

# Countdown to Life: The Extraordinary Making of You (2015), by the British Broadcasting Corporation and The Open University

In 2015, the British Broadcasting Corporation (BBC) partnered with The Open University to produce the three-part documentary series, *Countdown to Life: The Extraordinary Making of You*. Michael Mosley, a British television producer and journalist, hosts the documentary. Along with narrating animated scenes of a growing fetus in the womb, Mosley meets with individuals around the world who experienced mutations that can arise in the womb. Introduced over the course of the three episodes, several people share their personal stories of how their bodies did not develop correctly prior to birth. Throughout the documentary, animations of fetal development and individuals' stories about their own birth defects transition back and forth to show how a fetus develops. *Countdown to Life: The Extraordinary Making of You* informed the public of what happens to the fetus at the point of conception to the point of birth at forty weeks.

On 14 September 2015, BBC Science in London, England, in partnership with The Open University in Milton Keynes, England, released a documentary series that follows a human fetus from the moment of conception to the moment of birth. *Countdown to Life: The Extraordinary Making of You* is segmented into three episodes. Episode one, *The First Eight Weeks*, discusses what occurs in the embryo within the first eight weeks after conception. In *The First Eight Weeks*, the embryo starts as one cell and, by the end of the episode, has the beginnings of all vital organs and has formed an early human body. As the documentary continues with episode two, *Against the Odds*, explores the middle sixteen weeks of a fetus's development in the womb. During the middle sixteen weeks, the fetus's face is formed, and skin color and fingerprints develop. According to the documentary, hormones mold the personality of the fetus during the middle sixteen weeks. Finally, in the third episode titled *The Final Push*, the filmmakers examine the fetus from twenty-four weeks to forty weeks after conception. During that time, bones replace the cartilage that surrounded the skeleton and the fetus begins to see in the womb.

The first episode of *Countdown to Life: The Extraordinary Making of You*, explores what occurs to the embryo during the first eight weeks in the womb. As the first part of the documentary begins, four genetically identical sisters are introduced. Holly, Jessica, Ellie, and Georgie are quadruplets from Norfolk, England. According to the documentary, the odds of having four genetically identical children are one in 64 million. Similar to every other infant born, the four sisters began as a single sperm fertilizing a single egg. During conception, genetic material from each parent combine to make a genetic code, unique to each fetus. From day two to five, cells continually divide to produce more cells, so the embryo can grow. In the case of Holly, Jessica, Ellie, and Georgie, the single embryo divided into four distinct embryos. According to the documentary, one theory was presented for why quadruplets form and it was that the vital communication between cells breaks down. Due to the breakdown of communication, four clumps of cells formed within the single embryo and each clump of cells started to act independently. Each of the four clumps of cells separated and went on to create one, individual fetus. After the introduction of Holly, Jessica, Ellie, and Georgie, the first episode continues to examine the early stages of development.

Continuing with the first episode of the documentary, the film discusses what occurs at two hundred hours after conception. Beginning at two hundred hours, changes are occurring in each cell of an embryo that the documentary claims can possibly determine the length of life an embryo will have. In the film, host Mosley travels to Keneba, Gambia, where Swiss researchers perform a seventy-

year-long research study. The purpose of the study is to determine if the time during which the embryo is conceived can affect how long an individual lives after birth. The researchers compare individuals from birth to death who were conceived in the dry season, which starts in December and ends in June, and individuals conceived in the wet season, which starts in July and ends in November. In the dry season, mothers eat more calorie-rich grains compared to the mothers who conceive in the wet season, who eat more leafy greens. Once the fetuses are born, the research team then monitors them from birth, throughout childhood, and into old age.

As Mosley describes, the researchers found that there were no differences in the two groups of children until the age of fifteen. At the age of fifteen, however, researchers claim that individuals conceived in the dry season were less able to fight infections. The researchers argue that leafy greens, which pregnant women ate during the wet season, provided a mixture of chemicals that bound to strands of DNA. Those chemicals permanently changed the activity levels of genes important in regulating the immune system which, in turn, decreased the lifespan of the individuals conceived in the dry season. Following an examination of the research study in Keneba, the first episode of the documentary continues to discuss the case of a woman named Melanie Gaydos.

The first episode of the documentary uses the case of Gaydos to discuss what happens to the fetus within the first fifteen days after conception. Before day fifteen, cells in a fetus are identical, but at day fifteen, cells start to become more specialized. After day fifteen, cells transform into over four hundred different types that make up every part of the body. According to the documentary, any errors that occur at that point can have serious consequences, such as ectodermal dysplasia. Gaydos, an international model, was born with the genetic disorder ectodermal dysplasia. As explained in the first episode, the genetic disorder affects the development of the skin, hair, teeth, and nails. In the average fetus, there are three layers of specialized cells. Cells that build the gut and liver are on the bottom layer, whereas the cells that become the muscles, kidneys, bones, and blood are on the middle layer. On the top layer are the cells that become the skin, hair, teeth, and brain. In Gaydos's case, the top layer did not develop as expected. Gaydos's skin is highly sensitive, while her hair grew inwards, and her teeth crumbled. As the film notes, physicians stated they had never seen a condition like hers before. However, the documentary reports that physicians hypothesize that a mutated gene could have caused the condition. After the cells become more specialized on day fifteen, the first episode continues and discusses what happens in the first couple of weeks after conception.

