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INSTITUTE

On Science  
Issue 3 | September 2021

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**15 Facts at 15 Weeks**

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This year, the Supreme Court agreed to hear the case *Dobbs v. Jackson Women's Health Organization*, which would allow Mississippi to limit abortions at 15 weeks. Medical advancements have long surpassed the viability definition of 28 weeks in *Roe*, and each advancement only moves us closer to life-saving treatments earlier and earlier in the life of the unborn.

But what exactly is a 15-week-gestation fetus like? We've put together 15 amazing facts about the 15-week-gestation fetus.

### Introduction

A unique human being forms at fertilization when a man's sperm combines with a woman's egg creating a zygote, a single-celled human embryo, with a unique set of genetic information that determines his or her physical traits. A new human being is called an embryo for the first eight weeks of life inside the womb and a fetus from nine weeks until birth. There is enough genetic variation that no two humans have been, or ever will be, genetically identical.<sup>1</sup> That single-cell zygote will become a 30 trillion cell adult.<sup>2</sup>

Importantly, the age of an unborn child can be calculated two different ways. Doctors usually date a pregnancy from the start of the mother's last menstrual period, called the gestational age. But pregnancy biologically starts at fertilization, which usually occurs about two weeks after the start of the mother's last menstrual period. So, if a doctor tells a woman that she is 15 weeks pregnant, then that means that the unborn child is only approximately 13 weeks old. Similarly, if a woman gives birth when she is 40 weeks pregnant, the baby has been growing inside her for about 38 weeks.

## 15 Amazing Facts about the 15-Week-Gestation Fetus

### 1) All of the major organs have formed.

Immediately upon fertilization, a human being has a unique set of genes encoded by his or her sequence of DNA packaged into 46 chromosomes. These genes determine the physical traits of the baby, such as eye color, hair texture, and gender. These genes also contain the blueprint that ensures that eyes develop on the front of the face, that bones

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<sup>1</sup> National Institutes of Health (US) and Biological Sciences Curriculum Study, *Understanding Human Genetic Variation, NIH Curriculum Supplement Series [Internet]* (National Institutes of Health (US), 2007), <https://www.ncbi.nlm.nih.gov/books/NBK20363/>.

<sup>2</sup> AC Guyton and JE Hall, *Textbook of Medical Physiology.*, 10th ed. (Philadelphia: W.B. Saunders, 2000).

develop inside the body, and that ears connect to the brain so that people can perceive the sounds they hear. Every system in the body forms according to a pattern of genes.

During an individual's first three weeks of life, this pattern of genes forms the body's structure. The single cell starts dividing, and each proceeding cell continues dividing, about once every eight hours or so.<sup>3</sup> Thus, the embryo grows at an exponential rate! During the first week, the embryo travels to the uterus and embeds into the uterine wall in a multi-day process called implantation. Amazingly, even before implantation, the embryo releases chemicals forming a biochemical connection with his mother<sup>4</sup>. Tissues interact to form the placenta and umbilical cord, which are nature's greatest life support system for the developing human.

In the third week, chemical gradients formed by the mother's body and the embryo itself help the embryo develop a body plan. While during the first week, each embryonic cell could become any of the 4,500 different types of cells in a human body, now each cell starts to specialize based on its position<sup>5</sup>. Some cells receive chemical messages to become skin and nerve cells while others receive messages to become part of the lungs or intestines. Each of these cells continues to specialize based on the other cells around them, and every piece of the intricate body plan falls into place. In fact, almost every organ and tissue forms within the first eight weeks after conception. The rest of the pregnancy is spent growing these organs larger and more mature to prepare for life outside the womb.<sup>6</sup>

By 15 weeks of pregnancy, every major organ has grown and most are functional. The kidneys filter toxins out of the fetal bloodstream and the stomach and pancreas produce digestive enzymes.<sup>7</sup> Peristalsis, the contractions in the intestines that propel food through the digestive system, starts eight weeks after conception and does not stop until death.<sup>8</sup> Similarly, the heart moves blood through the embryo and fetus, which started just 22 days after conception with the first heartbeat and will not stop until death.<sup>9</sup> Nerves have connected to skin and muscle so that the embryo can move away from things that touch him starting five-and-a-half weeks after conception.<sup>10</sup> The major system that develops latest is the lungs. While the lobes of the lung and the airways are in place at 15 weeks'

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<sup>3</sup> Sadler, Thomas W., *Medical*, 14th ed., 2019.

