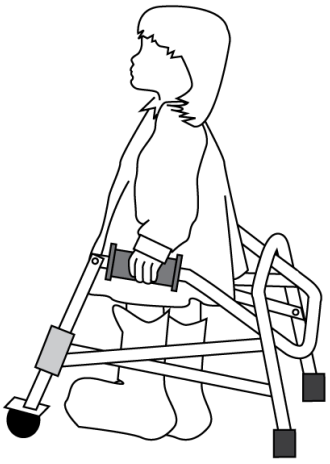
Birth Defects and Folic Acid

Part 1: Patient History



Anita Chavez, a 30-year-old woman, came to the free prenatal health clinic because she is expecting her second child. Anita already has a daughter who was born with a neural tube defect called spina bifida.

She did not realize that she was pregnant again until her third month of pregnancy. Once she found out she was pregnant, she started taking prenatal vitamins, and she stopped smoking and drinking. She also started being more careful to control her weight and diabetes.

Anita is worried that her next baby will also have spina bifida or a similar birth defect.

Use the information in the *Neural Tube Defects Fact Sheet* to answer the following questions.

1. List four risk factors that may increase Anita's risk of having a second child with a neural tube defect.
   - _____
   - _____
   - _____
   - _____

2. Do these risk factors mean that Anita's developing baby will definitely be born with a neural tube defect? Explain why or why not.

   _____

   _____

3. Are there actions that Anita could take during the remainder of her pregnancy to ensure that her developing baby will not develop spina bifida or anencephaly?

   _____

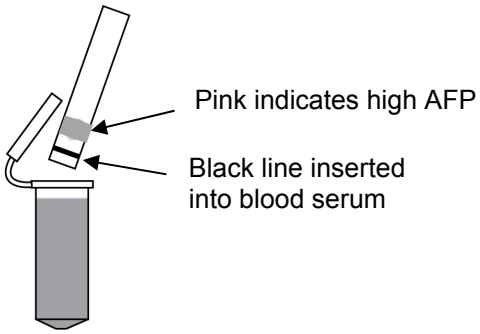
   _____

Part 2: Testing Anita's Blood—Alpha-Fetoprotein Test

Anita's doctor orders an alpha-fetoprotein (AFP) blood test. This test is done to check the level of AFP in a pregnant woman's blood. AFP is a substance made in the liver of an unborn baby. Normally, low levels of AFP can be found in the blood of a pregnant woman. A high level of AFP in the mother's blood means that her developing baby is more likely to have a birth defect.

However, if a high level of AFP is found, a neural tube defect is present only a small percentage of the time. The AFP test may give a false positive result. A false positive result means that the test may indicate that baby has a problem when it is in fact healthy. High levels of AFP can be caused by other factors — including if there is a miscalculation in fetal age or if the mother is carrying multiple fetuses (twins or more).

1. Follow the instructions below to test the level of alpha-fetoprotein (AFP) in **Anita's Blood Serum** (liquid part of blood).
   - Dip the end of the **AFP Fast-Test Strip** with the black line into Anita's blood serum as shown on the right. Be certain that at least half of the test strip is dipped into the serum.
   - If a pink line or dot appears on test strip, it indicates that there is a high level of AFP in the mother's blood plasma.



2. What conclusions can you draw from the results of the AFP test?

   _____

   _____

3. Can you be certain that Anita's developing baby will be born with a neural tube defect? _____ (yes or no)

   Explain your answer with two pieces of evidence.

   - _____
   - _____

Part 3: Further Testing—Ultrasound and Amniocentesis

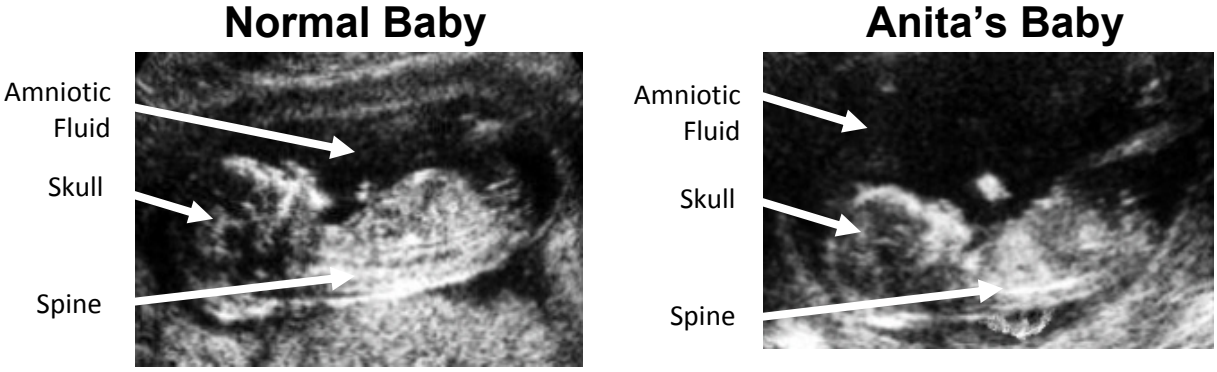
Anita's doctor explains that she should go for further testing that will provide more information about her baby's development. He schedules her for a sonogram and amniocentesis. He gives Anita an information sheet that explains the sonogram and amniocentesis procedures.

