APPENDIX 1a

Salt may be removed from tsunami-hit rice fields by 2014

BY SATOSHI OTANI STAFF WRITER

Stretching from Tohoku to Kanto, about 20,000 hectares of rice fields inundated by the tsunami following the Great East Japan Earthquake were left untillable due to saline contamination.

To clean up the mess, the Cabinet on April 26 gave the nod to drafting a supplementary bill to cover 90 percent of the costs. The cleanup work should be completed by 2014, according to the Ministry of Agriculture, Forestry and Fisheries.

At the end of March, the ministry, using satellite footage, estimated the area of farmlands destroyed or flooded by the tsunami at 23,600 hectares in six prefectures along the Pacific coast. Of that, about 20,000 hectares are rice fields.

One of the hardest-hit areas was Miyagi Prefecture, where two-thirds of its farmlands, about 15,000 hectares, are affected. In the towns of Shichigahama and Watari, 93 and 79 percent of their agricultural lands are damaged, respectively. The salt will prevent rice cultivation, so it must be removed.

The ministry plans to spread lime on the soil to absorb the sodium, and let freshwater and rainwater soak into the soil and wash the lime and salt away through a ground filter. To achieve this, underground drainage channels and other systems first need to be rebuilt.

But even before that work can start, all the rubble must be cleared.

After the typhoon that hit Yatsushiro, Kumamoto Prefecture, in September 1999, it took just three to five months to complete the drainage process, the ministry found.

In that case, once the drainage systems were fully installed, workers filled the fields with freshwater and then drained them. The steps were completed once or twice for each rice field, and farmers were able to plant rice the next year.

For rice to thrive, the soil's saline concentration can be no greater than 0.1 percent by weight.

Given the enormous damage caused by the March 11 earthquake, saline concentration measurements have not been carried out in most of the affected areas.

In fields with high saline concentrations, the filling and draining must be repeated, which will take several months.

On the other hand, the amount of damage varies significantly among the affected areas, and rice could be planted next year in a few areas. The ministry said it aims to fully restore rice cultivation in all stricken areas within three years.

The Cabinet decision on April 26 approved preparation of a supplementary bill to the main emergency budget for reconstruction and relief, which the Diet passed in May.

The supplementary bill will add the salt removal projects into the emergency budget and increase central government funding accordingly.

Meanwhile, in areas near the Fukushima No. 1 nuclear power plant, restoring land contaminated by radiation to normal will be extremely difficult. The areas include about 10,000 hectares of rice fields--some of them also stricken by tsunami--in three districts extending across the no-entry zone.

Ideas such as planting rapeseed and sunflowers--plants that absorb radioactive substances--in the soil have been

APPENDIX 1a

suggested.

However, critics say the effects of this plan would be limited, while creating a new problem of how to dispose of such plants. For farmlands with low-level radiation contamination, the surface layer of the soil will likely be removed, a ministry official said.

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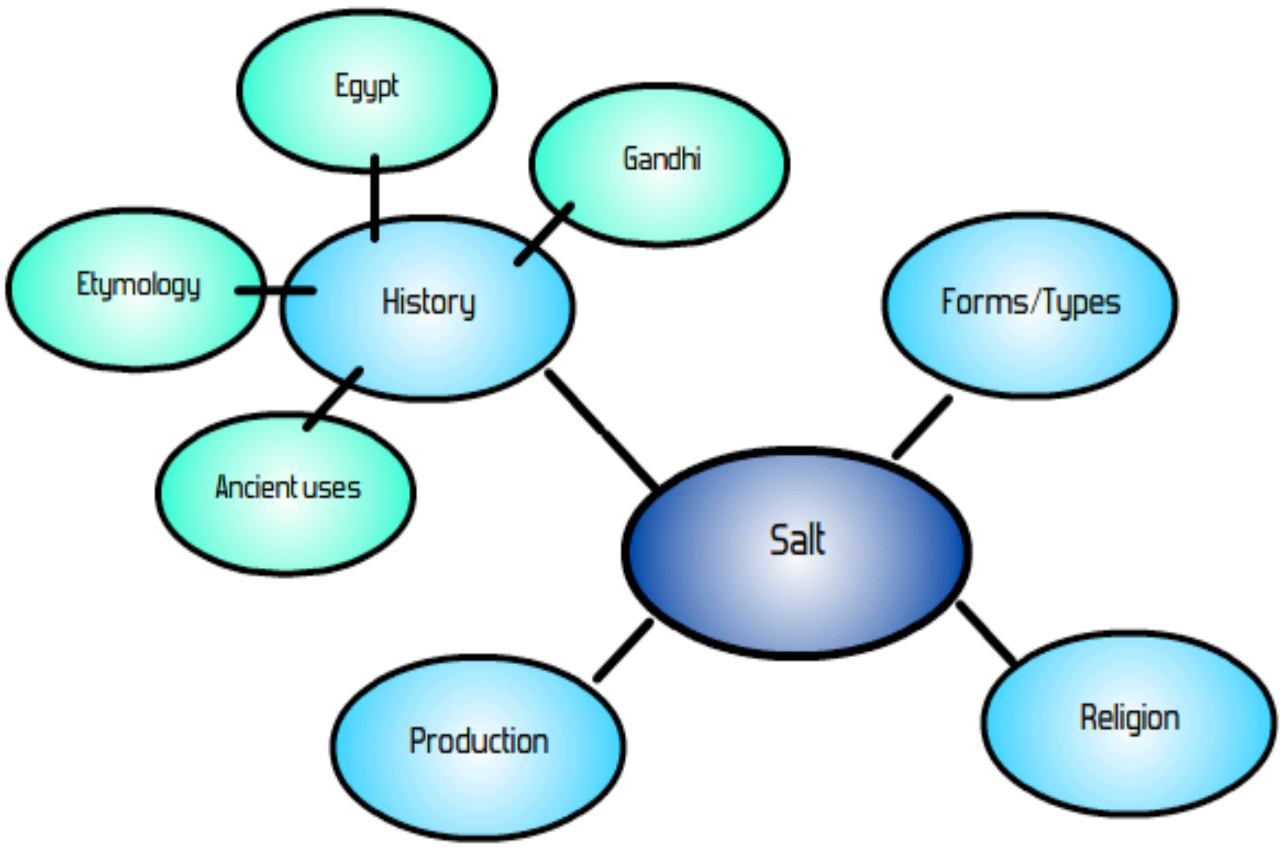
Sample concept map of *Salt* Wikipedia article

http://en.wikipedia.org/wiki/Salt

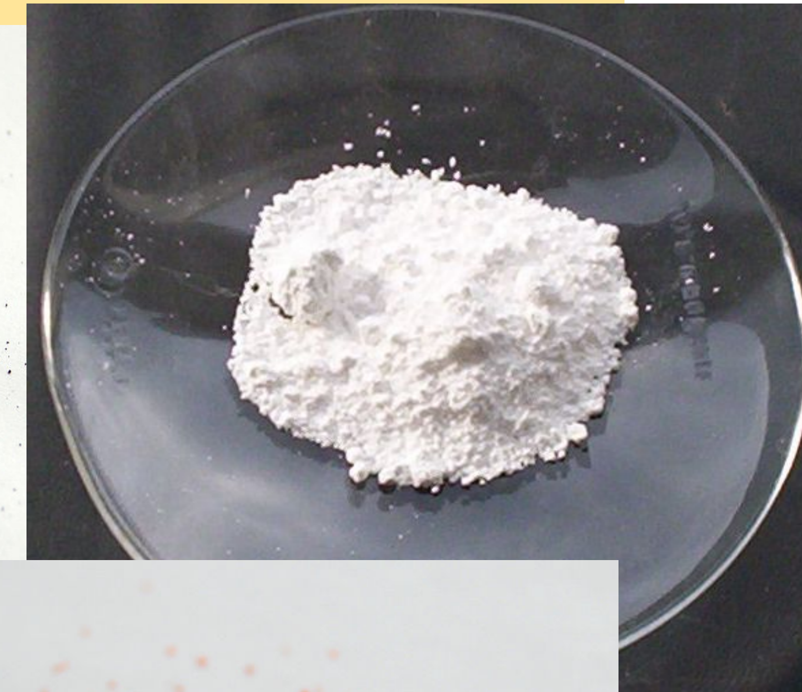
Produced with Concept Map Creator, Ryan Bensman, 2007,

Northwest Missouri State University

http://www.nwmissouri.edu/library/courses/research/conceptMap.html



Which is salt?



APPENDIX 1d

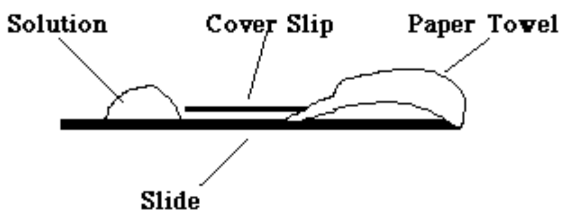
Exploratory Activity: Osmosis in *Elodea* Cells

Introduction: One of the functions of the cell membrane is to control the flow of materials into and out of the cell. In this investigation, you will observe the effects of placing plant cells in solutions of various concentrations.

Materials: *Elodea* leaves, microscope slides, cover slips, microscope, distilled water, tap water, 5% salt solution, 10% salt solution, paper towel.

Methods: Prepare a wet mount of an *Elodea* leaf with tap water. Observe the leaf at 40X and record your observations. Increase the magnification to 100X, observe, and record your observations.

Remove the slide from the stage of the microscope. Place 2 drops of the 5% salt solution on the slide at the edge of the cover slip. Tear off a small piece of paper towel and place the torn edge on the slide at the edge of the cover slip that is opposite the side where the salt solution was placed. The piece of towel should begin to soak up water, drawing the salt solution under the cover slip as it does so.



Methods (continued): Return the slide to the microscope stage and repeat the observations of the cells at 40X and 100X. Record your observations. Repeat the above procedure. Record your observations. Remove the slide from the stage, clean it and the cover slip, and put it away. Put the microscope on low power and put it away.

Observations:

Prepare sketches of a group of *Elodea* cells under each set of conditions. Label the sketches to note the cell structures that you can identify. Be sure to note any changes in the color, size, and shape of the cells. Make your sketches as accurate as possible.

Conclusions: Answer the following questions.

1. What is the shape of the typical *Elodea* cell?
2. What are the small green blobs found inside the cells? What is their function?
3. What happens to the cells as the salt water flows under the cover slip?
4. What happens to the cells when the salt water is flushed out with distilled water?
5. *Elodea* normally lives in fresh water. What changes would you observe in the cells of an *Elodea*

APPENDIX 1d

plant that was suddenly moved from fresh water to salt water? Why?