<sup>4</sup> Elisa Giacomini et al., "Secretome of in Vitro Cultured Human Embryos Contains Extracellular Vesicles That Are Uptaken by the Maternal Side," *Scientific Reports* 7, no. 1 (July 12, 2017): 5210, <https://doi.org/10.1038/s41598-017-05549-w>.

<sup>5</sup> R O'Rahilly and F Mueller, *Human Embryology and Teratology*, 3rd ed. (Wiley-Liss, 2001).

<sup>6</sup> Sadler, Thomas W., *Medical*.

<sup>7</sup> Keith L Moore, TVN Persaud, and Mark G. Torchia, *The Developing Human, Clinically Oriented Embryology*, 10th ed. (Philadelphia: Elsevier, 2016).

<sup>8</sup> Richard J. Grand, John B. Watkins, and Frank M. Torti, "Development of the Human Gastrointestinal Tract: A Review," *Gastroenterology* 70, no. 5 (May 1, 1976): 790–810, [https://doi.org/10.1016/S0016-5085\(76\)80277-6](https://doi.org/10.1016/S0016-5085(76)80277-6).

<sup>9</sup> Moore, Persaud, and Torchia, *The Developing Human, Clinically Oriented Embryology*.

<sup>10</sup> Moore, Persaud, and Torchia.

gestation, the alveoli, where gases are exchanged with blood, need time to grow. Although the fetus practices breathing in the womb starting eight weeks after conception,<sup>11</sup> the baby's lungs still need more time to mature before the fetus is ready for life outside the womb.<sup>12</sup>

## **2) The heart pumps 26 quarts of blood per day.**

The unborn baby's circulatory system pumps about 26 quarts of blood per day at 15 weeks' gestation. For comparison, an adult heart pumps 6,000 quarts of blood each day.<sup>13</sup>

## **3) The heart has already beat approximately 15,800,000 times.<sup>14</sup>**

By 22 days after fertilization (about five weeks' gestation), the heart starts beating.<sup>15</sup> The heart beats about 54 million times between conception and birth.<sup>16</sup> The fetal heart rate is quite variable. It rises from 98 beats per minute at 6 weeks' gestation to 175 beats per minute at 9 weeks' gestation,<sup>17</sup> and often slows over the next several months.

## **4) Each finger moves separately.**

Starting at 10-and-a-half weeks' gestation, when something touches the fetus's hand, he starts to close his fingers.<sup>18</sup> Typically, the fetus moves all of his fingers together, except the thumb. Over the next few weeks, he starts to bend his fingers more deeply and move his thumb, as if he were grasping an object. By 15 weeks' gestation, the fetus moves each finger separately and spontaneously explores his environment with his fingers.<sup>19</sup> By

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<sup>11</sup> J. I. de Vries, G. H. Visser, and H. F. Prechtl, "The Emergence of Fetal Behaviour. II. Quantitative Aspects," *Early Human Development* 12, no. 2 (November 1985): 99–120, [https://doi.org/10.1016/0378-3782\(85\)90174-4](https://doi.org/10.1016/0378-3782(85)90174-4).

<sup>12</sup> Moore, Persaud, and Torchia, *The Developing Human, Clinically Oriented Embryology*.

<sup>13</sup> F. S. Molina et al., "Heart Stroke Volume and Cardiac Output by Four-Dimensional Ultrasound in Normal Fetuses," *Ultrasound in Obstetrics & Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology* 32, no. 2 (August 2008): 181–87, <https://doi.org/10.1002/uog.5374>.

<sup>14</sup> EHD: Appendix, "Appendix | Prenatal Overview," accessed April 3, 2020, [https://www.ehd.org/dev\\_article\\_appendix.php#fb16](https://www.ehd.org/dev_article_appendix.php#fb16).

<sup>15</sup> Sadler, Thomas W., *Medical*.

<sup>16</sup> EHD: Appendix, "Appendix | Prenatal Overview."