Use the information in the *Ultrasound: Sonogram* and *Amniocentesis* information sheet to answer the following questions.

1. Which procedure is safest for the mother and the developing baby—sonogram or amniocentesis? Explain why.

   _____

2. The sonograms shown below show a normal 13 week fetus and Anita's fetus. Find the area on the baby's sonogram that suggests that Anita's baby has a neural tube defect. Circle this area on the sonogram.



Source: http://www.baby2see.com/development/ultrasound_sonogram/first_trimester_scans.html

3. What is amniotic fluid?

   _____

4. To collect amniotic fluid, a needle is inserted through the mother's _____ and _____ and through the _____ that surrounds the fetus.

5. Explain how a doctor knows where to insert the needle so that it draws amniotic fluid from the proper location and does not damage the developing fetus?

   _____

   _____

6. Your lab kit contains a sample of **Amniotic Fluid** collected from the amnion that surrounds Anita's fetus. Follow these instructions to determine the level of alpha fetoprotein in the sample. Use the labeled droppers provided to:
   - Place 2 drops of amniotic fluid in the circle on the AFP Test Sheet.
   - Add 2 drops of AFP Indicator to the fluid in the circle on the AFP Test Sheet.
   - Use the color AFP Color Chart to determine the level of alpha fetoprotein in the sample.
   - Record the AFP level _____

7. An alpha fetoprotein level above 1.5 indicates an increased chance of having a neural tube defect. Do the results of this test indicate that Anita's fetus definitely has a neural tube defect? Explain your answer.

   _____

   _____

   _____

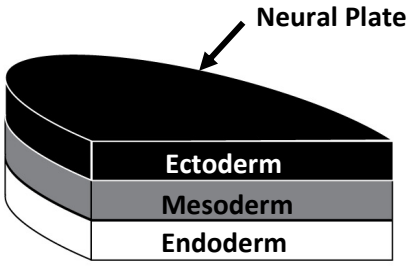
Part 4: What Happens During Development to Cause a Neural Tube Defect?

The exact cause of neural tube defects remains a mystery. No one knows what disrupts development of the nervous system to cause these birth defects. Scientists suspect genetic, nutritional, and environmental factors play a role.

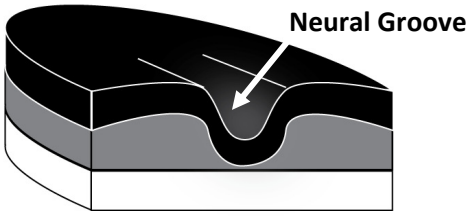
The human nervous system develops from embryonic tissue called ectoderm. Ectoderm gives rise to the skin, brain, spinal cord, and branching nerves.

Use the clay (ectoderm) in your kit and the diagrams below to model neural tube development.

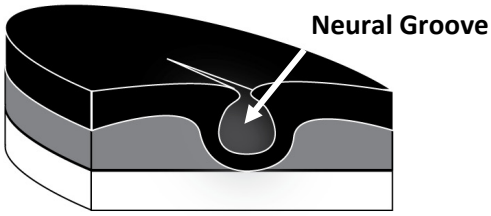
1. The first sign of the developing nervous system is the thickening of the ectoderm on the surface of the embryo to form a **neural plate** that can be seen at about the 16th day of development.
   - Use the clay (ectoderm) in your kit. Roll the clay into a ball and then press the clay to make a thin flat oval (like a pancake). This represents the **neural plate.**



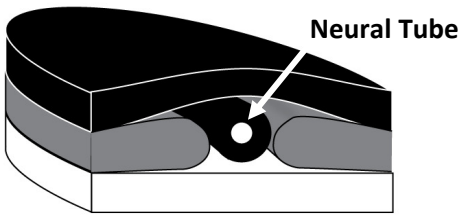
2. Over the next few days, a trench or dip forms in the neural plate. This creates a **neural groove**.
   - Make a trench or groove that runs down the middle of the neural plate—the neural groove.