Teacher Materials:

Teaching Tips | Evaluation Keys

Student Materials:

Background Reading

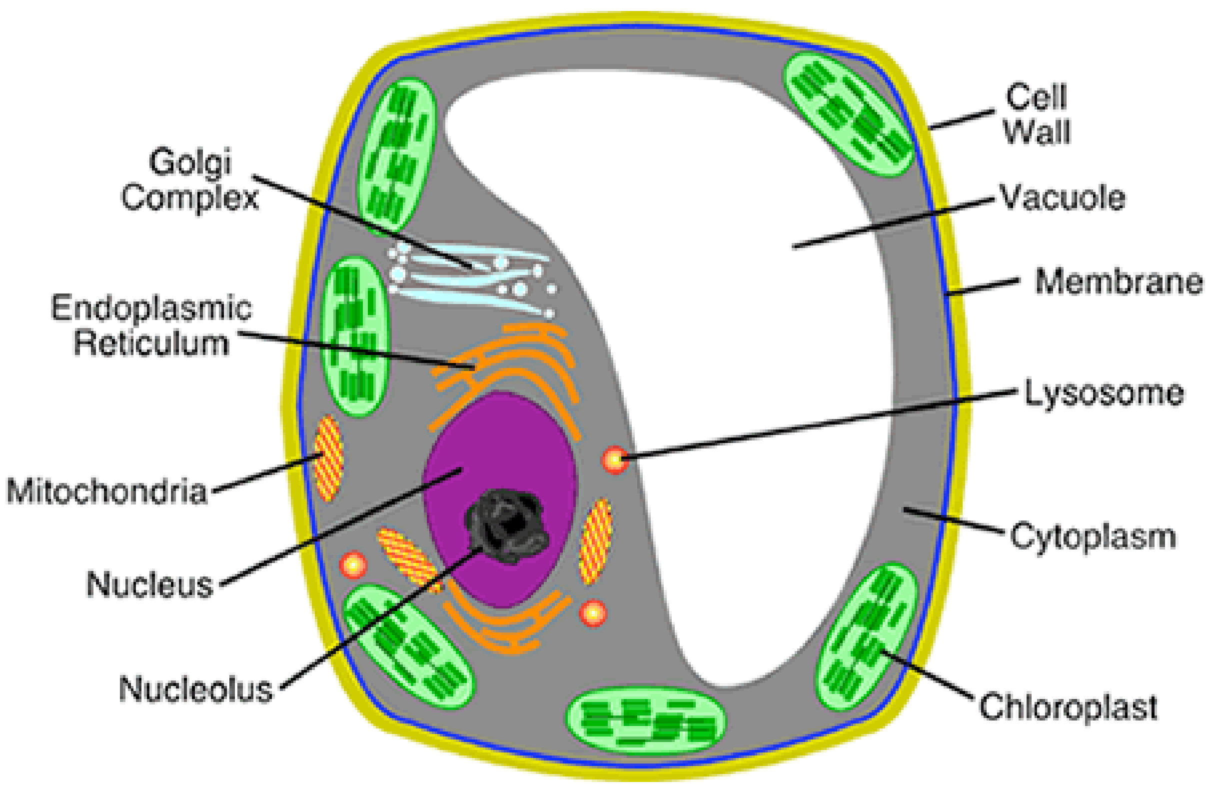
Osmosis in Elodea | Dynamic Equilibrium | Factors Affecting Diffusion

Osmosis | Osmosis and Blood Cells | Quiz

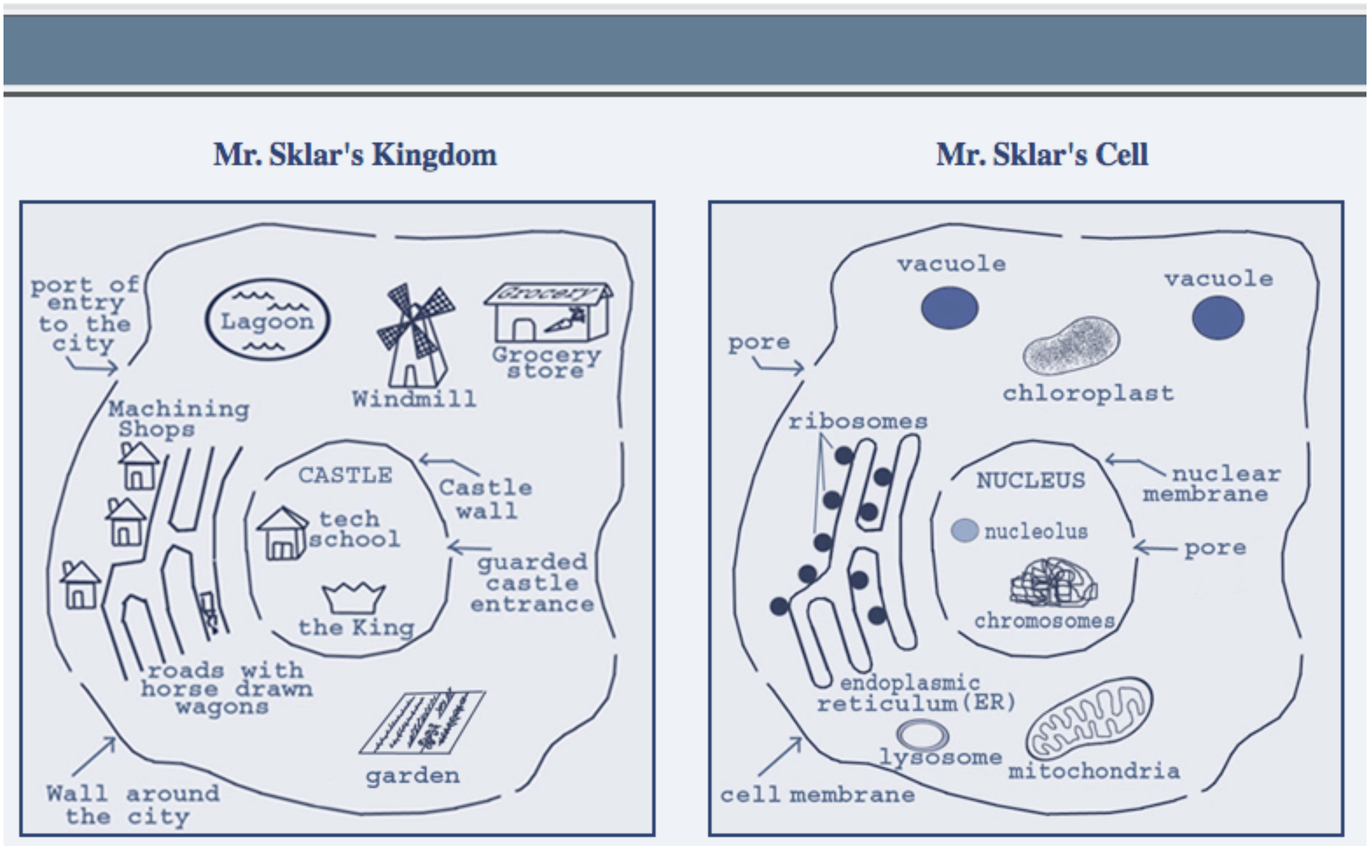
Return to Unit Overview

Science Education Connection
Department of Biochemistry
The University of Arizona
Wednesday, February 12, 1997
johnmcc@dakotacom.net

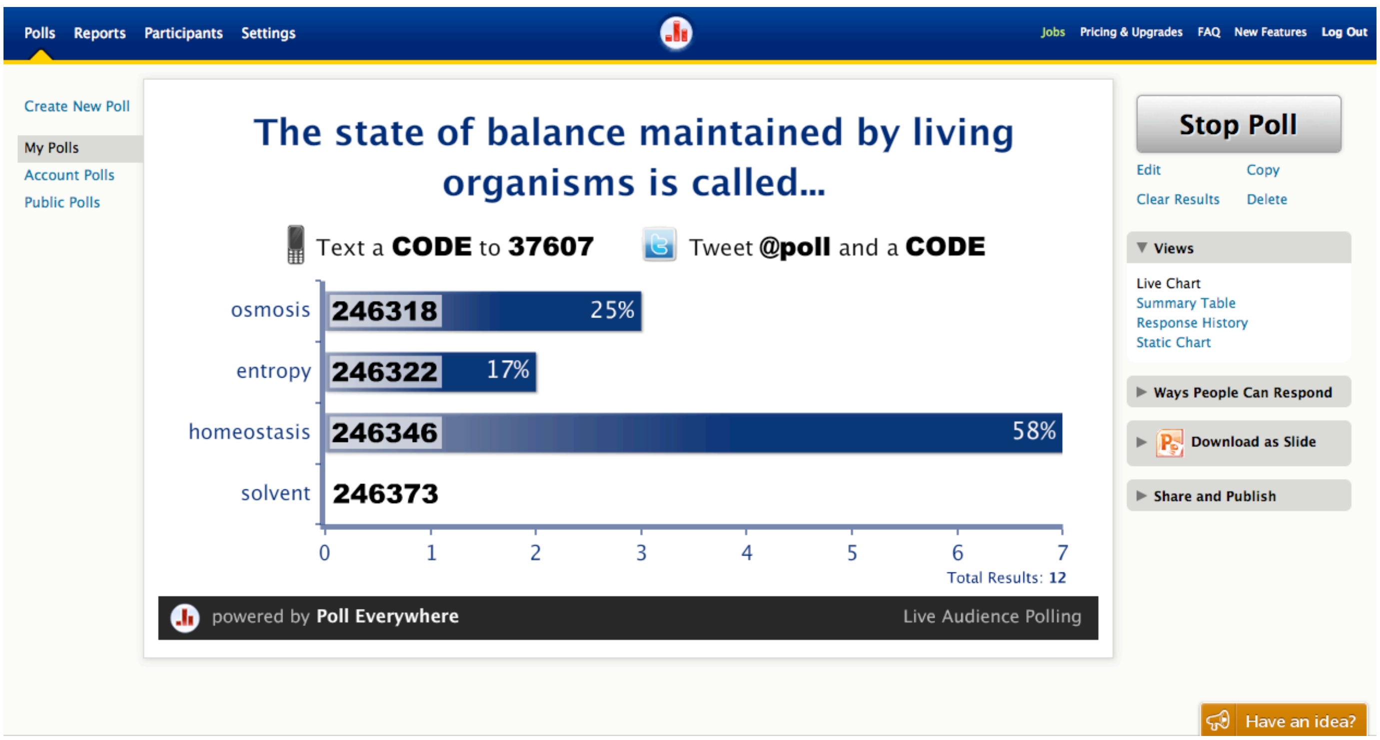
Sample plant cell drawing with essential components
http://www.biologycorner.com/bio1/cell.html



Sample cell analogy
Source: Aaron Sklar
http://www.aaronsklar.com/aaronsklar/scienceclasses/sci10/Biology/CellAnalogyCastle.htm



PollEverywhere.com text poll question showing sample results



Salinity notes

Number 8, October 2000, ISSN 1 325-4448

How to Texture Soils & Test for Salinity

Testing a soil sample is a reliable way to assess how salts are affecting plant growth. Even though it is quicker and easier to test water samples, a soil salinity test shows the soil conditions around plant roots, taking into account the influence of soil texture. Identifying current soil salinity conditions and recording salinity trends will help you recognise and predict soil salinity problems, and help you make sound land management decisions.

Taking soil samples

To perform the test you will need a sample of soil from the rootzone of your crop or pasture. Dig a hole with a shovel and take a sample (a few handfuls placed in a plastic bag). **This sample should be taken from a depth of 5-30cm.** If you have time (especially if sampling from near trees or in a deep-rooted pasture) take a sample from below 30cm (that is, in the lower rootzone). Take samples from both “heavier” and “lighter” country (different soil types).

Note that soil salinity will be highest before the rain break or before commencing irrigation, so you may want to test your soils then. Also note that the test result will be artificially high if you have added gypsum (a calcium salt) to the paddock recently (don’t test within three months of gypsum application).

The soil salinity field test

Soil salinity can be measured by a simple field test. This will give an indication of the amount of salt in your soil. The test is reasonably accurate in indicating if salts may cause yield losses or soil management problems, but is not as accurate as laboratory analysis (the field test’s expected error may be at least 10%). Sending soil samples away for laboratory testing is strongly recommended, and most commercial soil tests include salinity as one of the properties tested.

The field test for salinity is also called an **$EC_{1:5}$ (“EC one-to-five”) test** because a ratio of 1 part soil sample to 5 parts distilled water is used to find the salinity of the sample.

The three steps in a soil salinity test are:

1. **Assess the texture** of your soil sample.
2. **Measure the salinity** of a solution made up of distilled water mixed with the soil you have collected.
3. **Multiply the test result by the conversion factor** based on soil texture to get soil salinity (EC_e), which shows how soil salinity will affect plant growth.

Determining soil texture

Texture is an estimate of the relative amounts of sand, silt and clay particles in a soil. To convert your test result to actual soil salinity (EC_e) you need to texture your soil sample. Knowing the texture of your soil is important for many other reasons too; as texture affects fertility, water holding capacity, internal drainage, irrigation scheduling and soil workability for tillage. Soil texture usually changes with depth; so determining the texture of each visible change in the soil profile will help you understand the soil types on your farm.

