What protects this developing baby?

This developing baby, only about four months old, floats in a liquid world, receiving all its oxygen and nutrients from its mother's body. The journey from a single cell to a fully developed human being is guided by genetic instructions, environmental influences, and the complex actions of hormones in both mother and baby.

Activate Prior Knowledge

Have students look at the photo of the tree frog embryos from Media Gallery. Remind them that many animals, as they develop, go through a period of metamorphosis. For example, frog eggs are deposited in water, and a tadpole spends its first weeks in water before developing into a frog that will live primarily on land. Ask, In what sense does a fetus go through a metamorphosis when it leaves the mother's womb? Answers should include that it goes from a protected enclosed aqueous environment to an open one, must breathe through its lungs, take in nutrients through its mouth, process its own wastes.

Preview Vocabulary

Greek and Latin Word Origins The words commonly used to describe stages of human development are infant, adolescent, and adult. The Latin origin for the word infant translates into "not able to speak." The words adolescent and adult come from the same Latin source, meaning "to grow up." However, adolescence is associated with sexual immaturity, whereas adults are sexually mature. The word puberty, also derived from a Latin wording meaning "adult," is the stage of adolescence in which an individual becomes physiologically capable of sexual reproduction.

Academic Vocabulary Tell students that the word mature has many applications. It derives from a root that means "timely, seasonable" and so is suggestive of something that has ripened or reached its development: a mature cheese a mature audience a mature bond

The word immature, meaning "not fully developed," takes on the added connotation of being silly or childish.

Introduce Remind students that with asexual reproduction, there is one organism involved and no special reproductive organs. With sexual reproduction, two organisms are involved whose bodies must have structures capable of producing gametes. Give students a few minutes to compare the biological cost and benefits of each type of reproduction.

Discuss Go over student lists and quantify the costs and benefits of each. It will probably be apparent from the lists that there are far greater costs to sexual reproduction in terms of energy, materials, and time, and primarily a single benefit, genetic diversity. Ask, What does this suggest about the value of genetic diversity? worth the cost

Answers

Pathogens are transmitted in many ways.
34.3 Fetal Development

Objectives
- Describe development following implantation.
- Explain how an embryo gets nourishment.
- Explain how the mother and fetus affect each other’s health.

Section Resources
Online Student Resources
Study Guide (English and Spanish)
PowerNotes
Reinforcement Worksheet
Section Self-Check
Interactive Reader

Online Teacher Resources
PowerPresentation
Teacher Toolkit

Activate Prior Knowledge
Remind students that cells with the potential to differentiate into any body cell are described as totipotent. Those that can form into any cell of a given tissue are pluripotent. Ask, What type of cells are shown in the photograph in the VISUAL VOCAB? totipotent
Ask, At what point do totipotent cells become pluripotent? upon implantation

Vocabulary
Greek and Latin Word Origins
The Greek word blastos means “bud.” The blastocyst is also sometimes referred to as a blastosphere. By comparison, the word embryo derives, in part, from the Greek word bruein, which means “full to bursting.”

Differentiated Instruction

Below Level
To assess students’ understanding, write five to ten statements about the main points of the section. Focus on the implantation of the blastocyst in the uterus, the embryonic membranes, and fetal development during each trimester. Have students determine if the statements are true or false before reading the section, and then again after.

Teacher Toolkit, Section C. Anticipation Guide
FIGURE 3.1

FIGURE 3.2 Membranes Protecting the Embryo

As the pregnancy continues, membranes form that nourish and protect the developing embryo, as shown in FIGURE 3.2. One membrane, the amnion, becomes filled with fluid and is called the amniotic sac (AM-nee-AHT-ihk). This sac cushions the embryo within the uterus and protects it from sudden temperature changes. The amniotic sac surrounds the embryo until birth. Another membrane, the chorion (KAWR-ee-AHNS), also begins to form. The chorion helps to nourish the embryo as it develops. The outer surface of the chorion has small projections called chorionic villi that extend into the uterine lining.