The middle of the first episode focuses on the first few weeks after conception. Within a couple of weeks, the embryo has thousands of cells, and the genes that promote growth turn on. In the documentary, Mosley meets a girl named Nell from Brecon Beacons, Wales, who inherited an extra growth gene from her father. The average embryo inherits one growth gene from their mother and one growth gene from their father. The two growth genes balance one another out, and the embryo grows at an average rate. According to the documentary, because Nell inherited two growth genes from her father, she grew at a faster rate in the womb compared to the average embryo. Nell also produces an extra growth hormone, IGF2. The extra growth hormone can cause an accelerated growth during development and childhood. Following Nell's story, the episode introduces National Basketball Association or NBA, player Randy Foye, who was born with situs inversus, a condition in which the organs in the abdomen and chest are reversed from the normal position in the human body.

As the first part of the documentary continues to discuss how a mutation in the embryo can affect individuals for a lifetime, Mosley meets NBA player Foye in Denver, Colorado. Foye's heart is located on the right side of his chest, compared to the normal position in the left side. In addition, Foye's liver is on the left side, compared to the normal position in the right side. The odds of organs developing on the wrong side of the human body is one in 10,000 live births. Nineteen days after conception, the location of the internal organs is determined by cilia, hair-like structures. Cilia are found on several hundred cells located in the middle of the embryo. On day nineteen, the cilia start to spin clockwise, which creates a leftward current in the fluid that surrounds the cilia. The current switches on genes located on the left side of the cell. Once the left side genes are activated, the genes indicate where the organs need to go in the body. In Foye's case, the cilia never started to spin. Therefore, his organs did not have proper instructions on where to go inside the body.

Instead, the genes on the right side activated and the organs ended up on the opposite side of the body, compared to the average person's organs. After the introduction of Foye, the first episode explains what occurs between three weeks and eight weeks after conception.

As *The First Eight Weeks of The Countdown to Life: The Extraordinary Making of You* nears its end, Mosley explains what happens between week three and week eight of development. At week three in the womb, the embryo is shaped like a flat disk. The flat disk folds together and creates a tube that later becomes the spinal cord. After the formation of the tube, a collection of muscle cells at the center of the embryo starts to assemble to form the heart. As emphasized in the documentary, the heart is smaller than a grain of sand, yet the fetus has a heartbeat. At week five, an ultrasound, an imaging technique to produce images of the fetus, can detect the fetus's heartbeat. According to the documentary, after the fetal heartbeat is detected at week five, the heart will continuously pump blood throughout the body. One week later, at six weeks, the fetus begins to look somewhat human, as body structures such as hands start to emerge. At that time, the two hands resemble two flat paddles. Later, at thirty-eight days, the cells around the flat paddles slowly die away, which creates the hands' fingers. Following the formation of the hands, the inner ear is formed at eight weeks, which gives humans a sense of balance.

The second episode, *Against the Odds*, of *Countdown to Life: The Extraordinary Making of You*, looks at the middle sixteen weeks of fetal development. The second episode notes that during the middle sixteen weeks of development, the fetus starts to become an individual. The fetus's face is formed, skin color and fingerprints are developed, and hormones mold its personality. At eleven weeks, the fetus's arms and legs begin moving, while the body starts to develop the dominant hand, the preferred hand to perform motor tasks with. In addition, the nervous system, consisting of the brain, spinal cord, and nerves that connect the body, starts to function in the fetus. Two weeks later, at week thirteen, the fetus begins to develop a skin color. Prior to week thirteen, the fetus appeared transparent, but with the production of a substance called melanin, the fetus develops a skin tone. During week fourteen, the fetus begins to prepare for life after birth by developing an immune system that becomes fully active. During week fifteen, the fetus's brain creates all the cells of the cerebral hemisphere of the brain, which controls speech, thought, emotions, and other functions.

In the middle of episode two, *Against the Odds*, Mosley explains the effects of testosterone on the fetus. Both male and female fetuses receive a dose of the hormone testosterone at week fifteen. At the end of week fifteen, the release of testosterone peaks and floods the fetal body, during which males receive a larger dose than females. After week fifteen, the documentary jumps to weeks twenty-three, when the fetus puts on a significant amount of body fat. The large amount of body fat provides energy for muscles, specifically the heart muscle, of a fetus.

