## Milestones in Pain Development

- **4 wks:** Basic structures of nervous system established.
- **4 wks:** Earliest neurons in the cortex are born.
- **7 wks:** Synapse formation begins in cortex.
- **8-10 wks:** Spinal circuitry for pain detection is established. *The fetus is capable of reacting to painful sensory input.*
- **8-10 wks:** Subcortico-frontal pathways established.
- **12-18 wks:** Spino-thalamic pathways established. *The fetus is capable of mature pain perception.*
- **22-24 wks:** Long-range cortical projections form.
- **25 years of age:** Cortical circuitry reaches a “mature” state.

## Neural Circuitry for Pain Perception is in Place by 18 Weeks

At this stage, circuitry for pain perception is complete.
20 weeks post fertilization

Pain circuitry in the thalamus is complete. Rarely, a fetus born at this age survives.

Courtesy of Dr. Colleen Mallory
Neonatology, Northwestern University

Consciousness in congenitally decorticate children: developmental vegetative state as self-fulfilling prophecy

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Analyzed and videotaped behavioral responses of alert patient to 4160 cortical stimulations.

The authors note, “Pain responses were scarce (1.4%).”

Conclusion: Even for adult humans, the cortex is largely not involved in conscious perception of pain. Pain perception is localized to the thalamus, and this circuitry is in place by 18 weeks post fertilization.

Pain Behaviors are seen in premature infants at 23 wks

Courtesy of Dr. Colleen Mallory
Hormonal response to pain

- Stress hormones are released with needle puncture for blood draw at 20 wks in-utero:
  - 590% rise in β-endorphin
  - 183% rise in cortisol
- Pain response is identical for a 20 wk fetus, a premature infant (20-35wks) and an adult.

Why fetal pain matters for our society and for us

- We are horrified by pictures of the infants brutally killed by convicted murderer, Kermit Gosnell.
- Yet we tolerate this same brutality (and worse) for humans at 20 weeks of development
“Providing anesthesia for fetal surgery is challenging for many reasons... there is little margin for error.”

Yet, the authors do not justify embarking on this difficult task for merely pragmatic reasons (like suppressing fetal movement). Rather, they justify use of anesthesia based on the fetus’ experience of pain.