Brain already busy while in the womb

Nervous system circuitry appears to be buzzing with activity long before birth, according to studies using a variety of new techniques. This activity may shape development of the nervous system, as well as contribute to the behavior of the newborn, scientists reported last week in Anaheim, Calif., at a meeting of the Society for Neuroscience. They conclude that "some aspects of the mammalian central nervous system are more mature at birth than heretofore supposed."

Taste buds are among the earliest sense organs to appear in the fetus, says Charlotte M. Mistretta of the University of Michigan in Ann Arbor. She and colleagues perform experiments on an anesthetized sheep fetus delivered by cesarean section and still connected to its mother by the umbilical cord. The researchers have demonstrated that by the third trimester of pregnancy, fetal taste buds are responsive to chemicals in the amniotic fluid and that the characteristics of this response change substantially during subsequent fetal development.

Taste buds of a third-trimester sheep fetus respond to a variety of flavors, producing signals that are carried to the brain across at least one nerve-to-nerve synaptic connection, Mistretta reports. Early in the third trimester, the fetal taste buds react to ammonium chloride, but not to sodium chloride. Then they gradually increase their response to sodium — because, Mistretta suggests, they replace their receptor cells of one sensitivity with cells of another.

The olfactory system also appears to function before birth. An injection of an odorous substance into amniotic fluid can influence suckling behavior of newborn rats, reports Patricia E. Pedersen of Yale University.

Recent research has shown that three different components of the olfactory system come into play at different ages. Pedersen and Gordon M. Shepherd report that in rats just before birth the most active olfactory region in the brain is the area called the accessory olfactory bulb. There they see the greatest rate of energy use, which they measure by determining the uptake of laboratory-administered 2-deoxyglucose, an analog of a natural, energy-storing sugar. The accessory olfactory bulb receives information from a chemical-sensing organ called the vomeronasal organ, which opens into the nose and through which fluid is pumped. The vomeronasal organ in adult rats senses sexual scents.

Within hours of birth, the major olfactory activity has shifted to an area at the border between the accessory olfactory bulb and the main olfactory bulb (which receives signals from the nasal olfactory receptors). Finally, about six days after birth, the main olfactory bulb becomes the dominant region. These shifts reflect the dramatic change at birth from a liquid to a gaseous environment, Pedersen says.

In the darkness of the womb, the fetus cannot see. Nevertheless, even before the light-sensing parts of the photoreceptor cells develop, nerve cells of the visual system make connections, and these connections are functional, reports Carla J. Shatz of Stanford University. In the adult, nerve cell projections, called axons, coming from one eye contact brain cells in discrete layers of the structure called the lateral geniculate nucleus; and axons from the other eye contact the other layers. Shatz is examining how this pattern develops by studying slices of fetal brain tissue maintained in the laboratory.

Early in the third trimester of pregnancy, axons from the two eyes of a fetal cat share most of their brain territory, Shatz reports. The axons have many short side branches along their lengths, as well as a major arborization in the layer where they will eventually have their only contact. The side branches even make synapses in territories later inhabited solely by axons from the other eye, Shatz reports. She has demonstrated, using electrodes, that during this "intermixing period" both eyes can provide excitatory signals to the same cells. But the side branches gradually disappear as fetal and neonatal development progresses, until at adulthood each axon has only one major arborization and cells receive excitatory input from just one eye.

"What's new is our ability to get direct evidence of specific functional properties [of fetal nervous system structures]," Shepherd says. Shatz likens brain development to a building-block structure in which some blocks used in the construction are removed before the work is completed. "You can't recreate brain development," she says, "by looking only at the adult structure." *— J.A. Miller*

Space shuttle: Science despite problems

Many of the problems that affected last week's flight of the space shuttle Challenger had an impact on the most diverse of its scientific experiments, the SIR-B imaging radar system (SN: 9/22/84, p. 186). Difficulties with antennae — both SIR-B's and Challenger's own — and other factors resulted in the instrument's being able to image barely 40 percent of its originally planned targets, and to obtain, according to one official, only "15 percent of the data we had originally expected to get, in terms of number of bits." Yet the experiment, whose predecessor had made headlines when scientists found that it had apparently been able to "see" ancient riverbeds buried beneath the sands of the Sahara, was able to achieve a number of its goals.

A key item was to find out more about the potential of radar penetration of the surface. Receivers buried beneath the sands of Nevada, for example, were able to pick up clear transmissions from the radar system on at least three occasions. SIR-B researchers had thought that the sand penetration by their previous experiment (SIR-A) had been possible only because those images had been made over one of the driest regions on earth, the hyper-arid core of the Sahara in Egypt and Sudan. The Nevada sands, though dry, may have indicated that the technique works in a wider range of aridity, offering promise for expanded future studies.

SIR-B also was equipped with the ability to beam its radar groundward at varying "incidence angles," which the project's researchers have hoped would be useful in providing stereo imaging, as well as in establishing characteristic radar "signatures" for identifying different kinds of surface material. Stereo coverage was obtained at least three times over Mt. Shasta in California, and other types of crop-differentiation studies were conducted at several sites during the mission.

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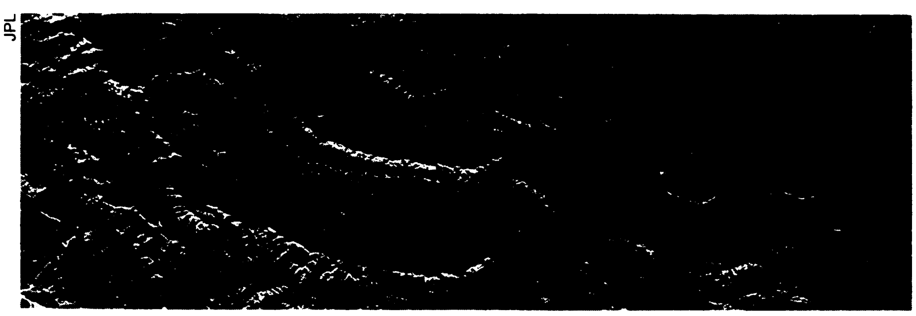

SIR-B radar image shows folded, layered rocks of the high plateau of northern Peru, crossed by the Maranon River, an Amazon tributary. Scene measures 14 by 42 km.

Learning about the capabilities of spaceborne radar usually requires extended studies on the ground to confirm what the radar images are showing, but experience with the new tool is already paying off. Diane Evans of Jet Propulsion Laboratory in Pasadena, Calif., discovered that she could confidently recognize geologic features in Peru's northern plateau, for example. "When I saw that image," she says, "I felt a whole lot better about the whole thing." *—J. Eberhart*