Episode three, *The Final Push*, examines what happens to the fetus in the womb between week twenty-five and week forty. During week twenty-five, the largest bone of the body, the pelvic bone, forms. To discuss the process of making bones during development, the documentary introduces nine-year-old Janelly, who was born without the ability to make bones. According to the documentary, a fetus starts with cartilage, and then cartilage is replaced with bones at week twenty-five. Bones are formed by specialized cells called osteoblasts. The osteoblasts surround the skeleton and replace the cartilage with a calcium-based mineral. The calcium-based mineral then produces a damaging chemical that prevents the bones from hardening. However, in the average fetus, the body will develop a response that activates a gene to create a protein, TNSLP. With that protein, the body neutralizes the damaging chemical, and bone formation can continue. At eighteen months old, Janelly was unable to make bones. Therefore, her parents enrolled her in a clinical trial in Australia. Researches in the trial were studying a new drug, which they gave to Janelly to help her replace the cartilage in her body with bones. Within six months, the drug began to replace the missing protein in her body and she began growing bones by the age of twenty-four months. After the introduction of Janelly, episode three continues with the changes the fetus undergoes at week twenty-seven and week twenty-eight.

In the middle of *The Final Push*, the documentary shows a fetus experiencing increased brain activity and development of senses. During week twenty-seven, the documentary discusses that most brain growth comes from fatty sheaths, which facilitate the transmission of impulses along nerves.

The fatty sheaths wrap around the brain cells and insulate the cells to send signals around the brain. By week twenty-eight, sounds from the outside world initiate the use of hair cells found in the ears by sending signals to the brain, known as sound. According to the documentary, the first sense to develop is hearing, while the other senses develop later. In addition, by the end of week twenty-eight, the fetus is starting to be able to see. As the ability to see is heightened by the end of week twenty-eight, Mosley travels to Pingelap Atoll, an island in the South Pacific Ocean.

As Mosley describes, Pingelap Atoll is known as Color Blind Island because more than ten percent of the population is color blind. Mosley explains that the individuals on Pingelap Atoll who are color blind can only see in black and white. At the back of the fetus's eyes is the retina, a layer at the back of the eyeball that contains light sensitive cells, cones and rods. The cone cells sense color, while the rods are highly sensitive to light and give the fetus the ability to see in the womb, but only in black and white. Proteins in the eye convert red, green, and blue light into nerve impulses that are sent to the brain and interpreted as a colored image. If the proteins do not function properly, the fetus will only be able to see in black and white for the rest of their lives, as is the case for many people on Pingelap Atoll. The mutated, nonfunctioning protein was passed down from the small population living on the atoll over two hundred and thirty years ago, and many of the current atoll dwellers have inherited it.

Mosley then travels to Canada to find out how extreme stress experienced by a pregnant woman can affect the fetus. In Quebec, Canada, professor Susan King performed a research study in 1998 on how stress during pregnancy can affect the fetus when older. King followed 176 pregnant women who went twenty-two days without electricity in their houses during an ice storm that hit Quebec in 1998. Due to the ice storm, the stress levels in the pregnant women were high. During the time of the ice storm, a woman named Julie was in her third trimester of pregnancy with her son, Vincent. King followed Vincent from the age of three until age fifteen. Throughout the twelve years, Vincent underwent two magnetic resonance imaging (MRI) exams, saliva tests, and memory tests.

The results of the tests from Vincent and the other participants indicated that some crucial genes were switched on and others switched off in the fetuses of the pregnant women due to stress. As she presents in the documentary, King concluded that the longer the mothers went without electricity, the larger the impact on the fetuses. More days without electricity was correlated with a fetus having a lower intelligence quotient or IQ and slower speech development. According to the documentary, the results of King's study indicated that the stressed mothers released a hormone that regulates the response to stress called cortisol. The cortisol in the mother's bloodstream was passed to the fetus's bloodstream by the placenta, the organ connecting the fetus to the pregnant woman in the womb. Because the fetus received the cortisol, it experienced a decrease in growth and development, thus hampering its cognitive functions later in life. Following the explanation of King's study, the documentary discusses what happens from week thirty-seven to week forty.

As episode three of the documentary nears its end, the documentary shows the fetus from week thirty-seven to week forty. By week thirty-seven, all the vital organs in the fetus have developed. Although the lungs have been developed, they lay dormant inside the fetus. The lungs are filled with fluid, and yet three weeks later, the fetus begins practicing breathing. At forty weeks, the fetus is born and the lungs become active, as the fetus takes its first breath. As *The Final Push of The Countdown to Life: The Extraordinary Making of You* ends, a fetus begins its life outside of the womb.

## Sources

1. British Broadcasting Corporation (BBC). "The Countdown to Life: The Extraordinary Making of You." Filmed. Posted September 14, 2015. <http://www.bbc.co.uk/programmes/b06crff1> (Accessed November 21, 2017).