Converting test results to soil salinity

In simple terms, a given amount of salt in sandy soils will be more concentrated in its effect on plant roots than an equivalent amount in clay soils. This is because sandy soils hold less water to dilute the salts than clay soils (they have a lower available water content). Find the multiplication factor for your textured soil sample on the Conversion Factor Table (Table 2). This factor will allow you to convert your test results into soil salinity readings. Note that EC_e is the term used to indicate actual soil salinity.

For example, if your soil is a light clay with a test result ($EC_{1:5}$) of 0.5 dS/m, multiply 0.5 by 8.6; which is 4.3 dS/m, an approximate value for the salinity of the soil (EC_e).

Note: these conversion factors are calibrated for southern NSW soils; based on Slavich & Patterson (1993) *Estimating the Electrical Conductivity of Saturated Paste Extracts from 1:5 Soil:Water Suspensions and Texture*. Different factors may be more suitable in other areas so, if in doubt, contact your local soil scientist.

Lab testing of soil samples

The soil samples you have collected can be sent away to a laboratory for full analysis, which identify a wide range of soil properties, including salinity, pH (acidity), sodicity (ESP), and amounts of phosphorus (P), nitrogen (N), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg) and organic matter. Regular soil tests allow you to monitor the health and condition of your soil, and make better land management decisions.

How to texture soils

1. Take a sample of soil sufficient to comfortably fit in the palm of your hand. Break up or remove any aggregates (clods of soil 2 mm or larger). Remove any stones, leaves or twigs.
2. Moisten the soil with water, a little at a time, and knead it until the soil forms a ball approximately 3 to 5 cm in diameter and so the ball just fails to stick to the fingers, adding more soil or water if necessary. The sample should not be saturated (water dripping out of the ball) or too dry (some soil is dusty and not wet at all). Make sure the soil is wet right through (this moisture content is around field capacity) and there are no lumps.
3. Continue kneading and moistening, if necessary, until there is no apparent change in the feel of the soil ball. Do not overwork the ball (no more than 3-4 minutes).
4. Assess the soil for coherence (see Table 1) by squeezing the moist ball in the hand. Knead ball for a further minute.
5. Assess feel (Table 1) as you knead the ball.
6. Ribbon the soil ball by pressing it between the thumb and forefinger and squeeze it into a ribbon until it breaks. Try to make a thin continuous ribbon about 2 mm thick.
7. Measure the length of the ribbon. Repeat this a few times to get an average ribbon length.
8. From the results for coherence, feel and ribbon length, estimate the soil texture group from Table 1. Remember this test is only an approximation; but with practice, you can quickly estimate texture of soils in the paddock.

Steps 1 and 2

Step 2

Step 6

Step 7

Table 1: Soil Texture Groups

Soil Texture Group	How to identify the Soil	Coherence	Feel	Approx. Ribbon Length	Approx % Clay	$EC_{1:5}$ to EC_e conversion factor
Sands (sand, loamy sand, clayey sand)	Have little coherence and cannot be moulded into a stable ball. Individual sand grains stick to fingers.	nil to slight	sandy, gritty	nil to 15mm	up to 10	**17**
Sandy loams (sandy loam, fine sandy loam)	Can be moulded into a stable ball. Sand grains can be seen and/or felt.	slight to just firm	sandy	15-25mm	10-25	**13.8**
Loams (loam, silty loam, sandy clay loam)	Soil ball is easy to manipulate and has a smooth spongy feel. Greasy to the touch & discolours fingers if organic matter present. Very silky and smooth if silty loam. Sandy clay loam (medium sand in a fine matrix) will ribbon 25-40mm and looks sandy.	firm	spongy, maybe greasy	about 25mm	20-30	**9.5**
Clay Loams (fine sandy clay loam, clay loam, silty clay loam)	Can be formed into a stable ball that is smooth and plastic to manipulate. May feel slightly sandy or silky.	firm to strong	smooth	40-50mm	30-35	**8.6**
Light Clays (sandy clay, silty clay, light clay, light medium clay)	Handles like smooth plasticine. Slight resistance to rolling out and shearing. Rod of light medium clay can be formed into a ring without cracking.	firm to strong	plastic	50-85mm	35-45	**8.6**
Medium & Heavy Clays	Smooth and very plastic with a moderate to strong resistance to rolling out and shearing. Heavy clay handles like stiff plasticine. Ribbon or rod can be formed into a ring in the palm without cracking.	strong	plastic	over 85mm	more than 45	**7**

COHERENCE

The way the moist ball of soil holds together:

Nil to slight coherence: soil won't hold together, or stay in a moulded ball. e.g. sands

Slight to firm coherence: holds together well, but needs water to form ball. e.g. loams

Strong coherence: holds shape very well. e.g. medium clay

FEEL & OTHER FEATURES:

How the balls looks and feels as you knead it:

Sandy: feels gritty and you can see coarser sand grains. Fine sand grains (which may be too small to see) make a grating sound as you rub the soil between fingers and thumb.

Spongy: typical of **loams**; also, high organic matter content gives a spongy feel.

Silky: a smooth, soapy, slippery feel is typical of high **silt** content.

Plastic: ball can be deformed & holds its new shape strongly. Feels sticky. Typical of **clays**.

Resistance to Shearing: how firm the soil feels as you form a ribbon. (Place the ball of soil between your thumb and forefinger and squeeze, sliding your thumb across the soil.) The firmness is a good way to distinguish light, medium and heavy clays. A light clay is easy to shear: a medium clay is stiff, a heavy clay is very stiff and often takes two hands to squeeze into a ribbon.

How to conduct a soil salinity field test

To perform the field test you will need a soil sample, some distilled water (good rainwater is suitable), a testing container (such as a jar with a lid) and a calibrated salinity meter (see Salinity Note 2: *Understanding Salinity Meters*):

1. Take a soil sample and leave it to dry as long as possible (leave sample bag or container open for at least a day to let moisture escape). It can be oven-dried on a tray in a cool oven.
2. Crush dried sample so there are no large aggregates (clods of soil 2mm or larger). You may need to crush these aggregates with a mortar-and-pestle, rolling pin or hammer. Remove any foreign matter, plant material and stones from the sample.
3. **The test involves adding one part soil for every five parts water. So if you add 50g of soil (weighed on scales) to the testing container, then you need to add 250ml of water.**
4. Shake the container for three minutes to make sure the salts dissolve. For clay loams and clay soils, more shaking (for one minute every 3 minutes repeated three times) will bring more salts into the solution and increase the accuracy of the test.
5. Allow the solution to settle for a minute before testing.
6. Place the salinity meter in the solution (but not in the soil in the bottom of the jar) and read the display once it has stabilised.
7. Wash the meter electrodes and sample jar with distilled or rainwater, and dry.
8. **Convert your salinity meter readings to soil salinity (EC_e) by multiplying the value by the Conversion Factor based on the texture of the soil sample (see Table 2 below).**

What Do the Readings Mean?

Differing types of crops and pastures have different levels of tolerance to salinity. At a soil salinity of 2dS/m, salts in the soil have minimal impact on the yield of most agricultural crops. When soil salinity rises to 6 dS/m most agricultural crops have begun to be affected. Refer to the *Soil & Water Salinity Calculator* or *Water Salinity Guidelines* for the relative tolerance to soil salinity of common crops and pastures.

Soil salinity information can be used to assist in making land management decisions. To make these decisions clearer, you should class your land according to its soil salinity and relative risk of further soil salinisation occurring. For more advice on managing land by land use classes contact your local salinity officer or refer the Salinity Note: *Managing Land by Salinity Classes.*

Table 2: $EC_{1:5}$ to EC_e Conversion Factors

Soil Texture	Multiplication Factor
Sands	17
Sandy Loams	13.8
Loams	9.5
Clay Loams & Light Clays	8.6
Medium & Heavy Clays	7

EM Surveying

Electromagnetic induction (EM) surveying can be used to determine soil texture or salinity over large areas. This indirect method measures the reflected (secondary) electromagnetic field from the soil, with more conductive soils generating a larger signal. EM readings are influenced by salt concentration and water content (hence their use in salinity surveys), by soil texture (hence their use in rice soil suitability surveys) and by the presence of metal objects and electrical fields. Results need careful interpretation to account for all these factors.

This information has been produced as part of Salt Action, the community and government initiative for managing salinity in NSW.

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Condobolin (02) 6895 2099
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Deniliquin (03) 5881 9999
Forbes (02) 6850 2922
Griffith (02) 6960 1300

NSW Agriculture

Salt Action

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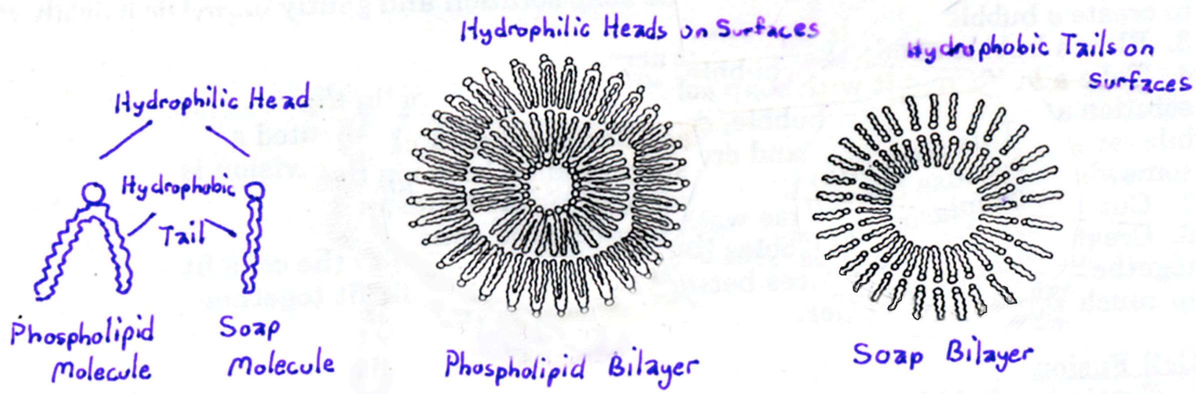
MEMBRANE MODEL: The Bubble Lab

The cell's plasma membrane is a phospholipid bilayer with protein molecules imbedded in it. The protein molecules transport other molecules through the membrane and into or out of the cell. All of the membranes in the cell (nuclear envelop, endoplasmic reticulum, membranes in the chloroplasts and mitochondria) are essentially the same as the plasma membrane.

The phospholipids bilayer is made of two layers of molecules. Each phospholipids molecule has a polar (hydrophilic) head and two non-polar (hydrophobic) tails. The hydrophobic tails of the two layers repel water and are attracted to each other. They form the inside of the membrane bilayer "sandwich" while the polar heads are on the outside closest to the water.

Soap bubbles are bilayers very similar to phospholipids membranes, so they can be used to investigate some of the properties of the cell membrane. The soap bubble bilayer is made of molecules with a hydrophilic head and a hydrophobic tail, except that the surrounding medium (air) is non-polar, so the tails of the bilayer face outward and the polar heads form the inside.



Materials

- Flat pan
- Straightened paper clip
- Plastic knife
- Drinking straw and string "membrane holder"
- Soap mixture
  - (900 ml water + 100 ml Joy liquid soap + 25 ml glycerin or corn syrup)
- String
- Thread circle

Procedure

1) Pour soap solution to about 1 cm. depth in your pan. Be careful not to make froth as you pour.

2) Holding the straws of the membrane holder, immerse it into the pan of soap solution. Raise it out of the pan and allow the excess soap to drip off. Hold up

the soap film-filled membrane holder and demonstrate the following characteristics of a lipid bilayer.