Together, the chorionic villi and the lining of the uterus form an important organ called the placenta. The placenta (pluh-SEHN-tuh) connects the mother and embryo to allow for the exchange of oxygen, nutrients, and wastes between them. Another structure, the umbilical cord, consists of two arteries and a vein that are twisted together. This cord connects the embryo inside the amniotic sac to the placenta. Nutrients and oxygen from the mother's blood diffuse into the chorionic villi, which contain blood from the embryo. The nutrients are carried to the embryo along the umbilical cord. In turn, wastes from the embryo are carried back along the umbilical cord to the chorionic villi. From there, the wastes diffuse into the mother's blood and are excreted in her urine.

The blood flows of the mother and the embryo move past each other but never mix. The placenta keeps the two flows separated. If proteins from the embryo leaked into the mother's circulatory system, they might be detected as foreign invaders by her immune system. The mother's immune system would then attack the proteins, which could end the pregnancy. The placenta provides a protective barrier for the embryo as it develops.

A Analyze How do the chorionic villi help to keep the baby's blood separate from the mother's blood?

B Apply Why might a pregnant woman need to be concerned about what she eats or drinks during pregnancy?

ENGLISH LEARNERS

Have pairs of students use Cornell notes to outline this section. In the right-hand column, students should make the section outline, following the blue and black heads and key points. In the left-hand column, students should list key terms—section vocabulary or other related words—and their definitions across from the part of the outline where the terms first appear. At the bottom, across both columns, students should add a short section summary.

Teacher Toolkit, Section C, Cornell Notes
Address Misconceptions

Common Misconception A missed flow phase means a woman is pregnant.

Correcting the Misconception Although pregnancy is the most common cause of a missed flow phase, the absence of menstruation or a menstrual period can have other causes, such as stress, medications, low body weight, excessive exercise, and health problems. An occasional missed period is not uncommon. Ask: How is it possible for someone to be pregnant if the period is not uncommon?

How is it possible for someone to be pregnant if the period is not uncommon?

- Ovulation occurs before a period. This stage covers weeks 1 to 8 when the zygote, embryo, and fetus describe different stages of development.

Vocabulary:
- Zygote—from the Greek word zygotos, meaning ‘yoked,’ or ‘joined,’ as when the sperm joins the egg and cell division begins.
- Embryo—from the Greek word embruon, meaning “to be full to bursting.” This stage covers weeks 1 to 8 when the entire body plan is developed.
- Fetus—from the Latin word fetus, meaning “offspring.” This stage covers weeks 9 to 36.

CONNECT TO TAKING NOTES
Use a timeline to help you take notes on early fetal development.

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-12</td>
<td>Egg zygote blastocyst fertilized forms implants; 3 layers form</td>
</tr>
</tbody>
</table>

Differentiated Instruction

BELOW LEVEL
Ask students to identify words in the text that are unfamiliar or that they do not remember. Have students use context clues to write their own definitions of these words. Then have students use a dictionary and the Glossary to make any necessary corrections or additions to their definitions. Possible unfamiliar words include determination, differentiation, potential, nutritional deficiencies, toxic, flexes, and prematurely.

Teacher Toolkit, Section D, New Word Analysis

PRE-AP
Have students use a T-chart to compare the hormone feedback loops of a menstrual cycle and pregnancy. To get students started, have them consider these questions:
- What hormones trigger the different phases of the menstrual cycle?
- What hormones maintain a pregnancy and stop the menstrual cycle?

Teacher Toolkit, Section C, T-Chart

Integrating Genetics

Until embryos are about two months old, their embryonic gonads are similar and can become testes or ovaries. A gene on the Y chromosome, called the SRY gene (for sex-determining region of the Y chromosome) triggers changes. In an embryo with an SRY gene, the embryonic gonads develop into testes. In an embryo without an SRY gene, the embryonic gonads develop into ovaries.

Answers

Infer: The fetus is undergoing cell determination and differentiation at this time; genetic errors and toxic chemicals can interfere with normal cell division and development.

Infer: Why might a fetus be more easily damaged by genetic errors or toxic chemicals during the first trimester than during any other trimester?

Main Idea

A zygote develops into a fully formed fetus in about 38 weeks.

Human pregnancies are divided into trimesters, or three periods of roughly three months each, as summarized in Figure 3.3. Throughout the nine months, several hormones help to maintain the pregnancy, including estrogen, progesterone, and human chorionic gonadotropin (goh-nad-uh-TROH-phin), which is produced by the placenta to help maintain progesterone levels. Thyroid hormones from the mother help to regulate the embryo’s development.

