textures into 12 classes. Notice that the loam textures are toward the middle of the diagram, because they contain a significant amount of sand, silt, *and* clay.

The term coarse-textured is often used for soils that are dominated by sand. Fine-textured refers to soils that are dominated by clay, and medium-textured soils are a more balanced mixture of sand, silt, and clay particles.

Why is soil texture important?

Soil texture is one of the most important properties to know how to measure, as it affects many other chemical, physical, and biological soil processes and properties such as the available water-holding capacity, water movement through the soil, soil strength, how easily pollutants can leach into groundwater, and the natural soil fertility.



Figure 1. Step 1: Take a handful of soil and break it up in your hand. Add water, and knead the mixture into a ball. The mixture should have the consistency of putty or Play-Doh®. Press the ball of soil between your thumb and forefinger, and try to make a ribbon. See how long you can make the ribbon before it breaks. Measure the ribbon length. Remember, there are 2.5 centimeters in 1 inch.



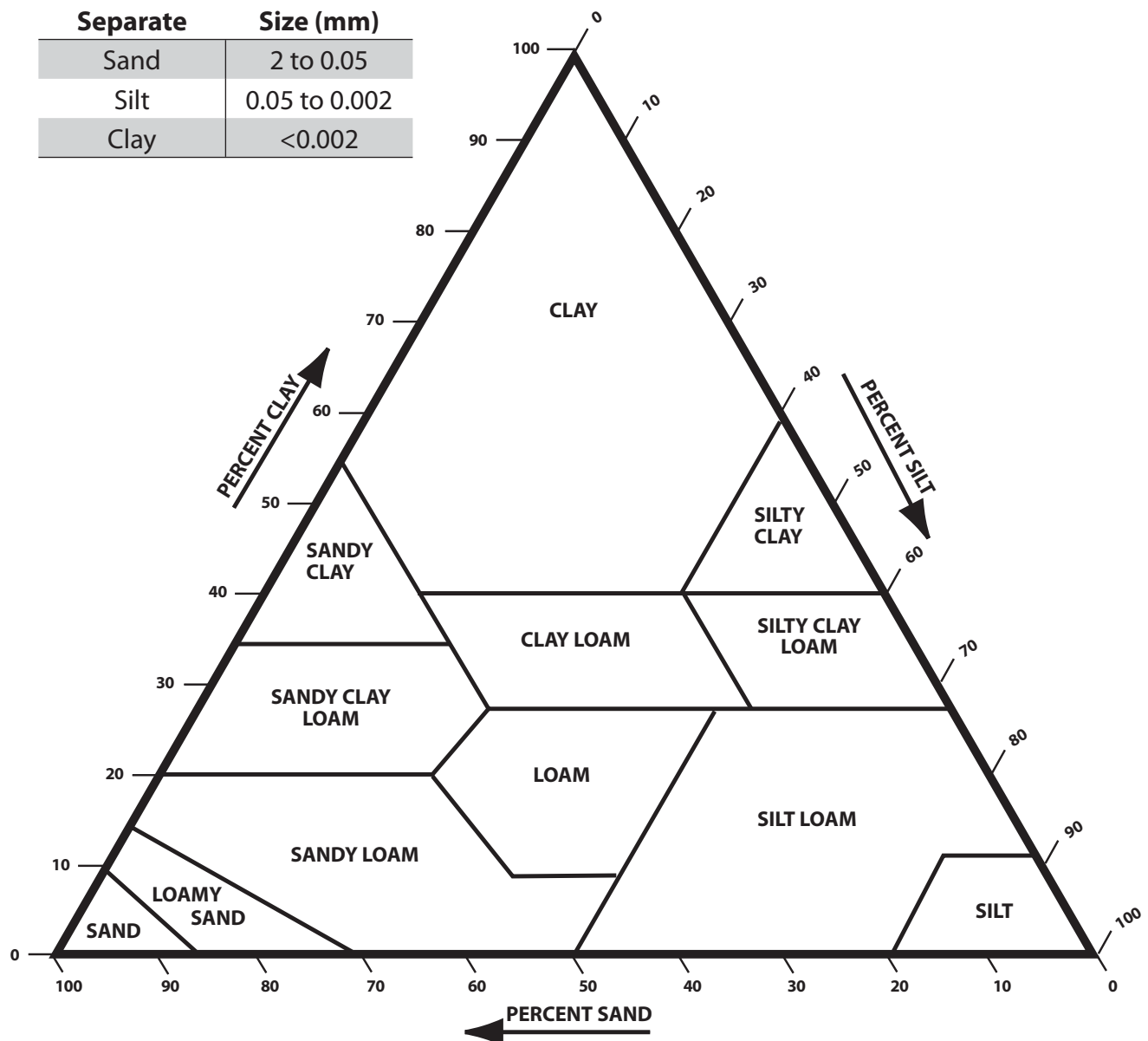
Figure 2. Step 2: Take a pinch of soil from your texture ball. Place it in the palm of your hand, and add water. Rub the soil and make a muddy puddle in your palm. How gritty does this feel?