<sup>17</sup> N Tezuka et al., "Embryonic Heart Rates: Development in Early First Trimester and Clinical Evaluation," *Gynecologic and Obstetric Investigation* 32, no. 4 (1991): 210—212, <https://doi.org/10.1159/000293033>.

<sup>18</sup> Tryphena Humphrey, "Some Correlations between the Appearance of Human Fetal Reflexes and the Development of the Nervous System," in *Progress in Brain Research*, ed. Dominick P. Purpura and J. P. Schadé, vol. 4, Growth and Maturation of the Brain (Elsevier, 1964), 93–135, [https://doi.org/10.1016/S0079-6123\(08\)61273-X](https://doi.org/10.1016/S0079-6123(08)61273-X).

<sup>19</sup> Humphrey.

16 weeks, he will have a weak but effective grasp that will become so strong that by 27 weeks' gestation he will be able to support his own body weight momentarily by grasping!<sup>20</sup>

### **5) The fetus prefers sucking his left or right thumb.**

As early as 10 weeks' gestation, it is possible to determine whether the unborn child is left-handed or right-handed by studying ultrasounds. About 85% of fetuses prefer moving their right hand over their left hand, and about 85% of adults prefer their right hand, too.<sup>21</sup> When examining the same children over time, almost every fetus that preferred sucking his or her right thumb remained right-handed, but only a few of the fetuses that sucked their left thumbs in their mother's womb changed preference and were right-handed by the age of 10.<sup>22</sup>

When scientists studied fetal movements at 14 weeks' gestation, they found that the fetus has goal-directed movements toward her own eyes and mouth as well as the uterine wall. Furthermore, if the fetus has a twin, some of her movements will be directed towards the twin as well.<sup>23</sup> Additionally, the fetus moves more gently when reaching towards her twin's face.<sup>24</sup> Similarly, by 18 weeks' gestation, the fetus will reach for her eyes and mouth faster and with greater precision when she uses her dominant hand.<sup>25</sup>

### **6) The entire body responds to touch.**

By 15 weeks' gestation, the fetus responds to light touches all over the body except the buttocks and the inside of the thigh.<sup>26</sup> Mostly, the fetus moves away from the light touch, but when something touches the sole of foot, the palm of the hand, or the mouth region, it elicits different reflexes. When something touches the bottom of the foot, the fetus will curl his or her toes at 15 weeks' gestation,<sup>27</sup> just like the adult reflex. This is

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<sup>20</sup> Humphrey.

<sup>21</sup> Peter G Hepper, Glenda R McCartney, and E. Alyson Shannon, "Lateralised Behaviour in First Trimester Human Foetuses," *Neuropsychologia* 36, no. 6 (June 1, 1998): 531–34, [https://doi.org/10.1016/S0028-3932\(97\)00156-5](https://doi.org/10.1016/S0028-3932(97)00156-5).

<sup>22</sup> Peter G. Hepper, Deborah L. Wells, and Catherine Lynch, "Prenatal Thumb Sucking Is Related to Postnatal Handedness," *Neuropsychologia* 43, no. 3 (January 1, 2005): 313–15, <https://doi.org/10.1016/j.neuropsychologia.2004.08.009>.

<sup>23</sup> Umberto Castiello et al., "Wired to Be Social: The Ontogeny of Human Interaction," *PLOS ONE* 5, no. 10 (October 7, 2010): e13199, <https://doi.org/10.1371/journal.pone.0013199>.

<sup>24</sup> Castiello et al.

<sup>25</sup> Valentina Parma et al., "The Origin of Human Handedness and Its Role in Pre-Birth Motor Control," *Scientific Reports* 7, no. 1 (December 1, 2017): 16804, <https://doi.org/10.1038/s41598-017-16827-y>.

<sup>26</sup> Humphrey, "Some Correlations between the Appearance of Human Fetal Reflexes and the Development of the Nervous System."

