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SCIENCE

SECTION E

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Does the birth of the brain begin a life?

☐ The latest findings on fetal development are leading some scientists to that conclusion

By MARGIE PATLAK
Special writer, The Oregonian

As states all over the country reconsider the legality of abortion, a basic and vitally important question comes to mind: When does a human life begin?

Some religions contend that conception is the starting point, whereas most current abortion laws heed to when the fetus might survive if born prematurely — at the end of six months, the second trimester.

Fueled by the latest findings on fetal development, however, some scientists say "brain birth" in the fetus should mark the begining of a human life, just as "brain death" already is used to signal the end of a life.

"What we take ourselves to be as persons," said developmental biologist Michael Flower of Lewis and Clark College, "are capacities made possible by our brains." In a recent paper, "Neuromaturation and the moral status of human fetal life," Flower outlined the thresholds in brain development in the embryo and fetus and their implications for the abortion debate.

The first brain cells don't appear in a human embryo until close to the third week after conception, and studies indicate the thinking and sensing portions of the brain where awareness resides don't click on until after the 28th week.

"Prenatal life is full of changes, by nature, and any of those changes may be of moral significance," Flower said.

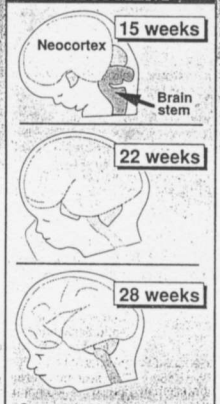
The human embryo wages a perilous journey that often ends before beginning its second week of life. Experts estimate that more than two-thirds of all human fertilized eggs never develop into newborns, often because of genetic defects that make life insupportable.

If an embryo weathers the odds and makes it to its seventh week, the first fully developed nerve cells, called neurons, can be found topping the spinal cord and forming what is known as the brain stem, according to Ronan O'Rahilly, director of the Carnegie Laboratories of Embryology at the University of California at Davis. This portion of the brain, once a person is born, regulates such vital functions as breathing, blood pressure and heartbeat.

The development of the brain stem is also probably responsible for most of the embryo's movements, which begin at about six weeks following conception, although most women can't feel any kicks and jabs until they are four months pregnant. These early twitters aren't done purposely by the embryo, however, and resemble the reflex kicks that people give when doctors tap them on the knee.

The fetus at the end of the first trimester does not have the developed upper portions of the brain that allow a person to intentionally move a part of their body, said Michael Bennett, neuroscience chairman at Albert Einstein Medical School in the Bronx.

BRAIN DEVELOPMENT



Some scientists believe "brain birth" should define when human life begins. The outer layer of the human brain, called the neocortex, is the center of consciousness and complex thinking and is what makes man unique from other animals. The first cells of the neocortex form about a month after conception, but studies indicate that the neocortex does not begin to function until after 28 weeks.

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Some ethicists say a human life begins when the brain stem is born, but Bennett counters that "the first appearance of a group of recognizable neurons or of reflexes doesn't make us human, because those are seen in lower animals."

What makes us distinctly human, according to Bennett and many other neuroscientists, is the outer layer of brain, which is called the neocortex. This critical portion of the brain is the seat of consciousness and complex thought. It enables a person to be aware and respond to his surroundings.

"The neocortex allows us to recognize one another, speak, and make plans," Flower said.

"Without our neocortex," Bennett said, "we wouldn't be much better than a reptile."

The first neocortical cells make

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Does the loss of essence end a life?

☐ The untraditional notion is that a person is dead who no longer has thoughts, memory, personality

By MARGIE PATLAK
Special writer, The Oregonian

A 1983 car accident propelled Missourian Nancy Cruzan, 25, into a state of limbo between life and death in what is known as PVS, for persistent vegetative state.

Seven years later, Cruzan has no awareness of herself and her surroundings and never will again, most neurologists say. Although she still has such reflex actions as breathing, coughing and opening her eyes in response to noise, Cruzan is unable to respond to anything.

PVS patients such as Cruzan may superficially resemble their former selves, but as neurologist David Levy of Cornell medical school said, "The person that everybody loved and cared for isn't there."

While the Supreme Court debates whether Cruzan and other patients permanently unconscious have a right to die, medical ethicists and neuroscientists are waging a far more unusual debate — whether the essence of these patients hasn't already died, leaving only their bodies behind. These people are proposing a new definition of death — one based on the notion "I think, therefore I am."