Soil Properties Related to Texture

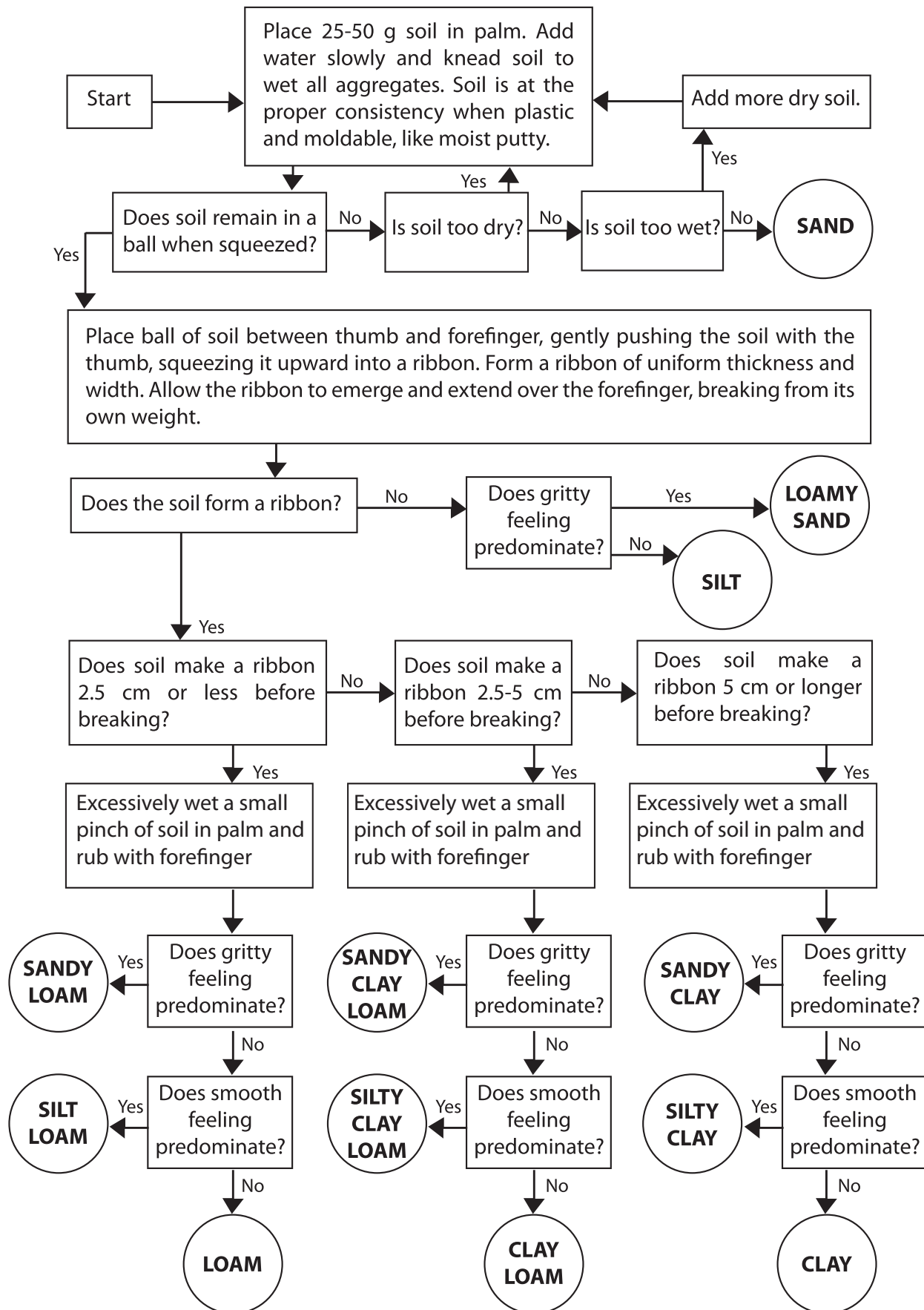
	Coarse	Medium	Fine
Water storage	Low	Medium	High
Water movement	Low	Medium	High
Power needed for digging or tillage	Low	Medium	High
Wind or water erosion (Ease of particle detachment)	High	Medium	Low
Wind or water erosion (Ease of transport)	Low	Medium	High
Plant nutrient storage	Low	Medium	High
Contaminant movement	High	Medium	Low