- **Fluidity:** The theory of the structure of the cell membrane is called the *Fluid Mosaic Model*. This means that the membrane is made of a pattern of many small molecules that are moving around and shifting position.

3) Can you see the light shining of the surface of the soap film? You should be able to see movement in the light pattern, demonstrating that the molecules of the film are constantly in motion.

- **Flexibility:** A lipid bilayer is a fluid arrangement within which the molecules can move freely through the plane of the bilayer. They can reorganize themselves into almost any shape without losing the contacts that satisfy their mutual attraction.

4) Twist the two straw handles in opposite directions and bend the film into different configurations.

A. What happens to the soap film?

The soap bilayer is actually less flexible than a cell membrane because a cell membrane is supported on both sides, one side by the cytoplasm and the other by lymph or other tissue fluids. So, whatever you are doing to the soap film, plus more, can be done to cell membranes without breaking them.

- **Self-Sealing:** Remember that the membrane is not a solid. It is made of two layers of many molecules attracted to each other.

5) Make another film in the membrane holder. Take the straightened paper clip and dip it in the soap solution. Stick the paperclip in the membrane and pass it through to the other side.

B. Did the membrane seal around the paperclip?

6) Make another film. Stick a dry paperclip through the membrane.

C. What happens? Why?

7) Make another film. Dip your finger into the soap solution, making sure that it is well covered, and stick it into the membrane. Remove your finger from the membrane.

D. What happens to the membrane when you remove your finger? Can the membrane heal around small punctures?

- **Transport Proteins:** In a cell membrane, small molecules such as water can sometimes move into the cell through small spaces in the lipid bilayer. Larger polar molecules cannot pass through the membrane because of the non-polar tails in the interior of the membrane. The only way these molecules can pass in and out of the cell is through channels created by protein molecules in the membrane. The proteins form a polar tunnel through which the molecules can pass.

8) Take a small piece of thread and tie it into a circle with the diameter of a dime. -
--Form another film in your membrane holder.
--Dip your thread circle in the soap solution and carefully stick it into the membrane.
--Pop the inside of the thread circle with a dry object. You now have a model of a transport protein in a cell membrane.

9) To demonstrate the fluidity of the membrane, stick your finger in the pore created by the thread circle and gently move it around the membrane.

- **Cell Division:** Cells divide when an organism is growing, when tissues need to be repaired, or when the surface area to volume ratio becomes too small (i.e. the cell grows too large).

10) Take a straw and dip the end in the soap solution. Hold it just above the surface of the soap solution and gently blow to create a bubble. Make a bubble about 8-10 cm across.

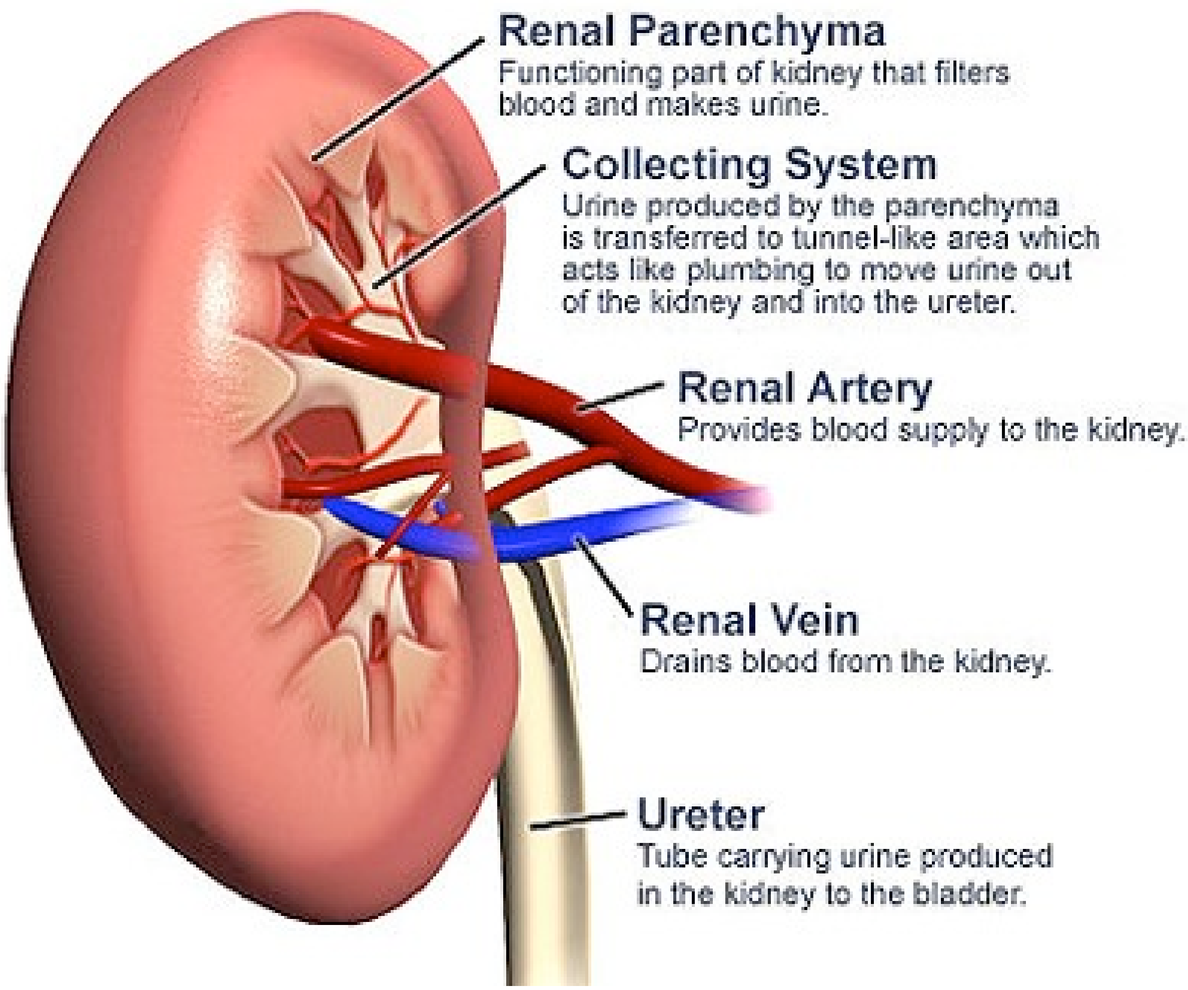
11) Take a knife, wet it with soap solution, and starting in the solution at one side of the bubble, cut the bubble in half. You have created a bilayer across the middle and made two bubbles. (Cell division is somewhat similar to this.)

12) Cut the two new bubbles in half. Keep dividing the bubbles until you have 10-80. Notice how the bubbles fit together without any spaces between them. Your cells fit together in much the same manner.

- **Cell Fusion:** There are circumstances in a cell where two membranes fuse into a single larger structure. Researches even fuse two cells together in a laboratory to create a larger cell with properties of each. (e.g. They can fuse an antibody-making cell with a cancer cell to get cells that keep multiplying and making antibodies.)

13) Use a straw to create a few bubbles in your soap solution. Coax the bubbles toward each other and try to get them to fuse into a single big bubble.

Basic diagram of kidney functioning
http://louisville.edu/medschool/nephrology/about



APPENDIX 3b

WebMD

Rehydration Drinks

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Diarrhea and vomiting can cause your body to lose large amounts of water, nutrients, and essential minerals called electrolytes. This happens faster and is more serious in babies, young children, and older adults.

Rehydration drinks and sports drinks replace fluids and electrolytes. Plain water doesn't provide necessary nutrients or electrolytes and may not be absorbed with diarrhea. **Note**: Rehydration drinks, such as Pedialyte, are designed for children. Adult rehydration drinks and sports drinks should not be used for babies and young children.

Rehydration drinks don't make diarrhea or vomiting go away faster, but they can prevent serious dehydration from developing.

You can make an inexpensive rehydration drink at home. But **do not give this homemade drink to children younger than 12**.

Measure all ingredients precisely. Small variations can make the drink less effective or even harmful. Mix the following:

- 1 quart (950 mL) water
- ½ teaspoon (2.5 g) baking soda
- ½ teaspoon (2.5 g) table salt
- ¼ teaspoon (1.25 g) salt substitute (potassium-based), such as Lite Salt or Morton Salt Substitute
- 2 tablespoons (30 g) sugar

By	Healthwise Staff
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Last Revised	April 26, 2010

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Name ________________ Date ______________

Exploring Salt & Humans in Google Earth

1. Explore the Venezuela-Brazil border. Choose a site for your (pretend) Yanomami village and make a placemark there.
   What is the latitude and longitude?

   Explain below why you chose that site. What resources can you see that are available (water, forest, cities, etc)?

2. Use the map provided showing salt production to make placemarks for the three closest salt production sites to your Yanomami villiage. ***Use a different color for these placemarks.***

3. Find the Akita Prefecture, Japan. Make another placemark.
   What is the latitude and longitude?

4. Turn on the ***Photos*** layer in Google Earth. View some photos and make a prediction about what life is like in this Japanese prefecture. (A prefecture is similar to a county or state.)

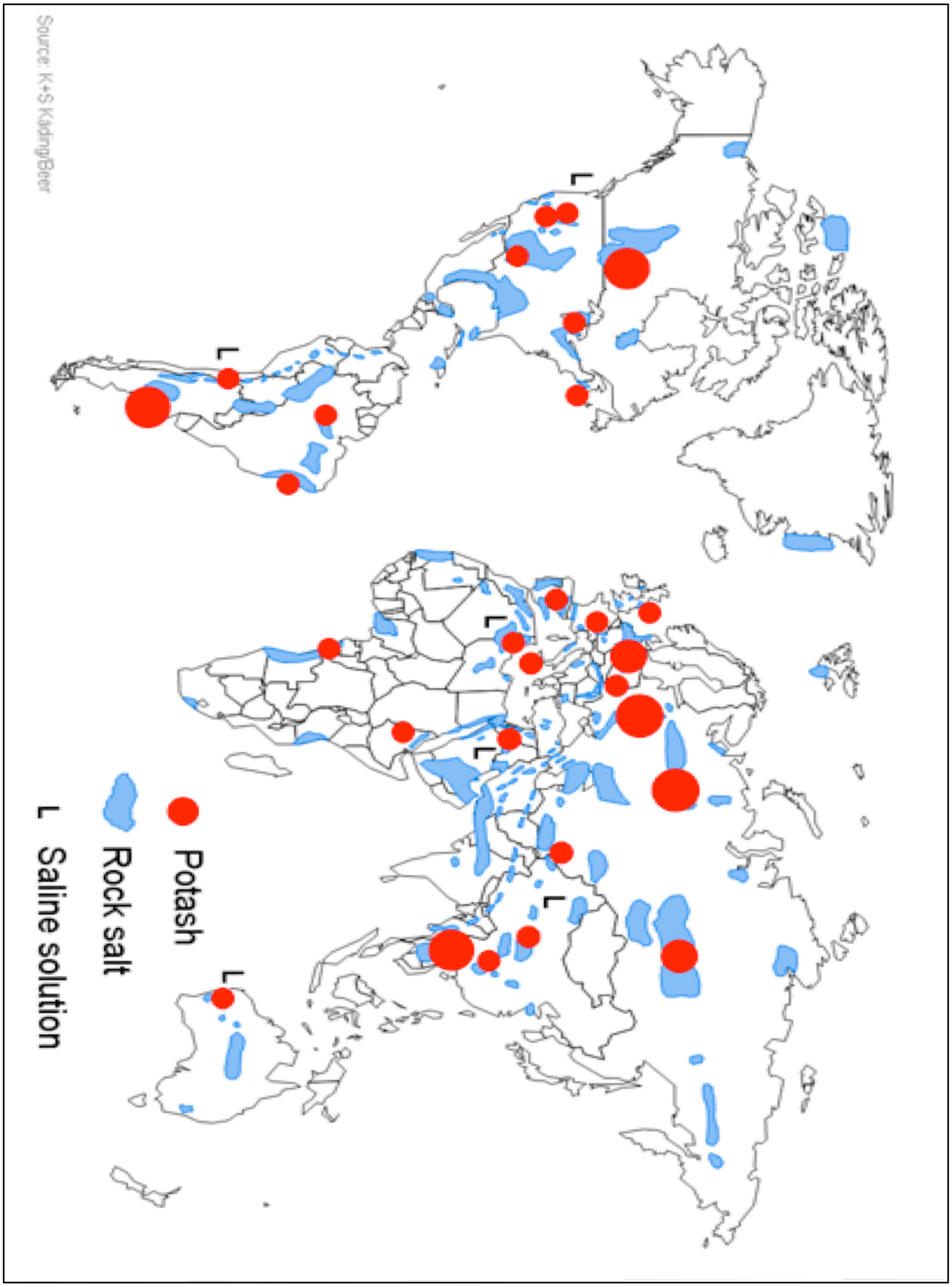
5. Make placemarks for the three closest salt production sites to the Akita Prefecture. ***Use the same color as your other salt placemarks.***

6. ***Predict*** which area (your Yanomami village or the Akita Prefecture) has some of the lowest salt consumption and which has some of the highest salt consumption in the world. Circle your answers below and also write your answers in the placemark descriptions.