The recent crisis in defining death stems from advances in artificial life-support systems and resuscitation techniques. This modern technology can restore and maintain vital functions such as breathing and blood pressure in a person whose higher brain functions, such as awareness and thought, have been permanently lost.

"There are two different notions of what it means to be dead that are contesting each other now," said medical ethicist Daniel Wikler of the University of Wisconsin-Madison medical school.

"One is the traditional biological notion — to be dead is to not have the biological side of you functioning. The other is more of a psychological or mental notion — to be dead is to no longer have your thoughts and memories and personality."

"In the past," Wikler said, "we didn't have to choose between the two notions of death because when your body shut down, your mind did too and vice versa. That's often no longer the case."

The current brain-death standard, which was adopted by most states in 1981, requires that someone's whole brain be dead in order to classify them as no longer alive.

But awareness, thinking and basically the gist of a person's identity reside in only a one-quarter-inch thick outer portion of the brain called the neocortex. When the neocortex is sufficiently damaged, but the rest of the brain is intact, a person is left in a persistent vegetative state that can last for decades.

The cost of maintaining a patient in such a state is more than $100,000 a year, let alone the emo-

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Life: Neocortex development critical stage in fetal growth

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their debut about a month after conception, but three-quarters of the neocortex isn't formed until the fetus is close to 6 months old, according to Miguel Marin-Padilla, an expert on human fetal brain development at Dartmouth College.

Although the fetal neocortex has most of its necessary nuts and bolts at this time, the bulk of it won't be working for several weeks down the road. As Flower put it, "the phones are in place but there are no wires connecting them."

In order for the neocortex to function, its nerve cells must establish a chain of communication by sprouting interconnecting fibers. A few isolated connections between nerves in the neocortex and the muscles they control can be detected in a fetus as young as 15 weeks, and by 22 weeks the most primitive part of the cortex that governs movement of the fetus's limbs has matured to the point of being functional, according to Marin-Padilla.

At this point, however, there still isn't enough circuitry for intentional movements. "If I pinch a child that is born at 22 weeks after conception," Marin-Padilla said, "he's going to move his arm away because of his reflexes. He's not thinking 'he pinched me, therefore I'm going to move my arm away from him.'"

Starting at about 28 weeks, there is a burst of connections made between the neurons in all parts of the neocortex by cells appropriately called interneurons.

"The bulk of what we do with our brains," said Marin-Padilla, "are done by these interneurons. These little guys allow you to write, play tennis and carry out a variety of complex functions."

Studies on pre-term infants seem to support the notion that 28 weeks marks a dramatic turning point in the fetus's brain development.

Neurologist Dominic Purpura, now dean of the Albert Einstein College of Medicine, showed several years ago that babies delivered shortly after 28 weeks can see as well as newborns, unlike those delivered before that time. Sight is a sense made possible by the neocortex. This finding bolsters the claim that the neocortex doesn't function until after 28 weeks.

Neuroscientist Pasco Rakic of Yale University has also recently shown that delivering rhesus monkeys prematurely does not speed up the rate at which connections are made between neurons in the visual portion of the neocortex. "Birth is not a particularly important threshold as far as brain development," he said.

Further evidence that the neocortex doesn't get "turned on" until sometime after the 28th week comes from brain-wave recordings taken from premature infants and fetuses. At about 30 weeks these recordings of fetuses start to resemble those of a newborn baby. At this point distinctive wake and sleep patterns can be seen.

Although these studies indicate the human fetus's neocortex is functioning sometime in the vicinity of its 30th week in the womb, no one knows for certain when the fetus becomes aware of its surroundings and capable of an intentional response. But studies of fetal behavior suggest that shortly before birth the fetus rudimentarily knows what's happening.

Psychologist Anthony DeCasper of the University of North Carolina at Greensboro, for example, had women read aloud a portion of the Dr. Seuss tale "The Cat in the Hat" twice daily during their last six weeks of pregnancy. After birth, the sucking patterns of the infants revealed that they consistently preferred the Dr. Seuss tale to another story, unlike infants not read to prenatally who showed no preference.