<sup>27</sup> Humphrey.

particularly interesting because newborns have an opposite reflex where they fan their toes up and outward, called the Babinski reflex. Additionally, when something touches the palm of the fetus's hand, the fetus will bend his or her fingers as if to grasp the object. Amazingly, when something touches the fetus's mouth area, the fetus will turn his or her head towards the object as if to prepare for nursing.<sup>28</sup>

### **7) The fetus responds to taste.**

After the mother eats, flavors from her food seep into the amniotic fluid, with the flavors peaking about 45 minutes after she eats.<sup>29</sup> These flavors help train the fetus to enjoy food from the mother's food culture; however, the fetus also has some preferences of his or her own! For example, if the amniotic fluid tastes sweet because of an injection of saccharin, the fetus swallows more amniotic fluid.<sup>30</sup> If the amniotic fluid tastes bitter, the fetus swallows less amniotic fluid.<sup>31</sup>

A 15-week-gestation fetus has plenty of tastebuds on his or her tongue, and these have connected with the cranial nerves, allowing the fetus to experience multiple tastes from a young age.<sup>32</sup>

### **8) The brain creates neurons at a rate of 250,000 per minute.**

Throughout early development, the brain and nerves develop faster than almost any other body system. This is likely so that the brain can direct the other body systems. Structures such as the intestines, lungs, muscles, ears, and heart need nervous system connections to function. In the fifth gestational week, the neural tube, which will become the brain and spinal cord, forms and the embryo's head is one-third of his overall size.<sup>33</sup> After this, the brain forms pockets of cells and folds multiple times to pack in as many neurons as possible. In fact, from five weeks until 26 weeks or so, the brain's main job is to

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<sup>28</sup> Humphrey.

<sup>29</sup> Julie A. Mennella, Anthony Johnson, and Gary K. Beauchamp, "Garlic Ingestion by Pregnant Women Alters the Odor of Amniotic Fluid," *Chemical Senses* 20, no. 2 (April 1, 1995): 207–9, <https://doi.org/10.1093/chemse/20.2.207>.

<sup>30</sup> P. G. Hepper, "Unravelling Our Beginnings | The Psychologist," 2005, <https://thepsychologist.bps.org.uk/volume-18/edition-8/unravelling-our-beginnings>; A. W. Liley, "The Foetus as a Personality," *The Australian and New Zealand Journal of Psychiatry* 6, no. 2 (June 1972): 99–105, <https://doi.org/10.3109/00048677209159688>.

<sup>31</sup> Liley, "The Foetus as a Personality."

<sup>32</sup> M. Witt and K. Reutter, "Embryonic and Early Fetal Development of Human Taste Buds: A Transmission Electron Microscopical Study.," *The Anatomical Record* 246, no. 4 (December 1996): 507–23, [https://doi.org/10.1002/\(SICI\)1097-0185\(199612\)246:4<507::AID-AR10>3.0.CO;2-S](https://doi.org/10.1002/(SICI)1097-0185(199612)246:4<507::AID-AR10>3.0.CO;2-S).

<sup>33</sup> J. Laffont, "Embryology of the Brain," *Journal of Neuroradiology = Journal De Neuroradiologie* 9, no. 1 (March 1982): 5–14.

create more neurons -- and fast. For many weeks, including 15 weeks' gestation, the brain creates 250,000 neurons per minute.<sup>34</sup> Babies are born with more neurons than the average adult – about 100 billion neurons.<sup>35</sup> Each of these neurons is born in a special location where all the dividing cells stay, but each neuron must move or migrate to its final destination. Just as the location of a cell tells a cell what sequence of DNA to use and therefore what type of cell to become, the timing of a neuron's birth tells the neuron what sequence of DNA to use, what type of neuron to become, and what chemical signals will communicate when reaching the correct destination in the brain.<sup>36</sup> Thus, at 15 weeks' gestation, many neurons are born and moving in a brain that is “under construction.”

### **9) Brain connections formed at 15 weeks' gestation last into adulthood.**

Not only must a brain cell become the correct type of neuron or support cell and reach its correct destination, but it must also connect with other neurons or target cells, like muscles, in order to be useful. Neurons start forming connections, called synapses, very soon after they are born. By adulthood, the average neuron has 7,000 synaptic connections to other neurons,<sup>37</sup> resulting in 150,000 kilometers, or 93,000 miles, of nerve fibers.<sup>38</sup> Many of the synaptic connections that form last into adulthood.

Sensory information from the eyes, ears, mouth, and body travels via nerves to subcortical areas and a brain structure called the thalamus, the gateway to the cortex. The thalamus acts like a relay center, condensing some information, or reducing a signal, if for instance the person is asleep, before passing it on to the cerebral cortex. The cerebral cortex helps process emotions, decision-making, working memory and attention. Many abilities that make human beings unique and distinct from other animals are governed by the cerebral cortex.