3. By the 21st day of development, a **neural tube** begins to form when the edges of the neural groove meet in the middle to begin forming the spinal cord and brain.
   - Beginning in the middle of the neural groove, push the edges of the clay together to make a tube—the neural tube.

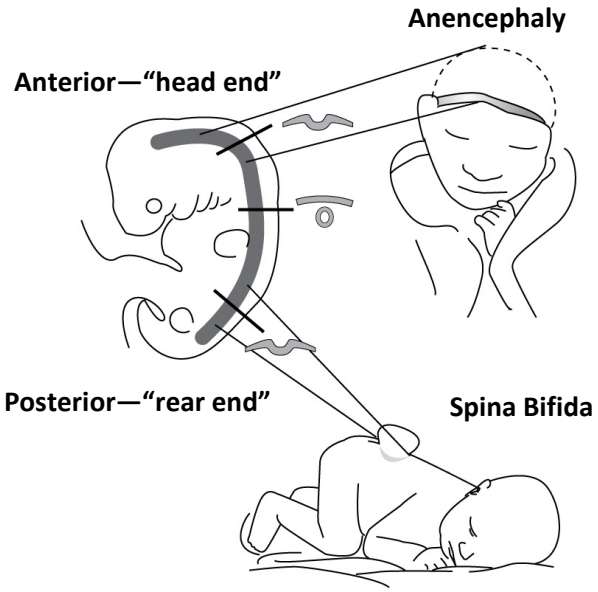


4. The closing of the neural tube is usually complete by the 28th day of pregnancy—before a woman is even aware that she is pregnant.
   - Continue to push the edges of the clay together to complete the closing of the tube—the neural tube.



The neural tube is the beginning of an embryo's central nervous system. It grows and develops to form the brain and spinal cord. The anterior (front) part of the neural tube enlarges and develops into the brain. The posterior (rear) part of the neural tube develops into the spinal cord.

Neural tube defects may occur if the neural tube does not close properly. Spina bifida (an abnormal spinal cord) results when the posterior part of the neural tube fails to close. Anencephaly (an abnormal brain) results when the anterior part of the neural tube fails to close properly.



5. How could you change your model to illustrate a neural tube defect that would lead to spina bifida?

   _____

   _____

   _____

6. How could you change your model to illustrate a neural tube defect that would lead to anencephaly?

   _____

   _____

   _____

IMPORTANT: Return the "Ectoderm" (clay) to the bag and seal the bag.

Part 5: A Difficult Decision

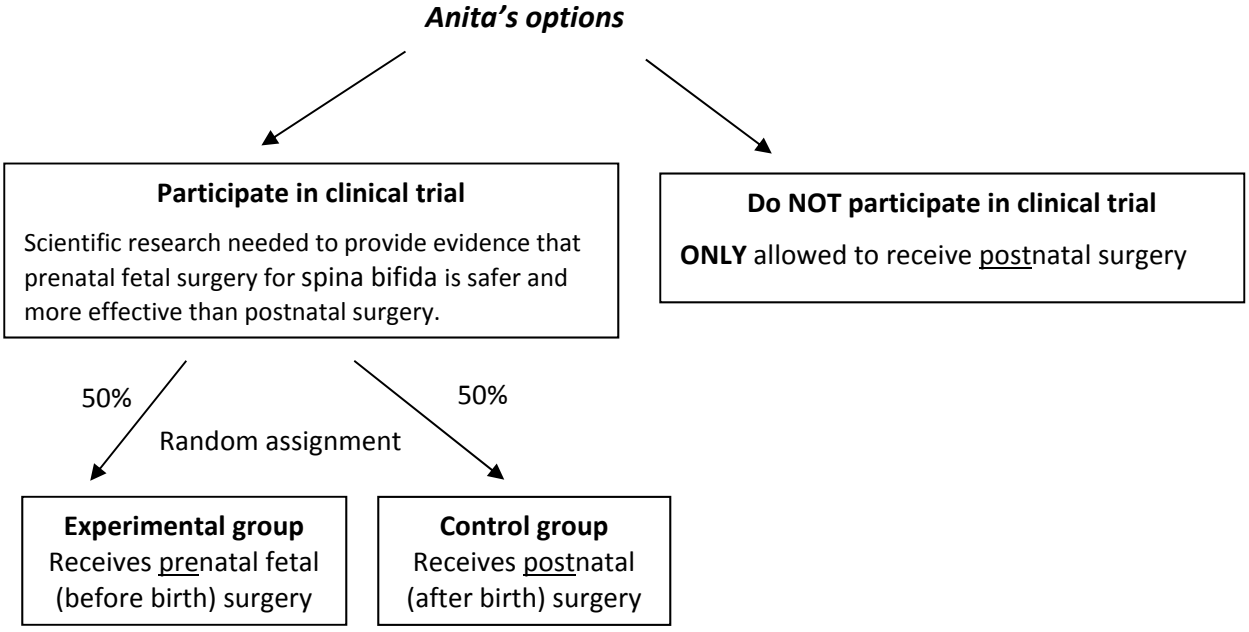
During Anita's fifth month of pregnancy, she has another sonogram. This sonogram reveals that her baby is a boy who has a severe type of spina bifida. With this type, a sac of fluid comes through an opening in the baby's back. Part of the spinal cord and nerves are in this sac and are damaged. This type of spina bifida causes moderate to severe problems such as difficulty going to the bathroom, loss of feeling in the legs or feet, and lack of mobility in the legs.