Soil Textural Classes

Separate	Size (mm)
Sand	2 to 0.05
Silt	0.05 to 0.002
Clay	<0.002



Procedure for Analyzing Soil Texture by Feel



References

S.J. Thien. 1979. *A flow diagram for teaching texture-by-feel analysis*. Journal of Agronomic Education 8:54-55.

DeAnn Presley,
Extension Specialist
Assistant Professor of Agronomy

Steve Thien
Professor of Agronomy

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Publications from Kansas State University are available on the World Wide Web at: www.oznet.ksu.edu

Contents of this publication may be freely reproduced for educational purposes. All other rights reserved. In each case, credit DeAnn Presley and Steve Thien, *Estimating Soil Texture by Feel*, Kansas State University, September 2008.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2852

September 2008

K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, Fred A. Cholick, Director.

Makin' Sandwiches

tomato - We have to accept each other's differences. (You say tomato, I say tomato)

bread for a sturdy foundation.

Mustard for the sunshine in life.

Miracle Whip for the miracles that can happen.

Beef – You have to beef up your relationship so it will last over the years

Ham – Sometimes you have to “ham it up” for the family

.Turkey – Love your kids, even when they’re turkeys.

Cheese – Sometimes you have to be a little cheesy.

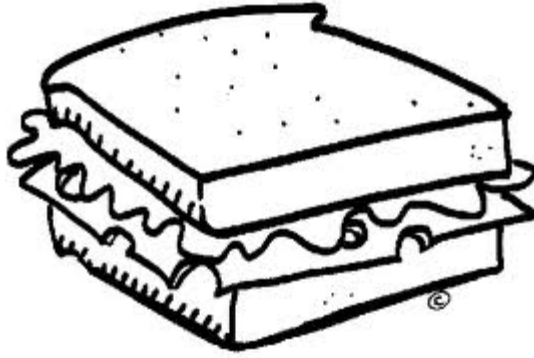
Lettuce- because sometime you have to Let others help you.

Pickles – because sometimes you just have to “dill” with what happens.

Chips – stay chipper (happy) through out the year – don’t go stale

Dessert – Fudge Round – well rounded – schoolwork family

Brownie w/nutes sometimes you have to be a little nutty!



Makin' Sandwiches

Makin' You!

Bread

Tomato

Mustard

Miracle Whip

Beef

Ham

Turkey

Cheese

Lettuce

Pickles

Chips

Desserts

– Fudge Round

Brownie w/nuts

Discover Your Personality

Instructions: Chose the words that best describe your personality. If you feel a word does not describe you at all, or just kind of describes you, skip it. You want to circle only the words that **best** describe you. Double the number of words you chose in each box and record that number on the blank for each animal.

TIPS:

- Do not pick what you want to be. Pick things that best describe you.
- Do not over think it. Move quickly. Don't ask for advice or input from others.
- Do not pre-conceive any ideas about which one you are. Take it openly.
- There is no formula for correct or incorrect. Some will score heavily in one area. Some will have two that are quite equal. There is no correct pattern, except the truthful one.