First Trimester

In the first trimester, embryonic stem cells undergo determination and differentiation to form the many specialized tissues and organs that will make up a human body. Recall that stem cells have the potential to become any one of the hundreds of different types of cells in the human body. The embryo can be more easily damaged during this trimester as the result of genetic errors or mutations, nutritional deficiencies in the mother, and any toxic chemicals, such as alcohol or drugs, that the mother may consume.

Even at this early stage, the complete body plan is already becoming visible. The heart begins beating at about five weeks. The early structures for the vertebrae and spinal cord have been formed. The brain is developing, many internal organs have appeared, and the arms and legs are evident. The embryo at nine weeks—now called a fetus—is only about 3 centimeters (about 1 in.) long, but is beginning to look like a small human being.

Second Trimester

The second trimester is a time of continuing development and increased physical activity. The heartbeat can now be heard by placing a stethoscope over the uterus. As the fetus flexes its muscles, the mother can feel movement within her uterus. During these three months, the uterus expands enough to make the mother’s pregnancy noticeable. As the fetus develops, the uterus continues to expand until it reaches four to five times its original size. At the end of the second trimester, the fetus may be only 30 centimeters (12 in.) long, but it looks more and more like a full-sized baby. Even its fingers and toes are fully formed, as shown in Figure 3.3.

Third Trimester

In the third trimester, the fetus grows to its largest size. At birth, most babies weigh about 3 to 4 kilograms (7 to 9 lb) and are about 50 centimeters (20 in.) long. Babies born prematurely at the beginning of the third trimester have a difficult time surviving. Their organs, especially their lungs, are often too immature to function well. Babies born prematurely toward the middle of the third trimester often survive and thrive. In the last month, the lungs are strengthened as the fetus sucks in and pushes out the amniotic fluid.
During each trimester, the fetus goes through different stages of growth and development.

First Trimester: Weeks 1–12
- Heart, brain, intestines, pancreas, kidneys, liver are forming.
- Heartbeat can be detected after week 5.
- Arms and legs begin to develop.
- Lenses of the eye appear; eyelids will later fuse shut to allow irises to develop.
- Individual fingers and toes begin to form.
- Hair, fingernails, and toenails develop.
- Cerebral hemispheres begin to form.
- Early structure of bronchi begin to develop.
- External sex organs show sex of the fetus.

Second Trimester: Weeks 13–27
- Most joints and bones have started to form.
- Skin is protected by fine hair and waxy substance.
- First movements are felt by mother.
- Wake and sleep cycles are more regular.
- Brain begins a stage of rapid growth.
- Eyes open and blink; eyebrows and eyelashes have formed.
- Fetus breathes in amniotic fluid, which strengthens lungs.
- Fetus swallows amniotic fluid and makes urine.

Third Trimester: Weeks 28–40
- Fetus responds more strongly to light and sound outside the uterus.
- Fetus has periods of dreaming: eyes are open when awake and closed when asleep.
- Fine body hair thins and scalp hair grows in.
- Bones are growing and hardening.
- Synapses between neurons form in huge numbers.
- Lungs complete development.
- Fetus turns to head-down position.

Study the pictures of the embryo and fetus. What are some of the structural changes that have taken place from week 8 to week 32?

Take It Further

A premature baby is born more than three weeks before the mother’s due date and has not had time to develop fully. With advances in technology, even fetuses that are 23 weeks along in their development and weigh only 1 pound have a chance of surviving. Underdeveloped lungs are the most common problem, but bleeding in the brain, retinal problems, and intestinal problems also are common. Babies born between 23 weeks and 26 weeks of development have the greatest risks of having serious medical problems if they survive. Ask, Why does every few days that a fetus stays in the uterus increase its chances of surviving and being healthy when it is born? A fetus develops so rapidly that even a few days can allow a fetus’s organs and systems to become more developed.

Critical Viewing

Sample Answers:
- Facial features—eyes, nose, mouth, ears—are defined by week 32: head hair is evident; arms, legs, hands, and feet are developed; body and head have reached the proportions of a newborn.

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