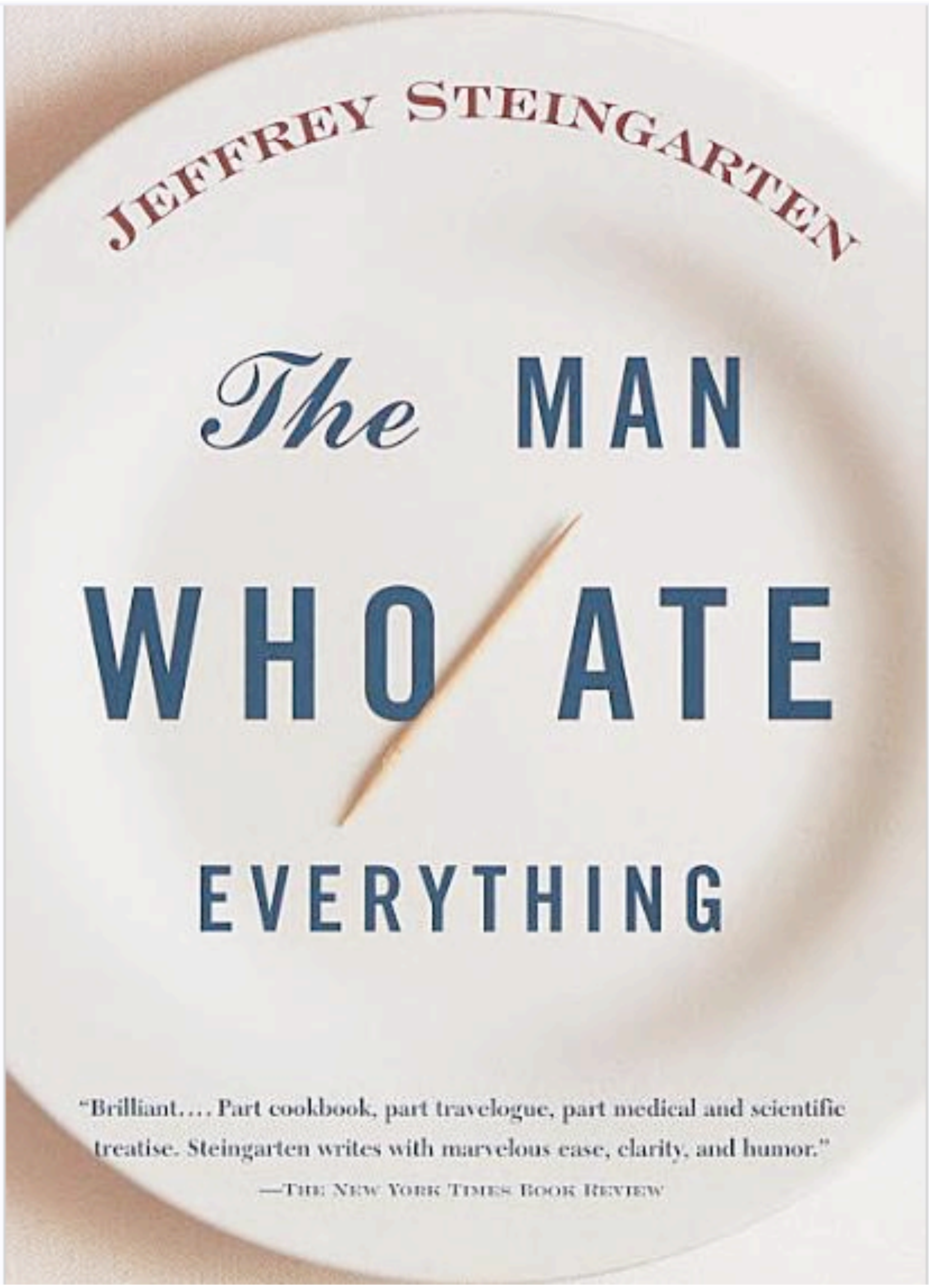
   The Yanomami have some of the (highest/lowest) rates of salt consumption in the world.

   People living in the Akita Prefecture of Japan have some of the (highest/lowest) rates of salt consumption in the world.

7. What other factors about where people live might influence how much salt they eat?


Potash
Rock salt
L Saline solution
Source: K+S Kading/Beer

APPENDIX 4b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"Brilliant.... Part cookbook, part travelogue, part medical and scientific treatise. Steingarten writes with marvelous ease, clarity, and humor."
—THE NEW YORK TIMES BOOK REVIEW

FIRST VINTAGE BOOKS EDITION, NOVEMBER 1998

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Salt

The Yanomamo Indians of northern Brazil have the most famous blood pressure in the world because it is the lowest. You can hardly read an article about blood pressure these days that doesn't drag in the Yanomamo Indians of northern Brazil. I am amazed that the Yanomami can stay so calm surrounded by giant bugs, snakes, and investigators forever taking their blood pressure, which at last report averaged an amazingly low 95 over 61. The average blood pressure in the United States is 120 over 80—halfway between the Yanomami and hypertension, which is another word for high blood pressure and starts at 140 over 90. A fifth of all Americans are hypertensive, but none of the Yanomami are. This is lucky for the Yanomami because high blood pressure multiplies your chances of having a heart attack, kidney disease, or a stroke.

The Yanomami eat incredibly tiny amounts of salt, and we eat lots of it, which has led some doctors to imagine that eating salt causes hypertension. The Yanomami consume about 87 milligrams of salt a day, which occurs naturally in their food and equals two shakes from a standard saltshaker. This minuscule amount, among the lowest in the world, is explained by the Yanomami's isolation from commerce, the briny sea, and mineral salt deposits. Americans eat 12,000 milligrams of salt a day, about 266 shakes, most of it added in cooking and processing.

(The weight of an average shake has, to my knowledge, never before been investigated. To compute it, I loaded my salt-shaker with 15 grams of salt, counted 330 shakes before it was empty, did it again for accuracy's sake, reached the same result, divided 330 shakes into 15 grams and arrived at 45 milligrams per shake.)

Does eating salt cause high blood pressure? Mankind has a great deal riding on this question, because—no matter what some people may tell you—salt is indispensable to good food and good cooking. It sharpens and defines the inherent flavors of foods and magnifies their natural aromas. Salt unites the diverse tastes in a dish, marries the sauce with the meat, and turns the pallid sweetness of vegetables into something complex and savory. Salt also deepens the color of most fruits and vegetables and keeps cauliflower white. Salt controls the ripening of cheese and improves its texture, strengthens the gluten in bread, and can preserve meat and fish, while transforming its texture. Cooked without salt, most dishes taste dull, lifeless, and lacking in complexity; in some, flavors are unbalanced and sweetness predominates, according to Michael Bauer in a terrific article on salt in the August 30, 1989, *San Francisco Chronicle,* reporting in part on a series of blind taste tests that he and Marion Cunningham had arranged. And in a recent issue of *Cook's* magazine, a vast majority of America's leading chefs lined up behind the culinary value of salt. As Robert Farrar Capon has put it, "To undersalt deliberately in the name of dietary chic is to omit from the music of cookery the indispensable bass line over which all tastes and smells form their harmonies."

There are thirty-five low-salt cookbooks on the market today. Most of them substitute heaps of herbs, spices, garlic, and onions for salt. When you try these recipes, the food tastes mainly of herbs, spices, garlic, and onions instead of what you wanted for dinner in the first place, like a nice plump four-pound chicken rubbed with a tablespoon of poultry fat and then a teaspoon of salt and roasted at 425 degrees for ninety minutes until the skin is golden and crackling and the juices run rich with flavor. Be sure to baste every ten minutes.

We are probably the first generation since the beginning of the world to be paranoid about salt. We would all die without salt. It is the only mineral we eat straight out of the ground. Salt was venerated in primitive cultures and exchanged as money where it was scarce. Our blood and our bodies are as salty as the seas from which life emerged, which may explain cannibalism in places where salt is in short supply. The earliest roads were built to transport salt, the earliest taxes were levied on it, military campaigns were launched to secure it, and African children were sold into slavery for it. Salt gave Venice its start in the sixth century as the commercial capital of Europe, caused the French Revolution, nearly defeated Mao Tse-tung, and helped Gandhi bring India to independence.

Because we need salt to live, we are genetically programmed to crave it starting four months after we are born. Salt phobics argue that since only a fifth of a gram of salt a day—200 milligrams, or a medium-large pinch—is absolutely essential to our survival, anything more than that must surely be excessive. This reasoning is absurd. How much music or poetry a day is essential for our survival? How much sex do we absolutely need to propagate the species? How much salt must we eat to survive, and how much do we need to have a very nice day? Every human society with easy access to salt eats forty times the minimum, and the reason is simple. Salt gives us pleasure by making food taste better. Then, after dinner, our bodies eliminate the salt we don't need. That is why God gave us kidneys.

Even lowering your intake to 500 milligrams of sodium a day, about 10 percent of the American average, would involve exquisite torture. First of all, you would have to eliminate all processed foods—canned, frozen, and packaged—which account for at least a third of the salt in our diet. Canned peas or a frozen side dish of rice can contain a hundred times the salt in raw peas and rice. A cup of fresh corn has only 7 milligrams of sodium, but a cup of canned creamed corn has 671, more than your allowance of sodium for an entire day; a serving of canned soup contains one full gram of sodium, two days' supply. An ounce of cornflakes contains as much salt as the same amount of salted peanuts.

Even after you eliminate processed foods and salt added in cooking or at the table, you will still be eating double or triple your 500-milligram sodium ration. That's because many foods are inherently salty, like dairy products (an ounce of cottage cheese is saltier than a bowl of thirty potato chips), breads, spinach, celery, Swiss chard, seafood, turnips, kale, and artichokes. If you want to eat a wide range of foods, you will have to leach out the salt and most of the taste from these vegetables by boiling them in distilled water. (In some places, tap water is too salty for a 500-milligram diet.) And meat is considerably saltier than vegetables.

If salt caused high blood pressure, the average American would be hypertensive, which is not the case. I eat all the salt I want, much more than the Yanomami do, and my blood pressure is slightly below normal. My wife's is even lower—not much different from the Yanomami—and she eats what I do because I do all the cooking. American vegetarians generally have lower blood pressure than American carnivores, yet both take in about the same amount of salt.

The Yanomami differ from Americans in many ways besides salt. They are very skinny, they drink absolutely no alcohol, they are geographically isolated and therefore genetically distinct, and they get lots of exercise under the lush leafy canopy of their Brazilian rain forest, where automobiles are extremely scarce. The Solomon Islanders used to be almost as popular among salt phobics as the Yanomami—until they were brought into the modern age and their blood pressure rose. But this was not attributable to salt. Obesity and lack of exercise were identified as the causes.