Anita's doctor explains that she needs to make a serious decision.

- She could have surgery performed on the baby immediately after is it born (postnatal surgery).

OR

- She could participate in a **clinical trial** (research study) that is being done to determine whether prenatal surgery (performed when the baby is still in the womb) for spina bifida is safer and more effective than postnatal surgery.



Anita really wants the prenatal surgery to close the hole in her baby's spine while he is in the womb. She had heard wonderful things about the prenatal surgery. She feels that the prenatal surgery will give her baby the best chance for a normal life. Anita agreed to participate in the clinical trial because she feels that a 50/50 chance of having the prenatal surgery is better than no chance of having the prenatal surgery.

1. Why do half of the children in the clinical trial receive postnatal (after birth) surgery?

   _____

   _____

   _____

2. Flip a coin (there is a penny in your kit) to see whether Anita is assigned to the control group (HEADS) or the experimental group (TAILS). To what group is Anita assigned—the control group or the experimental group? _____

3. Your lab kit contains two blue cards—Control Group and Experimental Group. ONLY open the blue card that corresponds with the results of your coin toss.
   - HEADS control group card
   - TAILS experimental group card

4. Read the information on the card. If you were Anita, how would you feel about being in this group?

   _____

   _____

   _____

Are you curious about what is on the other card? After you have answered question 4, you may open the other card if you wish.

5. Some patients, doctors, and scientists have expressed concerns about the ethical issues involved in the clinical trial that compared fetal surgery with postnatal surgery for spina bifida.

   - Describe at least one reason why it was important to conduct this clinical trial.

     _____

     _____

     _____

   - Describe at least one reason why people may feel that the design of this clinical trial raises ethical issues.

     _____

     _____

     _____

6. If you were a mother who was pregnant with a fetus who had a severe form of spina bifida, would you agree to participate in the clinical trial? Explain why or why not.

   _____

   _____

   _____

   _____

Part 6: Could neural tube defects be prevented?

Studies have shown that if all women who could become pregnant were to take a multivitamin with the B-vitamin folic acid, the risk of neural tube defects could be reduced by up to 70%. Folic acid is a water soluble B-vitamin that helps build healthy cells. Because it is water soluble, folic acid does not stay in the body for very long, so women need to take it every day to help reduce the risk of neural tube defects.

The U.S. Food and Drug Administration recommends that women of childbearing age (15-45) take 400 micrograms (mcg) of folic acid vitamin supplement daily, regardless whether they are planning a pregnancy or not. This is due to the fact that folic acid only works before women know they are pregnant. So if women wait to start folic acid until they know they are pregnant, it will likely be too late for the vitamin to offer protection from neural tube defects.

1. If Anita starts taking prenatal vitamins that contain folic acid after she knows she is pregnant, can this prevent neural tube defects? Explain your answer.