Before the cerebral cortex forms, a thick plate of neurons form, called the subplate.<sup>39</sup> Neurons destined for the cerebral cortex first migrate into the subplate while they wait for

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<sup>34</sup> Silvia Budday, Paul Steinmann, and Ellen Kuhl, “Physical Biology of Human Brain Development,” *Frontiers in Cellular Neuroscience* 9 (2015): 257, <https://doi.org/10.3389/fncel.2015.00257>.

<sup>35</sup> Suzanaerculano-Houzel, “The Human Brain in Numbers: A Linearly Scaled-up Primate Brain,” *Frontiers in Human Neuroscience* 3 (2009): 31, <https://doi.org/10.3389/neuro.09.031.2009>.

<sup>36</sup> Budday, Steinmann, and Kuhl, “Physical Biology of Human Brain Development.”

<sup>37</sup> Herculano-Houzel, “The Human Brain in Numbers.”

<sup>38</sup> Bente Pakkenberg et al., “Aging and the Human Neocortex,” *Experimental Gerontology*, Proceedings of the 6th International Symposium on the Neurobiology and Neuroendocrinology of Aging, 38, no. 1 (January 1, 2003): 95–99, [https://doi.org/10.1016/S0531-5565\(02\)00151-1](https://doi.org/10.1016/S0531-5565(02)00151-1).

<sup>39</sup> Anna Hoerder-Suabedissen and Zoltán Molnár, “Development, Evolution and Pathology of Neocortical Subplate Neurons,” *Nature Reviews Neuroscience* 16, no. 3 (March 2015): 133–46, <https://doi.org/10.1038/nrn3915>.

the supporting cells in the cortex to mature. Then they migrate into their final positions. Eventually, the subplate fades away and becomes white matter.<sup>40</sup>

Scientists have found connections between the thalamus and the subplate as early as 12 weeks' gestational age.<sup>41</sup> Recent work has shown that connections between the auditory nerves, auditory region in the thalamus, and neurons in the subplate survive into adulthood.<sup>42</sup> Auditory information is organized by pitch in the ear, thalamus, and cortex. That organization pattern was also seen in the subplate, suggesting that preliminary high-level processing may happen long before the cortex is fully formed.<sup>43</sup>

### 10) The fetus can feel pain.

In order for the fetus to perceive pain, he or she must have functional pain receptors and nerve connection to the brain. Pain receptors develop in the skin between 10- and 17-weeks' gestational age.<sup>44</sup> The first sensory receptors in the skin form and connect to the spinal cord at six weeks' gestation, but these nerves are specific for touch information, not pain.<sup>45</sup> The neurotransmitters specific to pain processing, substance P and enkephalins, also appear early in development at 10-12 weeks' gestation and 12-14 weeks' gestation, respectively.<sup>46</sup> The spinal nerves needed to transmit touch and pain information to the thalamus have formed by 15 weeks' gestation.<sup>47</sup>

As mentioned earlier, the thalamus forms connections with the neurons that will migrate into the cerebral cortex as early as 12 weeks' gestation,<sup>48</sup> and the thalamus forms connections with the true cerebral cortex after 24 weeks' gestation.<sup>49</sup> While some scholars suggest that the cortex is absolutely necessary for the perception of pain, a growing body of research suggests that it is not. For example, one case study has shown that a 55-year-old

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<sup>40</sup> Stuart WG Derbyshire and John C Bockmann, "Reconsidering Fetal Pain," *Journal of Medical Ethics* 46, no. 1 (January 2020): 3–6, <https://doi.org/10.1136/medethics-2019-105701>.

<sup>41</sup> Ivica Kostović and Nataša Jovanov-Milošević, "The Development of Cerebral Connections during the First 20–45 Weeks' Gestation," *Seminars in Fetal and Neonatal Medicine*, Assessing Brain Function in the Perinatal Period, 11, no. 6 (December 1, 2006): 415–22, <https://doi.org/10.1016/j.siny.2006.07.001>.