It was while contemplating the vacuous taste of an unsalted potato chip that I decided to read through the medical research

Dietary Reference Intakes : Electrolytes and Water

Nutrient	Function	Life Stage Group	AI	UL[a]	Selected Food Sources	Adverse Effects of Excessive Consumption	Special Considerations
Sodium	Maintains fluid volume outside of cells and thus normal cell function.		(g/d)	(g/d)	Processed foods to which sodium chloride (salt) /benzoate/phosphate have been added; salted meats, nuts, cold cuts; margarine; butter; salt added to foods in cooking or at the table. Salt is ~ 40% sodium by weight.	Hypertension; increased risk of cardiovascular disease and stroke.	The AI is set based on being able to obtain a nutritionally adequate diet for other nutrients and to meet the needs for sweat losses for individuals engaged in recommended levels of physical activity. Individuals engaged in activity at higher levels or in humid climates resulting in excessive sweat may need more than the AI. The UL applies to apparently healthy individuals without hypertension; it thus may be too high for individuals who already have hypertension or who are under the care of a health care professional.
		Infants					
		0–6 mo	0.12	ND[b]			
		7–12 mo	0.37	ND[b]			
		Children					
		1–3 y	1.0	1.5			
		4–8 y	1.2	1.9			
		Males					
		9–13 y	1.5	2.2			
		14–18 y	1.5	2.3			
		19–30 y	1.5	2.3			
		31–50 y	1.5	2.3			
		50–70 y	1.3	2.3			
		> 70 y	1.2	2.3			
		Females					
		9–13 y	1.5	2.2			
		14–18 y	1.5	2.3			
		19–30 y	1.5	2.3			
		31–50 y	1.5	2.3			
		50–70 y	1.3	2.3			
		> 70 y	1.2	2.3			
		Pregnancy					
		14–18 y	1.5	2.3			
		19–50 y	1.5	2.3			
		Lactation					
		14–18 y	1.5	2.3			
		19–50 y	1.5	2.3			

NOTE: The table is adapted from the DRI reports. See www.nap.edu. Adequate Intakes (AIs) may be used as a goal for individual intake. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover the needs of all individuals in the group, but lack of data prevent being able to specify with confidence the percentage of individuals covered by this intake; therefore, no Recommended Dietary Allowance (RDA) was set.

[a]UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for potassium, water, and inorganic sulfate. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

[b]ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCE: *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate.* This reports may be accessed via www.nap.edu.

Dietary Reference Intakes : Electrolytes and Water

Nutrient	Function	Life Stage Group	AI	UL[a]	Selected Food Sources	Adverse Effects of Excessive Consumption	Special Considerations
Chloride	With sodium, maintains fluid volume outside of cells and thus normal cell function.		(g/d)	(g/d)	See above; about 60% by weight of salt.	In concert with sodium, results in hypertension.	Chloride is lost usually with sodium in sweat, as well as in vomiting and diarrhea. The AI and UL are equi-molar in amount to sodium since most of sodium in diet comes as sodium chloride (salt).
		Infants					
		0–6 mo	0.18	ND[b]			
		7–12 mo	0.57	ND[b]			
		Children					
		1–3 y	1.5	2.3			
		4–8 y	1.9	2.9			
		Males					
		9–13 y	2.3	3.4			
		14–18 y	2.3	3.6			
		19–30 y	2.3	3.6			
		31–50 y	2.3	3.6			
		50–70 y	2.0	3.6			
		> 70 y	1.8	3.6			
		Females					
		9–13 y	2.3	3.4			
		14–18 y	2.3	3.6			
		19–30 y	2.3	3.6			
		31-–50 y	2.3	3.6			
		50–70 y	2.0	3.6			
		> 70 y	1.8	3.6			
		Pregnancy					
		14–18 y	2.3	3.6			
		19–50 y	2.3	3.6			
		Lactation					
		14–18 y	2.3	3.6			
		19–50 y	2.3	3.6			

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Dietary Reference Intakes : Electrolytes and Water

Nutrient	Function	Life Stage Group	AI	UL[a]	Selected Food Sources	Adverse Effects of Excessive Consumption	Special Considerations
Potassium	Maintains fluid volume inside/outside of cells and thus normal cell function; acts to blunt the rise of blood pressure in response to excess sodium intake, and decrease markers of bone turnover and recurrence of kidney stones.		(g/d)	No UL.	Fruits and vegetables; dried peas; dairy products; meats, and nuts.	None documented from food alone; however, potassium from supplements or salt substitutes can result in hyperkalemia and possibly sudden death if excess is consumed by individuals with chronic renal insufficiency (kidney disease) or diabetes.	Individuals taking drugs for cardiovascular disease such as ACE inhibitors, ARBs (Angiontensin Receptor Blockers), or potassium sparing diuretics should be careful to not consume supplements containing potassium and may need to consume less than the AI for potassium.
		Infants					
		0–6 mo	0.4				
		7–12 mo	0.7				
		Children					
		1–3 y	3.0				
		4–8 y	3.8				
		Males					
		9–13 y	4.5				
		14–18 y	4.7				
		19–30 y	4.7				
		31–50 y	4.7				
		50–70 y	4.7				
		> 70 y	4.7				
		Females					
		9–13 y	4.5				
		14–18 y	4.7				
		19–30 y	4.7				
		31–50 y	4.7				
		50–70 y	4.7				
		> 70 y	4.7				
		Pregnancy					
		14–18 y	4.7				
		19–50 y	4.7				
		Lactation					
		14–18 y	5.1				
		19–50 y	5.1				

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Dietary Reference Intakes : Electrolytes and Water

Nutrient	Function	Life Stage Group	AI	UL[a]	Selected Food Sources	Adverse Effects of Excessive Consumption	Special Considerations
Water	Maintains homeostasis in the body and allows for transport of nutrients to cells and removal and excretion of waste products of metabolism.	 Infants 0–6 mo 7–12 mo Children 1–3 y 4–8 y Males 9–13 y 14–18 y 19–30 y 31–50 y 50–70 y > 70 y Females 9–13 y 14–18 y 19–30 y 31–50 y 50–70 y > 70 y Pregnancy 14–18 y 19–50 y Lactation 14–18 y 19–50 y	(L/d) 0.7 0.8 1.3 1.7 2.4 3.3 3.7 3.7 3.7 3.7 2.1 2.3 2.7 2.7 2.7 2.7 3.0 3.0 3.8 3.8	No UL.	All beverages, including water, as well as moisture in foods (high moisture foods include watermelon, meats, soups, etc.).	No UL because normally functioning kidneys can handle more than 0.7 L (24 oz) of fluid per hour; symptoms of water intoxication include hyponatremia which can result in heart failure and rhabdomyolosis (skeletal muscle tissue injury) which can lead to kidney failure.	Recommended intakes for water are based on median intakes of generally healthy individuals who are adequately hydrated; individuals can be adequately hydrated at levels below as well as above the AIs provided. The AIs provided are for total water in temperate climates. All sources can contribute to total water needs: beverages (including tea, coffee, juices, sodas, and drinking water) and moisture found in foods. Moisture in food accounts for about 20% of total water intake. Thirst and consumption of beverages at meals are adequate to maintain hydration.

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American Heart Association.
Learn and Live

Test Your Sodium Smarts

You may be surprised to learn how much sodium is in many foods. Sodium, including sodium chloride or salt, can come from natural sources or be added to foods. High–sodium diets are linked to increased blood pressure and a higher risk for heart disease and stroke. The American Heart Association recommends that you aim to eat less than 1,500 mg of sodium per day.

When you buy prepared and packaged foods, you can read the amount of sodium in the product per serving, in milligrams (mg), by looking at the Nutrition Facts panel. Read the Nutrition Facts panel for the overall nutrition information including calorie, fat and sodium content before you make food choices. Select and prepare foods with little or no salt.

Test your sodium smarts by answering these 10 questions about which food products are higher in sodium — we'll calculate your score at the end. Most examples use the USDA National Nutrient Database for Standard Reference, which shows the average nutrient values of multiple commercially prepared food products of the same type. Sodium amounts can vary depending on the brand, which is why we are showing averages. We've chosen "regular" or "traditional" varieties of foods as examples to illustrate their high sodium content. When you shop, we recommend that you select sodium free, low–sodium, or reduced–sodium foods whenever they are available to reduce your sodium consumption.

Good luck!

Start Quiz

http://www.heart.org/HEARTORG/quizTemplate.jsp?pid=ahaweb.quiz.quizintro&quizId=100001

American Heart Association.
Learn and Live

Question 1

Which food has more sodium? Click on the item you believe has more sodium.

○ **1.)** Raisin bread (enriched)
1 large slice (32g)

○ **2.)** French or Vienna bread (including sourdough)
1 small slice (32g)

Check Answer

American Heart Association®
Learn and Live

Correct

Correct Answer is : **2.) 1 small slice of French bread has more sodium.**

No matter how you slice it, bread is one of the most common sources of sodium. Sodium is added to bread to help with the texture and rising action of the dough. The amount of sodium differs by bread type and can add up quickly when you eat more than one slice.

1.) Raisin bread (enriched)
1 large slice (32g) **Sodium 125 mg**

2.) French or Vienna bread (including sourdough)
1 small slice (32g) **Sodium 208 mg**

Source: USDA National Nutrient Database for Standard Reference, supplemented by published data from food packages if needed

Next Question

American Heart Association
Learn and Live

Question 2

Which food has more sodium? Click on the item you believe has more sodium.

○ **1.)** American cheese (pasteurized process, low-fat)
1 slice (21g)

○ **2.)** Swiss cheese (low-fat)
1 slice (28g)

Check Answer

American Heart Association. Learn and Live

Incorrect

Correct Answer is : **1.) 1 slice of American cheese has more sodium.**

American cheese is a highly processed cheese-like product. Highly processed foods tend to be high in sodium because food manufacturers use salt or other sodium-containing compounds to preserve food and to improve their taste and texture.

1.) American cheese (pasteurized process, low-fat)
1 slice (21g) **Sodium 300mg**

2.) Swiss cheese (low-fat)
1 slice (28g) **Sodium 73mg**

Source: USDA National Nutrient Database for Standard Reference, supplemented by published data from food packages if needed