Lion		Beaver	
Likes authority Confident Firm Enjoys challenges Problem solver Bold Goal-driven Strong willed Self-reliant Persistent	Takes charge Determined Enterprising Competitive Productive Purposeful Adventurous Independent Controlling Action-oriented	Enjoys instructions Consistent Reserved Practical Factual Perfectionist Detailed Inquisitive Persistent Sensitive	Accurate Controlled Predictable Orderly Conscientious Discerning Analytical Precise Scheduled Deliberate
number chosen:_____		number chosen:_____	
Otter		Golden Retriever	
Enthusiastic Visionary Energetic Promoter Mixes easily Fun-loving Spontaneous Creative-new ideas Optimistic Infectious laughter	Takes Risks Motivator Very verbal Friendly Enjoys popularity Likes variety Enjoys change Group-oriented Initiator Inspirational	Sensitive feelings Calm Non-demanding Avoids confrontations Enjoys routine Warm and relational Adaptable Thoughtful Patient Good listener	Loyal Even keeled Gives in Indecisive Dislikes change Dry humor Sympathetic Nurturing Tolerant Peace maker
number chosen:_____		chosen:_____	

Discover Your Personality

Instructions: Chose the words that best describe your personality. If you feel a word does not describe you at all, or just kind of describes you, skip it. You want to circle only the words that **best** describe you. Double the number of words you chose in each box and record that number on the blank for each animal.

TIPS:

- Do not pick what you want to be. Pick things that best describe you.
- Do not over think it. Move quickly. Don't ask for advice or input from others.
- Do not pre-conceive any ideas about which one you are. Take it openly.
- There is no formula for correct or incorrect. Some will score heavily in one area. Some will have two that are quite equal. There is no correct pattern, except the truthful one.

Lion		Beaver	
Likes authority Confident Firm Enjoys challenges Problem solver Bold Goal-driven Strong willed Self-reliant Persistent	Takes charge Determined Enterprising Competitive Productive Purposeful Adventurous Independent Controlling Action-oriented	Enjoys instructions Consistent Reserved Practical Factual Perfectionist Detailed Inquisitive Persistent Sensitive	Accurate Controlled Predictable Orderly Conscientious Discerning Analytical Precise Scheduled Deliberate
Double the number chosen:_____		Double the number chosen:_____	
Otter		Golden Retriever	
Enthusiastic Visionary Energetic Promoter Mixes easily Fun-loving Spontaneous Creative-new ideas Optimistic Infectious laughter	Takes Risks Motivator Very verbal Friendly Enjoys popularity Likes variety Enjoys change Group-oriented Initiator Inspirational	Sensitive feelings Calm Non-demanding Avoids confrontations Enjoys routine Warm and relational Adaptable Thoughtful Patient Good listener	Loyal Even keeled Gives in Indecisive Dislikes change Dry humor Sympathetic Nurturing Tolerant Peace maker
Double the number chosen:_____		Double the number chosen:_____	

PERSONALITY TYPES DEFINED

•**Lion**—This personality likes to lead. The lion is good at making decisions and is very goal-oriented. He enjoys challenges, difficult assignments, and opportunity for advancement. Because lions are thinking of the goal, they can step on people to reach it. Lions can be very aggressive and competitive. Lions must learn not to be too bossy or to take charge in others' affairs.

Their Strengths: Goal-oriented, strong, direct, produce results, confident, challenge others

Weakness: Argumentative, too dictatorial

Their Environment: Lots of projects, awards on the wall, large calendar, office furniture arranged in a formal way

They Gain Security by: Control

Their Pace: Fast and decisive

Their Needs: A climate that responds; want others to be efficient and to the point

They're Irritated by: Wasted time, being unprepared, arguing, blocking results

For Growth They Need to: Appear less critical, respect people's personal worth, develop tolerance for conflict, pace themselves. Avoid killing morale by being too heavy handed. Be softer and include others in making decisions. Recognize that directness can hurt others. Learn to express grace.