<sup>42</sup> Jessica M. Wess et al., "Subplate Neurons Are the First Cortical Neurons to Respond to Sensory Stimuli," *Proceedings of the National Academy of Sciences* 114, no. 47 (November 21, 2017): 12602, <https://doi.org/10.1073/pnas.1710793114>.

<sup>43</sup> Derbyshire and Bockmann, "Reconsidering Fetal Pain."

<sup>44</sup> Carlo V. Bellieni, "Analgesia for Fetal Pain during Prenatal Surgery: 10 Years of Progress," *Pediatric Research*, September 24, 2020, 1–7, <https://doi.org/10.1038/s41390-020-01170-2>; Humphrey, "Some Correlations between the Appearance of Human Fetal Reflexes and the Development of the Nervous System."

<sup>45</sup> Bellieni, "Analgesia for Fetal Pain during Prenatal Surgery."

<sup>46</sup> Bellieni.

<sup>47</sup> Bellieni.

<sup>48</sup> Derbyshire and Bockmann, "Reconsidering Fetal Pain."

<sup>49</sup> Kostović and Jovanov-Milošević, "The Development of Cerebral Connections during the First 20–45 Weeks' Gestation."

patient experienced pain even when he had extensive damage in the cortical regions that process pain,<sup>50</sup> and children lacking a cortex often react to pain in ways similar to neurotypical children.<sup>51</sup>

While the cortex may not be fully developed, a number of brain structures that process pain activity including the brainstem, insula, and thalamus, are sufficiently mature to process pain at 15 weeks' gestation.<sup>52</sup> Sekulic and colleagues state: "Bearing in mind the dominant role of the reticular formation of the brain stem, which is marked by a wide divergence of afferent information, a sense of pain transmitted through it is diffuse and can dominate the overall perception of the fetus."<sup>53</sup> Furthermore, pain processing appears to develop before the mechanisms that moderate pain signals, so the fetus may experience a greater intensity of pain at 15 weeks' gestation than an older fetus or child.<sup>54</sup>

### **11) Females have most of the eggs that they will ever produce.**

While the embryo is still developing a full body system around seven weeks' gestation, some of the embryonic cells that have remained outside the body migrate into the developing ovary or testes. In females, these future egg cells start dividing immediately, until the female fetus has about 7 million eggs around 21 weeks' gestation.<sup>55</sup> Therefore, the 15-week-gestation fetus likely has millions of egg cells. Most of these cells die; at birth there are only 1 million eggs, and by puberty, only about 300,000 eggs remain. During a woman's reproductive lifetime, she will only ovulate 300 to 400 of these total eggs.<sup>56</sup>

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<sup>50</sup> Justin S. Feinstein et al., "Preserved Emotional Awareness of Pain in a Patient with Extensive Bilateral Damage to the Insula, Anterior Cingulate, and Amygdala," *Brain Structure and Function* 221, no. 3 (April 1, 2016): 1499–1511, <https://doi.org/10.1007/s00429-014-0986-3>.

<sup>51</sup> D. A. Shewmon, G. L. Holmes, and P. A. Byrne, "Consciousness in Congenitally Decorticate Children: Developmental Vegetative State as Self-Fulfilling Prophecy," *Developmental Medicine and Child Neurology* 41, no. 6 (June 1999): 364–74, <https://doi.org/10.1017/s0012162299000821>.

<sup>52</sup> Slobodan Sekulic et al., "Appearance of Fetal Pain Could Be Associated with Maturation of the Mesodiencephalic Structures," *Journal of Pain Research* 9 (2016): 1031, <https://doi.org/10.2147/JPR.S117959>.

<sup>53</sup> Sekulic et al.

<sup>54</sup> Sekulic et al.

<sup>55</sup> EHD: Prefertilization, "Prefertilization | Prenatal Overview," accessed June 30, 2020, [https://www.ehd.org/dev\\_article\\_intro.php](https://www.ehd.org/dev_article_intro.php).

<sup>56</sup> O'Rahilly and Mueller, *Human Embryology and Teratology*.; "Female Reproductive System: Structure & Function," Cleveland Clinic, accessed August 14, 2021, <https://my.clevelandclinic.org/health/articles/9118-female-reproductive-system>.