Brain development continues after birth, and some neuroscientists speculate, throughout the entire life span. Because it is such a gradual process of improvement, some argue it's impossible to objectively draw the line and establish when a human life begins based on brain status. "It depends on how we define a person," said Rakic. "For drinking alcohol, we say someone is not a person until they are 18 years old."

But Flower argues that "after about 30 weeks the human fetus is sufficiently like us so that it would have a clear claim for us to leave it alone, try to save its life, etc."

Even he admits, however, that science can only provide facts for people to ponder but not a definite answer to when life begins.

"My sister is a fundamentalist Christian and disregards my scientific evidence because she's more concerned about the soul. My feminist friends say the scientific evidence is irrelevant because it's a matter of rights."

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Death: New tests improve diagnoses of brain damage

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tional costs wrought to the patient's family who cannot put the death of the person behind them.

Because of the uncertainty of a diagnosis, however, many patients' physicians and families are reluctant to consider these patients a lost cause and withdraw the feeding tubes that keep them alive.

"You can make a good argument that someone who is permanently unconscious meets a commonly accepted notion of what it means to be dead," Wikler said, "but that's not to say we know who these guys are."

Physicians currently have difficulty assessing the amount of neocortex damage a patient has as well as the loss of higher brain functions tied to that damage.

Standard imaging techniques only provide a general picture of the impairment and as neurologist Sheldon Berrol of the University of California, San Francisco, pointed out, "I've seen identical CT scans — one from a vegetative patient and one from a patient who is severely disabled but is doing very well and going to school."

A neurologist mainly relies on a number of clinical signs when assessing whether someone is persistently vegetative. But the accuracy of this diagnosis depends on time — the more time someone is in a persistent vegetative state, the more likely they'll remain in one.

Although after six months the chance of someone "waking up" from such a state is virtually nil, according to Levy, there is still the rare patient who does. Berrol said that each year he sees three or four patients who recover. But, he added, "there are very few miracles, just a lot of misdiagnosed cases."

A number of newer tests may improve the accuracy of a diagnosis, including measurements, in the fluid that bathes the brain, of enzymes released by destroyed neocortex cells. One type of scan scan also holds promise in revealing whether the neocortex is functioning in a brain-damaged individual, but the high cost of this technology may hamper its widespread use.

Speedier diagnosis of persistent vegetative state is also on the horizon for some patients.

Anesthesiologist Peter Safar, who is the director of the International Resuscitation Center at the University of Pittsburgh, is coordinating an immense international study aimed at finding those clinical signs that within days of a patient's cardiac arrest — brought on by drowning, heart attack, blood loss and a variety of other bodily insults — give a 100 percent accurate prognosis of persistent vegetative state.

Although this study should improve the PVS diagnosis of many brain-damaged individuals, the results won't apply to patients whose brains were directly injured by accidents or stroke.

No tests are 100 percent accurate in determining neocortical brain death, and few physicians are willing to classify someone as dead unless they can be absolutely certain.

However, as neurologist Oscar Reinmuth of the University of Pittsburgh said in a recent article in the journal Critical Care Medicine, "Using accuracy as the criteria, the best of all predictors is rigor mortis, but this is not useful therapeutically."

Wikler added that doctors often "pull the plugs" on patients well before they are dead because there's little chance that further therapy will help. Less certainty is needed to justify denying therapy, such as food and water, to patients in a persistent vegetative state, he said, than is needed to consider them dead.

After about six months of someone being in such a state, many ethicists and neurologists believe therapy can be stopped. If one adheres to a neocortical-based definition of death, the likelihood of such a long-term patient still being "alive" is slim.

But because such patients still breathe and have a heartbeat — the traditional signs of life — many people have difficulty accepting them as dead.

Wikler has introduced the concept of "living remains" to deal with this situation. "If someone dies and their heart is transplanted," he said in an article in Hastings Center Report, "the heart goes on living in someone else's body and is the living part of their remains. It's not stretching it too far to talk about your entire body — if you're in a PVS — being your living remains if we accept this mentalistic notion of what it is to be alive."

"If someone is whole-brain dead," continued Wikler, who was part of the president's commission that ushered in the current brain-death definition, "you turn off the respirator and within about 10 minutes they turn into a corpse in a traditional sense. In the case of a PVS person, you have to stop feeding them, and then it takes a week or so before they turn into a corpse. But the difference between these two cases is aesthetic rather than moral. In both cases you have a living, breathing body that you declare dead."