In Dealing With Them: Avoid attacking their character, telling them what to do, presenting win-lose scenarios. Provide them with options, the freedom to act. Be efficient and competent. If you disagree – argue facts, not personal feelings. Be precise, time-disciplined, and well-organized. Do not waste their time. They don't need a lot of information to make a decision.

Limitation: Doesn't understand that directness can hurt others; hard time expressing grace

•**Beaver**— Beavers are very organized. Beavers think that there is a right way to do everything and they want to do it exactly that way. Beaver personalities are very creative. They desire to solve everything and desire to take their time and do it right. Beavers do not like sudden changes. They need reassurance.

Their Strengths: Hard-working, detailed, accurate, focused on quality. Have high-standards.

Weakness: Unrealistic expectations of self and others, too perfect

Their Environment: Structured and organized, charts and graphs, functional decor, formal seating arrangement

They Gain Security by: Preparation

Their Pace: Slow and systematic

Their Needs: A climate that describes and focuses on accuracy and preciseness

They're Irritated by: People who do not know what they are talking about, lack of attention to detail, surprises, unpredictability

For Growth They Need to: Make faster decisions, tolerate conflict, learn to compromise, adjust to change and disorganization. See the optimistic side of things. Learn to relax and don't expect others to do things just like they do.

In Dealing With Them: Avoid criticizing, blunt personal questions, incomplete or inaccurate recommendations. Provide them with evidence that what you say is true and accurate. Give frequent progress reports and reviews. Avoid gimmicks and don't rush decision making.

Limitation: Seeing the optimistic side of things, expressing flexibility

•**Otter**—Otters are very social creatures. Otter personalities love people. They

enjoy being popular and influencing and motivating others. Otters are sometimes hurt when people do not like them. Otter personalities usually have lots of friends, but not deep relationships. They love to goof-off. (They are notorious for messy rooms.) Otters like to hurry and finish jobs. (Jobs are not often done well.) The otter personality is like Tigger's in *Winnie The Pooh*.

Strength: People person, open, positive

Weakness: Talks too much, too permissive

Their Strengths: Ability to rally troops to achieve goals or desired outcome. Open and positive attitude.

Their Environment: Cluttered, awards and slogans on the wall, personal pictures, friendly

They Gain Security by: Flexibility

Their Pace: Fast and spontaneous

Their Needs: A climate that collaborates

They're Irritated by: Too many facts, too much logic, boring tasks, same old approach, routine, being alone, people who are ignoring their opinions

For Growth They Need to: Respect priorities, more logical approach, follow through, get better organized, remember commitments, concentrate on the task at hand. Think before they speak and consider consequences before acting or making a decision.

In Dealing With Them: Avoid negativism, rejection, arguing. Be interested in them. Support their dreams, feelings, and opinions. Do not hurry the discussion – give them a chance to talk. Don't deal with details. Put everything to them in writing. Everyone likes to spend time with Otters, except Beavers.

Limitation: Remembering past commitments, follow through with discipline

• **Golden Retriever**—Golden retrievers are great at making friends. They are very loyal. Retriever personalities do not like big changes. They look for security and can be very sensitive. Retrievers are very caring and have deep relationships, but usually have only a couple of close friends. A golden retriever wants to be loved by everyone. He looks for appreciation and works best in a limited situation with a steady work pattern.

Strength: Accommodating, calm, affirming

Weakness: Indecisive, indifferent, unable to express emotions, too soft on other people

Their Strengths: Accommodating, calm, affirming. Possess a great amount of compassion. Listening.

Their Environment: Family pictures, slogans on the wall, personal items, relaxed friendly decorations

They Gain Security by: Close relationships

Their Pace: Slow and easy

Their Needs: A climate that processes

They're Irritated by: Pushy and aggressive behavior, insincerity, being put on the spot, disrupting the status quo

For Growth They Need to: Take risks, delegate to others, confront, develop confidence in others, learn to change and adapt. Work on internal motivation as they are hard to motivate and frustrate the other personality types. Practice saying no. Making firm decisions.

In Dealing With Them: Avoid conflict, sudden unplanned risky changes, overloading or confusing concepts. Give them assurances, reliability, and assistance in presenting to others. Be non-threatening and sincere. Show interest in their feelings. Don't push. Assure them you will stand behind their decision.