## 12) The fetus has practiced breathing for over six weeks.

Starting at 10 weeks gestational age, the fetus makes intermittent breathing motions. By 13 weeks' gestation, the fetus will make many breathing motions in a row, taking 2-3 seconds between each breath.<sup>57</sup> In the fifth month, the fetus's movements and breathing follows a daily cycle, called a circadian rhythm.<sup>58</sup> The fetus is especially active from 14-19 weeks' gestation. In fact, the longest period without general movements is usually no longer than 5-6 minutes.<sup>59</sup> Many of these movements are ones that will help the fetus with life outside the womb, including swallowing, sucking, and breathing.

Furthermore, fetal breathing movements increase about two hours after his mother eats<sup>61</sup>. By 30 weeks' gestation, the fetus breathes 30-40% of the day with respiration rates between 30 and 70 breaths per minute, and as the fetus gets closer to his due date, he breathes more and more often. Still, even late in the pregnancy, the fetus can stop breathing for up to 2 hours. This breathing practice only moves a small amount of fluid, and does not pull it deeper into the lungs than the trachea<sup>62</sup>. All of the fetus's oxygen comes from the placenta until birth.

## 13) Eye movements are easily seen in ultrasound recordings.

The first recorded eye movements come from the 12th week of gestation. When something touches the upper eyelid, the eyes roll downward and the muscles around the eye "squint".<sup>63</sup> Sporadic eye movements begin around 14 weeks' gestation,<sup>64</sup> and rapid eye movements, such as those seen during sleep, are first detected around 18 weeks'

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<sup>57</sup> de Vries, Visser, and Precht, "The Emergence of Fetal Behaviour. II. Quantitative Aspects."

<sup>58</sup> J. I. de Vries et al., "Diurnal and Other Variations in Fetal Movement and Heart Rate Patterns at 20-22 Weeks," *Early Human Development* 15, no. 6 (November 1987): 333-48, [https://doi.org/10.1016/0378-3782\(87\)90029-6](https://doi.org/10.1016/0378-3782(87)90029-6).

<sup>59</sup> de Vries, Visser, and Precht, "The Emergence of Fetal Behaviour. II. Quantitative Aspects."

<sup>60</sup> Renato Natale, Constance Nasello-Paterson, and Robert Turliuk, "Longitudinal Measurements of Fetal Breathing, Body Movements, Heart Rate, and Heart Rate Accelerations and Decelerations at 24 to 32 Weeks of Gestation," *American Journal of Obstetrics and Gynecology* 151, no. 2 (January 15, 1985): 256-63, [https://doi.org/10.1016/0002-9378\(85\)90022-5](https://doi.org/10.1016/0002-9378(85)90022-5).

<sup>61</sup> de Vries et al.

<sup>62</sup> Maria Victoria Fraga and Susan Guttentag, "Chapter 42 - Lung Development: Embryology, Growth, Maturation, and Developmental Biology," in *Avery's Diseases of the Newborn (Ninth Edition)*, ed. Gleason Christine A. and Sherin U. Devaskar (Philadelphia: W.B. Saunders, 2012), 571-83, <https://doi.org/10.1016/B978-1-4377-0134-0.10042-3>.

<sup>63</sup> Humphrey, "Some Correlations between the Appearance of Human Fetal Reflexes and the Development of the Nervous System."

<sup>64</sup> N. Horimoto et al., "Fetal Eye Movements," *Ultrasound in Obstetrics & Gynecology* 3, no. 5 (1993): 362-69, <https://doi.org/10.1046/j.1469-0705.1993.03050362.x>.

gestation.<sup>65</sup> Therefore, the 15-week-gestation fetus mostly makes slower and infrequent spontaneous eye movements. The eyelids are fused shut at this age.<sup>66</sup>

**14) If a doctor took an X-ray this week, the fetus’s skeleton would be visible.**

The fetal skeleton starts forming from a series of ridges, called somites, along the embryo’s back. These somites develop in the sixth week. Most of the skeleton starts as cartilage, and then special cells called osteoblasts start creating the hard bone tissue. In a single long bone, the middle of the bone starts to harden first, and the ends keep growing longer and longer as cartilage. By 15 weeks’ gestation, much of the unborn baby’s skeleton has hardened from cartilage into bone.<sup>67</sup>

**15) Surgeons have successfully performed surgery on fetuses at 15 weeks’ gestation.**

When ultrasound scans reveal structural defects or life-threatening diseases early in the pregnancy, doctors may recommend a prenatal surgery. Recent medical advances have enabled some babies to receive life-saving treatments while still in the womb – long before they are born!