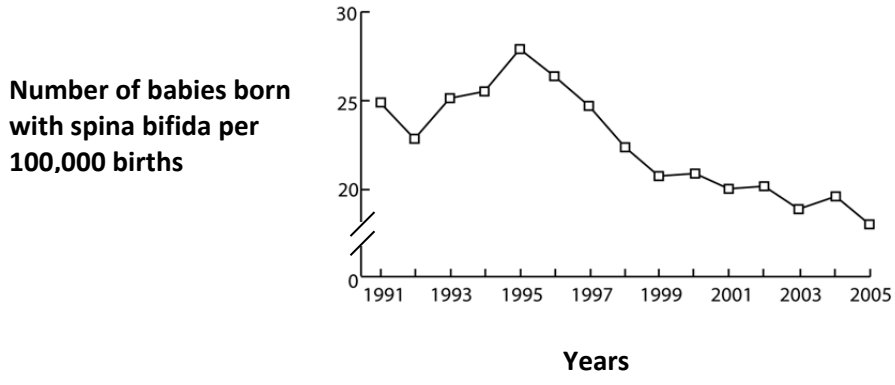
   _____

   _____

   _____

The U.S. Food and Drug Administration in 1996 authorized that all enriched cereal grain products be fortified with folic acid, with optional fortification beginning in March 1996 and mandatory fortification in January 1998. The data below shows the rates of spina bifida over the period of 1991 through 2005.

Spina Bifida Births in the United States, 1991-2005



2. Based on the information in graph (on the previous page), *Spina Bifida Births in the United States, 1991–2005,* what conclusions can you draw about the impact of fortification of cereal grains with folic acid on the incidence of spina bifida?

   _____

   _____

3. Based on the information in the table below, *Women's Awareness of Folic Acid,* what conclusions can you draw about the understandings that women have about the importance of increasing their folic acid intake BEFORE becoming pregnant?

   _____

   _____

Women's Awareness of Folic Acid

Women who:	Percentage
Heard about folic acid in 1995	52%
Heard about folic acid in 1998	68%
Are not currently pregnant who take a multivitamin containing folic acid	29%
Know folic acid helps prevent birth defects	13%
Know folic acid should be taken before and during pregnancy	7%

4. State two actions that could be taken to increase the number of women who take folic acid supplements BEFORE they know they are pregnant?

   - _____
   - _____

Part 7: Preventing other birth defects

There are many other types of birth defects. Some of these are inherited — caused by defective genes inherited from the parents. Others are a result of the environmental factors — exposure of an embryo or fetus to harmful substances or pathogens while they are in the uterus (womb). Others may be due to an interaction between genes and the environment. There are actions that a woman can take to reduce the risks of having a child with birth defects.

The exposure of an embryo or fetus to harmful substances or pathogens may have no effect, or they may cause major (obvious at birth) birth defects, or minor (subtle but noticed later in life) birth defects.

The chart below illustrates when developing organs may be affected by harmful substances or pathogens. The chart will help you think about the effects of the mother's lifestyle on embryonic and fetal development.

- **Black bars** represent times when harmful substances may cause major birth defects such as missing limbs (arms or legs), cleft palate, or deformed brain or spinal cord structure.
- **Gray bars** represent times when harmful substances may cause minor birth defects such as low birth weight, slow mental development, deafness, or visual problems.

First sign of possible pregnancy—a late period

	Embryonic Stage (in weeks)								Fetal Stage (in weeks)			
Organ	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**16**	**20-36**	**38**
Nervous System												
Heart												
Arms & Legs												
Eyes												
Teeth												
Ears												

1. An **embryo** is an unborn offspring in whom the major body organs are still forming. Once the major organs have formed, the unborn offspring is called a **fetus.** At the beginning of what week does an embryo become a fetus?

   _____

2. At which stage (the embryo stage or the fetus stage) is exposure to harmful substances, such as alcohol or drugs, most likely to cause major birth defects?

   _____

3. During which weeks might prenatal exposure to harmful substances lead to major birth defects that affect the nervous system?

   _____

4. During which weeks might prenatal exposure to harmful substances be most likely to cause minor structural or physiological (functional) defects that affect the nervous system?

   _____

5. Most women do not suspect they are pregnant until the end of week 3.

   - Why do doctors recommend that women who MAY become pregnant avoid X-rays, certain medications, drugs, alcohol, and other potentially harmful substances?

     _____

     _____

   - What parts of the developing baby may be harmed by exposure to harmful substances before the mother realizes she is pregnant?

     _____

Use the information in the *Preventing Birth Defects* brochure to answer the following questions.

6. Give four examples of chemicals or pathogens that can enter the fetus and cause birth defects.
   - _____
   - _____
   - _____
   - _____

7. Describe three examples of actions that could be taken during pregnancy to reduce the risks for birth defects caused by environmental factors.
   - _____
   - _____
   - _____

8. Describe three examples of actions that could be taken before pregnancy to reduce the risks for birth defects caused by environmental factors.
   - _____
   - _____
   - _____