Limitation: Seeing the need to be more assertive, holding others accountable

SMART GOALS

A series of horizontal lines in teal and light blue colors, extending across the width of the slide below the title.

SPECIFIC

- **Specific:** A specific goal has a much greater chance of being accomplished than a general goal. To set a specific goal you must answer the six “W” questions:
 - *Who: Who is involved?
 - *What: What do I want to accomplish?
 - *Where: Identify a location.
 - *When: Establish a time frame.
 - *Which: Identify requirements and constraints.
 - *Why: Specific reasons, purpose or benefits of accomplishing the goal.
- **EXAMPLE:** A general goal would be, “Get in shape.” But a specific goal would say, “Join a health club and workout 3 days a week.”

MEASUREABLE

- **Measurable** - Establish criteria for measuring progress toward each goal you set.
- How much? How many?
- How will I know when it is accomplished?

ATTAINABLE

- **Attainable**
- Goals that may have seemed far away and out of reach eventually move closer and become attainable.
- Can you really reach this goal?

REALISTIC

- **Realistic-**
- a goal must represent an objective toward which you are both *willing* and *able* to work.
- A goal can be both high and realistic; you are the only one who can decide just how high your goal should be.

TIMELY

- **Timely** – A goal should have a time frame
- “Someday” won’t work. But if you anchor it within a timeframe, “by May 1st”, then you’ve set your unconscious mind into motion to begin working on the goal.

Creating S.M.A.R.T. Goals

Specific

Measurable

Attainable

Realistic

Timely

Specific: A specific goal has a much greater chance of being accomplished than a general goal. To set a specific goal you must answer the six “W” questions:

*Who: Who is involved?

*What: What do I want to accomplish?

*Where: Identify a location.

*When: Establish a time frame.

*Which: Identify requirements and constraints.

*Why: Specific reasons, purpose or benefits of accomplishing the goal.

EXAMPLE: A general goal would be, “Get in shape.” But a specific goal would say, “Join a health club and workout 3 days a week.”

Measurable - Establish concrete criteria for measuring progress toward the attainment of each goal you set.

When you measure your progress, you stay on track, reach your target dates, and experience the exhilaration of achievement that spurs you on to continued effort required to reach your goal.

To determine if your goal is measurable, ask questions such as.....

How much? How many?

How will I know when it is accomplished?

Attainable – When you identify goals that are most important to you, you begin to figure out ways you can make them come true. You develop the attitudes, abilities, skills, and financial capacity to reach them. You begin seeing previously overlooked opportunities to bring yourself closer to the achievement of your goals.

You can attain most any goal you set when you plan your steps wisely and establish a time frame that allows you to carry out those steps. Goals that may have seemed far away and out of reach eventually move closer and become attainable, not because your goals shrink, but because you grow and expand to match them. When you list your goals you build your self-image. You see yourself as worthy of these goals, and develop the traits and personality that allow you to possess them.

Realistic- To be realistic, a goal must represent an objective toward which you are both *willing* and *able* to work. A goal can be both high and realistic; you are the only one who can decide just how high your goal should be. But be sure that every goal represents substantial progress.

A high goal is frequently easier to reach than a low one because a low goal exerts low motivational force. Some of the hardest jobs you ever accomplished actually seem easy simply because they were a labor of love.

Timely – A goal should be grounded within a time frame. With no time frame tied to it there's no sense of urgency. If you want to lose 10 lbs, when do you want to lose it by? "Someday" won't work. But if you anchor it within a timeframe, "by May 1st", then you've set your unconscious mind into motion to begin working on the goal.

Your goal is probably realistic if you truly *believe* that it can be accomplished. Additional ways to know if your goal is realistic is to determine if you have accomplished anything similar in the past or ask yourself what conditions would have to exist to accomplish this goal.

T can also stand for Tangible – A goal is tangible when you can experience it with one of the senses, that is, taste, touch, smell, sight or hearing.

GOALS

Specific

Measurable

Attainable

Realistic

Timely

Goal #1

S

M

A

R

T

Goal #2

S

M

A

R

T

Goal #3

S

M

A

R

T

Goal #4

S

M

A

R

T