Fetal surgery has proven successful in treating twin-to-twin transfusion syndrome, spina bifida, congenital heart defects, and other disorders.<sup>68</sup> In twin-to-twin transfusion syndrome more blood flows abnormally between identical twins who share one placenta. This jeopardizes the lives of both twins. If left untreated, one or both of the twins may die. Surgeons use a minimally invasive technique, called fetoscopic laser ablation, to disconnect shared blood vessels in the placenta connecting the twins. This surgery has been successfully performed on twins as young as 14 weeks and six days’ gestation.<sup>69</sup> Multiple surgical teams have performed this technique on twins at 15 weeks’ gestation.<sup>70</sup> When

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<sup>65</sup> Hatem A. Tawfik et al., “Embryologic and Fetal Development of the Human Eyelid,” *Ophthalmic Plastic and Reconstructive Surgery* 32, no. 6 (November 2016): 407–14, <https://doi.org/10.1097/IOP.0000000000000702>.

<sup>66</sup> Tawfik et al.

<sup>67</sup> Moore, Persaud, and Torchia, *The Developing Human, Clinically Oriented Embryology*.

<sup>68</sup> Colleen Malloy, Monique Chireau Wubbenhorst, and Tara Sander Lee, “The Perinatal Revolution,” *Issues in Law & Medicine* 34 (2019): 15.

<sup>69</sup> David Baud et al., “Fetoscopic Laser Therapy for Twin-Twin Transfusion Syndrome before 17 and after 26 Weeks’ Gestation,” *American Journal of Obstetrics and Gynecology* 208, no. 3 (March 1, 2013): 197.e1-197.e7, <https://doi.org/10.1016/j.ajog.2012.11.027>.

<sup>70</sup> L. Lecointre et al., “Fetoscopic Laser Coagulation for Twin–Twin Transfusion Syndrome before 17 Weeks’ Gestation: Laser Data, Complications and Neonatal Outcome,” *Ultrasound in Obstetrics & Gynecology* 44, no. 3 (2014): 299–303, <https://doi.org/10.1002/uog.13375>; Baud et al., “Fetoscopic Laser Therapy for Twin-Twin Transfusion Syndrome before 17 and after 26 Weeks’ Gestation.”

performed promptly, fetoscopic laser surgery gives the best outcomes for saving both babies.

Similarly, spina bifida is a severe disorder in which part of the baby's spinal cord does not close properly. Depending on the location and extent of the damage, spina bifida can cause intellectual and motor impairments, including paralysis of the legs. In the past, surgeons would repair the spinal cord defects in the first few days after birth to try to give the infants the best chance to heal and grow on a normal trajectory. However, doctors discovered that repairing the defect before birth led to better outcomes for the child. In a groundbreaking study from the Children's Hospital of Philadelphia, treating babies while still in the womb was *so effective* that the trial was stopped early so that every baby could benefit from the prenatal spinal cord repair. When surgery was performed on fetuses before 26 weeks' gestation, the children experienced lower rates of death and neurological complications, as well as better mental and motor outcomes. In fact, many of these children could walk independently after the early intervention.<sup>71</sup>

It is interesting to note that in prenatal surgeries, the fetus is anesthetized separately from the mom to create the best outcomes for the surgery.<sup>72</sup> Thus, the medical establishment treats a fetus as a patient with full rights when the mother eagerly wants to keep her child alive.

It is clear from the science that unborn children at 15 weeks' gestation are already amazingly complex human beings. They can be treated as independent patients, they show preferences independent from their mothers, and they have goal-directed behaviors. These humans deserve protection, too.

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<sup>71</sup> Julie S. Moldenhauer and N. Scott Adzick, "Fetal Surgery for Myelomeningocele: After the Management of Myelomeningocele Study (MOMS)," *Seminars in Fetal and Neonatal Medicine*, Fetal intervention, 22, no. 6 (December 1, 2017): 360–66, <https://doi.org/10.1016/j.siny.2017.08.004>.

<sup>72</sup> Bellieni, "Analgesia for Fetal Pain during Prenatal Surgery."