Previous Page

Name ___________________ Date ________________

Low Sodium Taste Test

Food/Spice ____

Overall Taste Ranking 1 2 3 4 5 6

In comparison to a full-sodium option: Better Same Worse

Would you consider switching? Yes No

Food/Spice ____

Overall Taste Ranking 1 2 3 4 5 6

In comparison to a full-sodium option: Better Same Worse

Would you consider switching? Yes No

Food/Spice ____

Overall Taste Ranking 1 2 3 4 5 6

In comparison to a full-sodium option: Better Same Worse

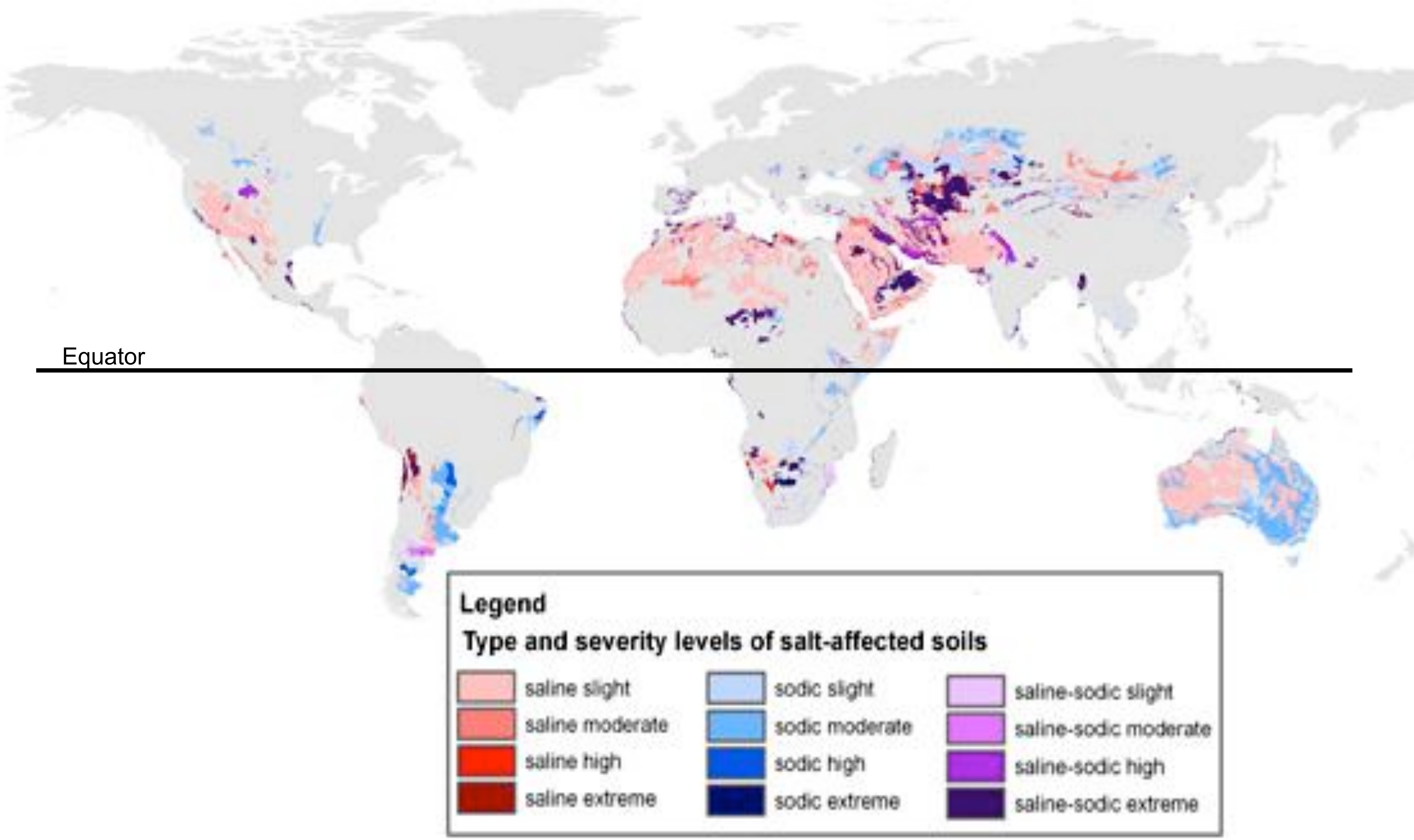
Would you consider switching? Yes No

Food/Spice ____

Overall Taste Ranking 1 2 3 4 5 6

In comparison to a full-sodium option: Better Same Worse

Would you consider switching? Yes No



Source: ClubGreen® http://www.clubgreen.nl/vraag/Biosaline-agroforestry-and-forestry-world.jpeg

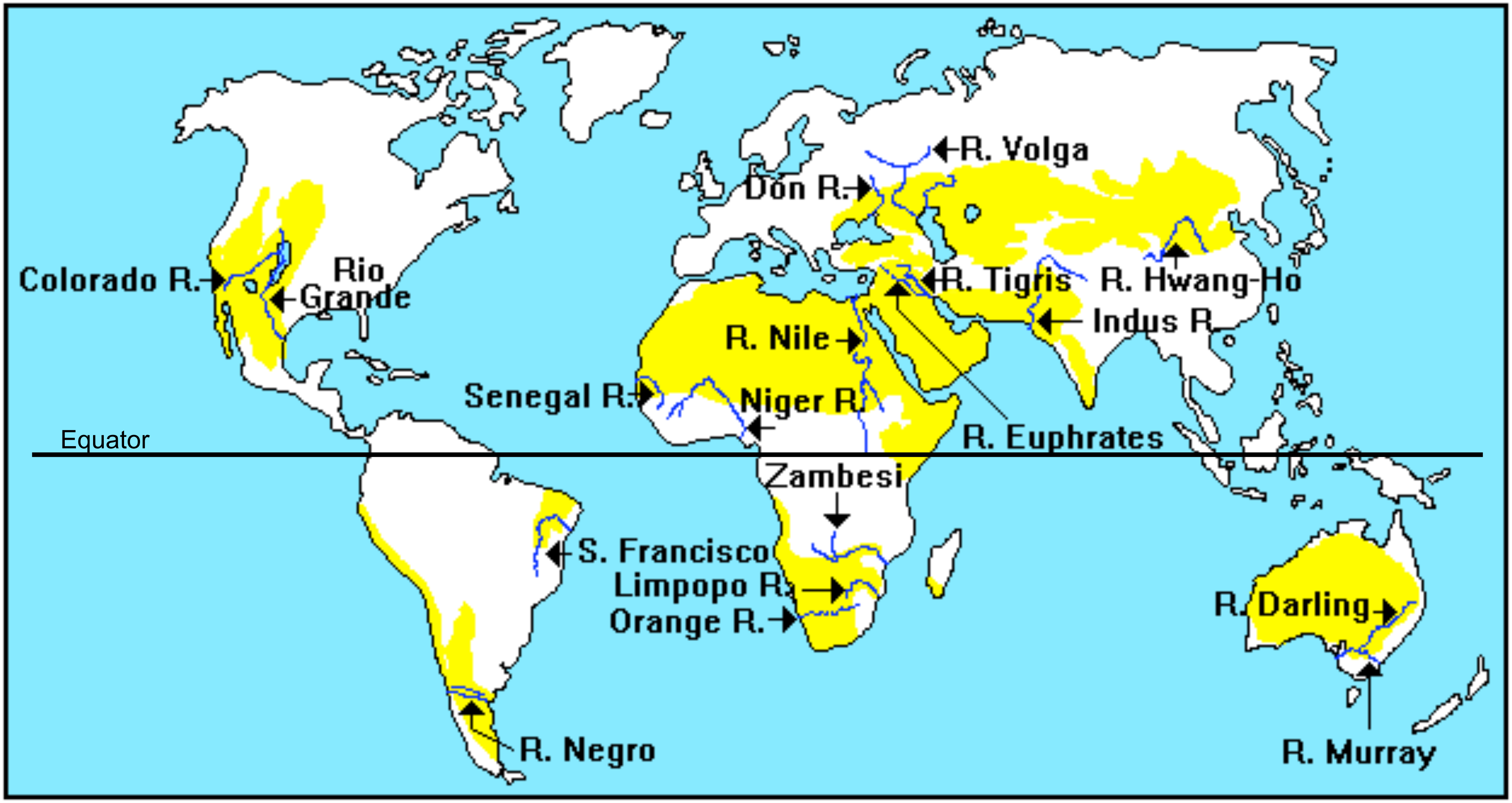
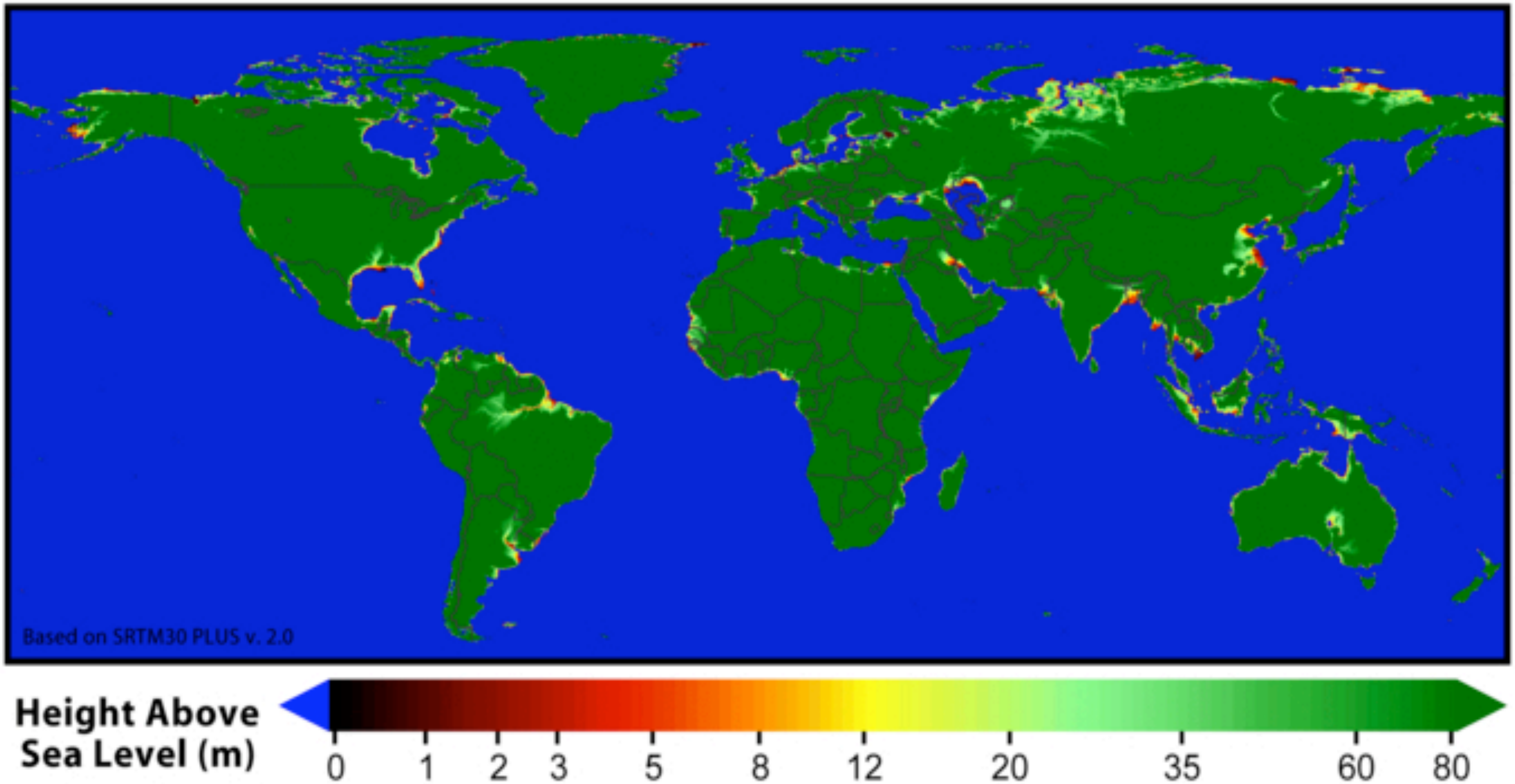


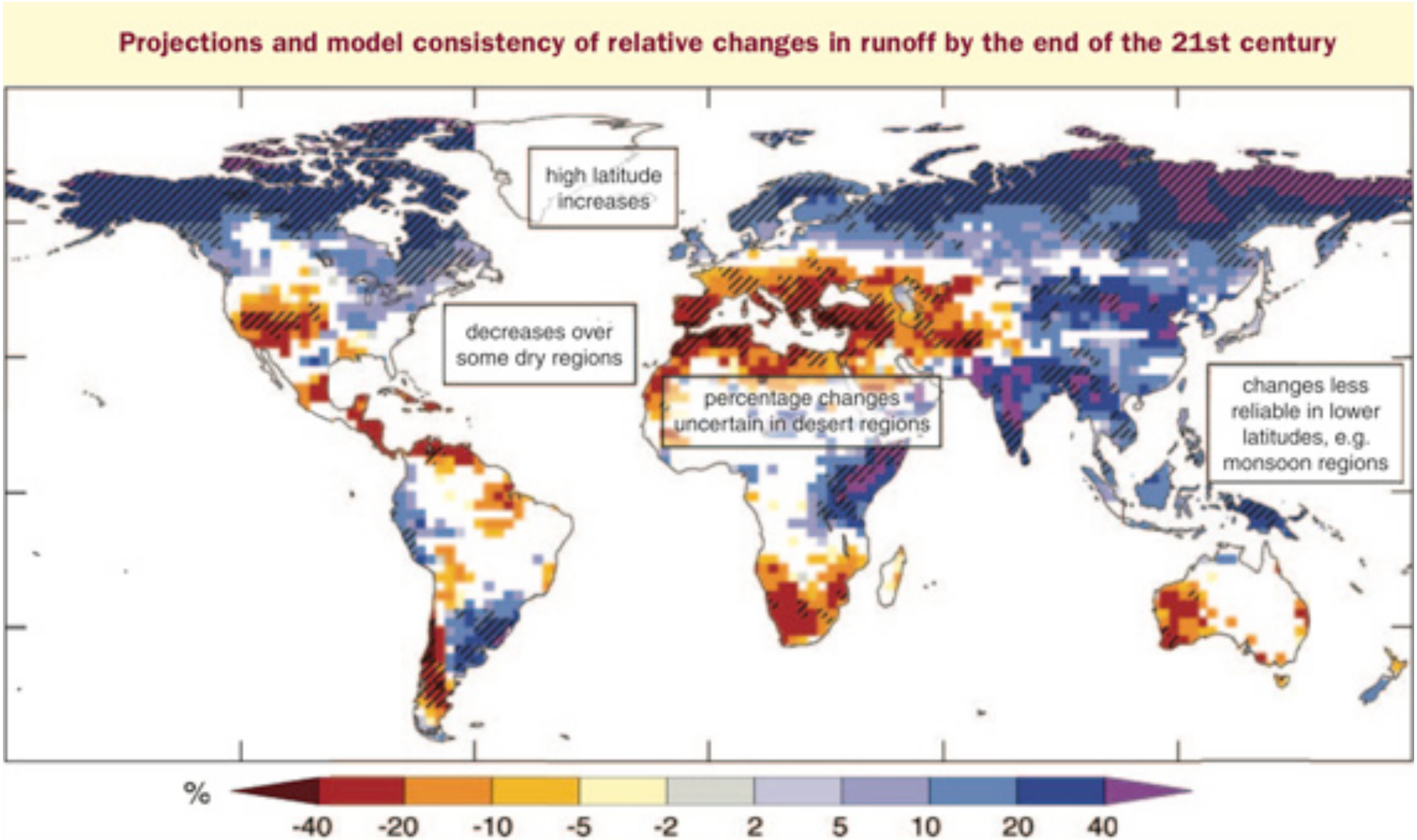
Figure 24 *Arid and semi - arid regions of the world [Ref.3]*
[Reproduced by permission]

Source: Food and Agriculture Organization of the United Nations http://www.fao.org/fishery/topic/13470/en

Regions Vulnerable to Sea Level Rise

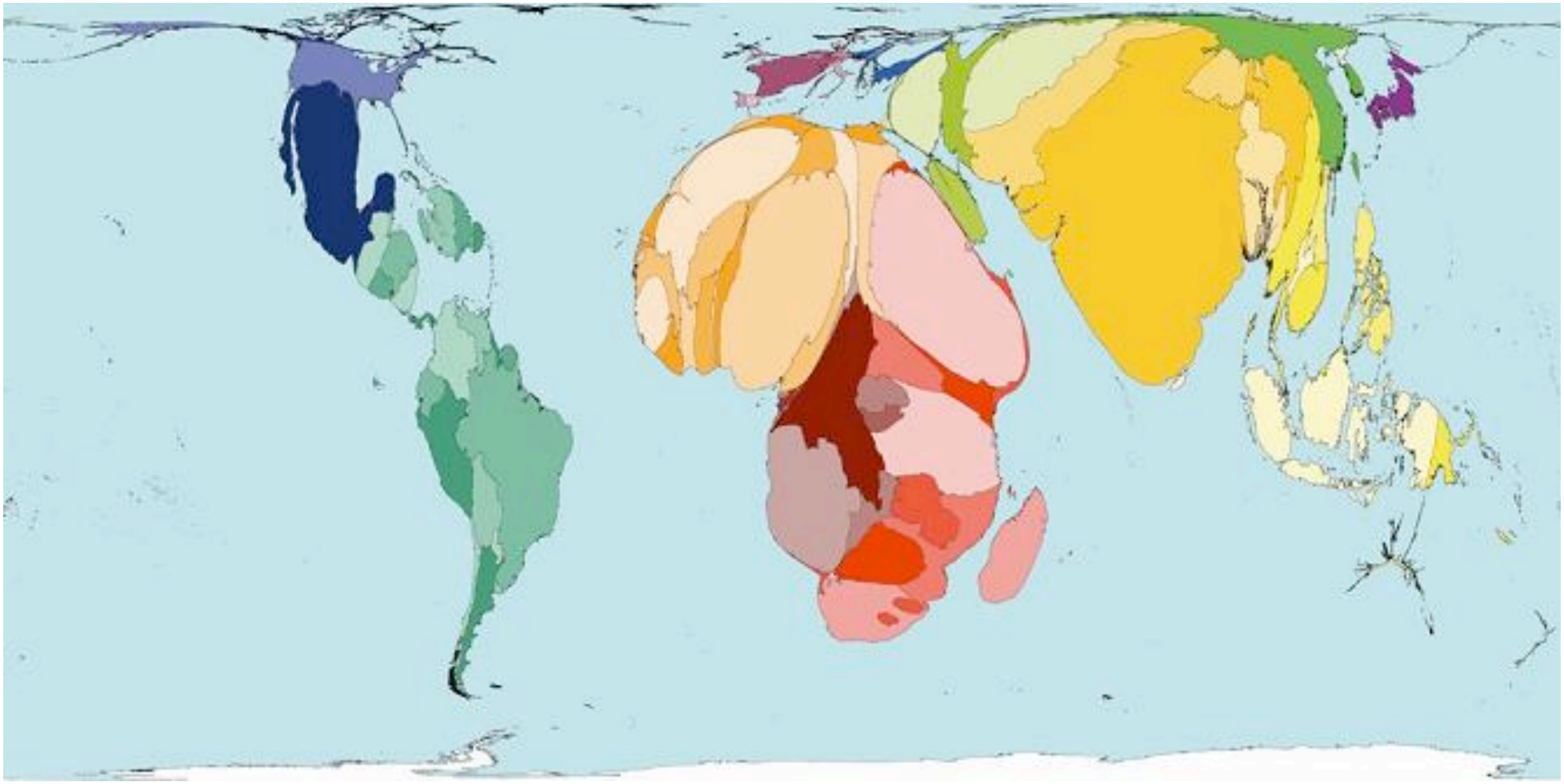


Source: Robert Rohde, Global Warming Art: Sea Level Rise Explorer http://www.globalwarmingart.com/wiki/Special:SeaLevel



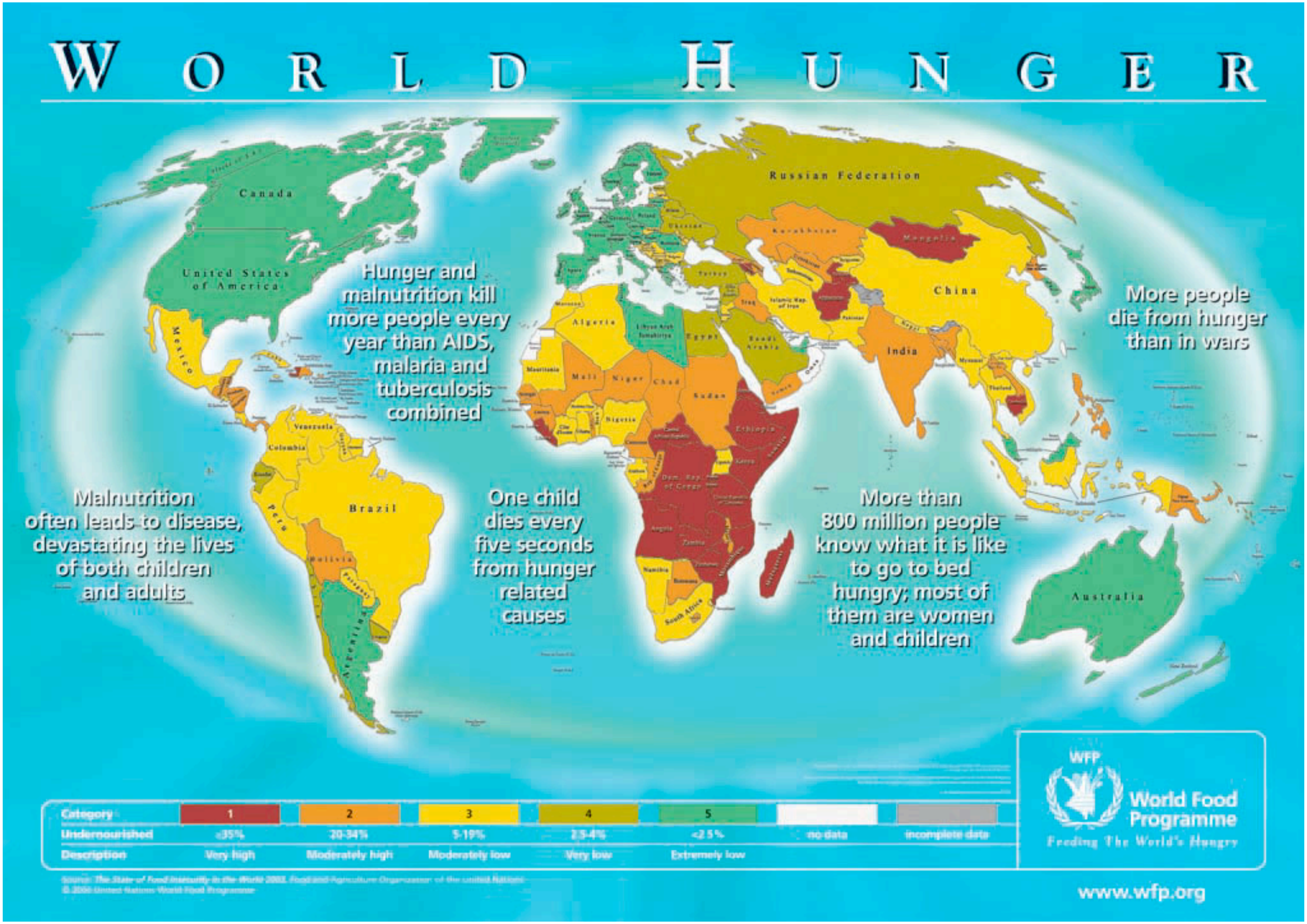
Source: IPCC, 2007

http://www.agci.org/classroom/hydrosphere/index.php



Deaths From Starvation

Source: Worldmapper http://www.worldmapper.org/display_extra.php?selected=412



WORLD HUNGER
Canada
United States of America
Mexico
Colombia
Venezuela
Brazil
Peru
Bolivia
Argentina
Russian Federation
Kazakhstan
Mongolia
China
India
Turkey
Iraq
Saudi Arabia
Algeria
Egypt
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
Angola
Zambia
Namibia
Botswana
South Africa
Madagascar
Mauritania
Australia
Hunger and malnutrition kill more people every year than AIDS, malaria and tuberculosis combined
More people die from hunger than in wars
Malnutrition often leads to disease, devastating the lives of both children and adults
One child dies every five seconds from hunger related causes
More than 800 million people know what it is like to go to bed hungry; most of them are women and children
Category
1
2
3
4
5
Undernourished
≥35%
20-34%
5-19%
2.5-4%
<2.5%
no data
incomplete data
Description
Very high
Moderately high
Moderately low
Very low
Extremely low
WFP
World Food Programme
Feeding The World's Hungry
www.wfp.org