

Life's Greatest Miracle (2001), by Julia Cort and NOVA ^[1]

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The Public Broadcasting Station (PBS) documentary *Life's Greatest Miracle* (abbreviated *Miracle*, available at <http://www.pbs.org/wgbh/nova/miracle/program.html> ^[4]), is arguably one of the most vivid illustrations of the making of new human life. Presented as part of the PBS television series NOVA, *Miracle* is a little less than an hour long and was first aired 20 November 2001. The program was written and produced by Julia Cort and features images by renowned Swedish photographer [Lennart Nilsson](#) ^[5]. It comes as a sequel to the award-winning 1983 NOVA production, *The Miracle of Life*, which exhibits Nilsson's photography as well. The program showcases a combination of graphic animation, endoscopic and microscopic footage, as well as the story of a couple who are expecting a child. It features a number of new technological and scientific developments not present in its prequel, providing additional relevant information. By depicting human development in a clear and fresh manner, *Miracle* helps shed light on this indispensable aspect of life. Following is a description of the documentary, highlighting the key points of the film and explaining images featured in it.

Miracle is divided into eight sections. Section one, titled "Passing on Your DNA," opens with a discussion of the prodigious natural drive to reproduce. This universal drive is recognized as a unifying theme for life on earth, and DNA is identified as the four-billion-year-old mastermind behind the entire operation. Sexual reproduction, unlike asexual reproduction ([cloning](#) ^[6]), practiced by most bacteria, results in gene shuffling and produces crucial variation. The discussion of the biological benefits of sexual reproduction is accompanied by the depiction of various organisms going about their reproductive processes. Recognizing the complexity of such processes, the film poses the question of what happens, and how? How, from such humble beginnings, do such complex and functional living systems arise? A closer look at the human testis begins to answer this question; detailed photographs reveal the tiny, coiled tubes that make up the male organ. These tubes produce about a thousand new, genetically unique [sperm](#) ^[7] every second through [meiosis](#) ^[8], which is digitally animated in *Miracle* and explained in the context of its significance to sexual reproduction.

After discussing the process of gamete production and the importance of sexual reproduction, *Miracle* takes a closer look at mating and the female reproductive system in section two, "The Egg's Journey." This section opens with Melinda Tate Iruegas and Sergio Iruegas, a couple expecting their first child. Intermittently throughout the film, the couple discuss their experiences, hopes, and feelings during the various stages of Melinda's [pregnancy](#) ^[9]. *Miracle* then explains the significant differences between male and female reproductive systems. While Sergio, like all other healthy males, has been producing [sperm](#) ^[7] continuously since puberty, Melinda's eggs all formed when she was a [fetus](#) ^[10]. A woman Melinda's age (early thirties) has a few thousand left of her original millions of eggs, but normally only one is capable of [fertilization](#) ^[11] each month. Vivid video illustrates how a single [egg](#) ^[12] is selected, pampered by support cells in the [ovary](#) ^[13], and ushered into the fallopian tube where it awaits [fertilization](#) ^[11] by [sperm](#) ^[7]. Before any male may mate with a female and fertilize her [egg](#) ^[12], however, he must earn mating rights. Here, *Miracle* depicts the struggle between males as

they vie for the chance to mate with a female, essentially competing for a chance to pass on their genetic material. The film explains that when a male succeeds in wooing a female and proceeds to mate with her, a series of chemical changes take place, culminating in the ejaculation of [sperm](#) [7], which allows for [fertilization](#) [11] of the [egg](#) [12]. The course of the sperm's voyage is covered in the following segment.

Section three, "The Sperm's Journey," describes just that. Though the [sperm](#) [7] encounter a number of obstacles on their adventure, their ultimate success is largely dependent on the woman's body. Once ejaculated into the [vagina](#) [14], the [sperm](#) [7] strive to escape the acidic environment; about 40% of the [sperm](#) [7] of a healthy male will be able to propel themselves toward the [cervix](#) [15] using their flexible, whip-like tails. Around the time of [ovulation](#) [16] each month, the protective mucus cap of the [cervix](#) [15] liquefies, creating channels that allow any present and able [sperm](#) [7] to enter. In addition, the uterine muscles contract in a wave-like fashion to help the [sperm](#) [7] progress into the fallopian tube. If the female has ovulated and an [egg](#) [12] is present, the [sperm](#) [7] that have traveled thus far will attempt to fertilize it. As the film points out, however, the [sperm](#) [7] that fertilizes the [egg](#) [12] is usually not the first [sperm](#) [7] there, but rather one of those that were caught in the fallopian cilia, modified, and gradually released. Once these [sperm](#) [7] reach the [egg](#) [12], they must get past the helper cells and penetrate the thick protein coating of the [egg](#) [12], called the [zona pellucida](#) [17]. Through animation, *Miracle* explains that entry into the [egg](#) [12] requires chemical forces as well as mechanical ones; that is, the proteins on the surface of the sperm's cap must match up with the proteins of the [zona pellucida](#) [17]. Once this match occurs, the cap disintegrates and the membranes of the two gametes fuse, introducing the sperm's genetic content into the [egg](#) [12] itself.

After capturing [fertilization](#) [11] in words and images, *Miracle* continues with section four, "The First Two Weeks." Despite successful [fertilization](#) [11], a majority of fertilized eggs still fail to become [viable](#) [18] offspring, since a number of additional obstacles lie ahead. During the next five days, the [fertilized egg](#) [19], still locked in the [zona pellucida](#) [17], makes its way to the [uterus](#) [20], undergoing repeated cellular division along the way. Once in the [uterus](#) [20], the mass of cells now known as the [blastocyst](#) [21] secretes enzymes that break open the [zona pellucida](#) [17] and is seen escaping onto the uterine lining. Here, it negotiates with the mother's immune system, convincing it that it is not a harmful foreign body. After suppressing the maternal immune system response, the [blastocyst](#) [21] implants in the rich uterine lining, from which it receives nourishment. Some, like Melinda Iruegas, report experiencing morning sickness and nausea at this stage, as the baby makes a more significant impact on their body. Sergio experiences similar symptoms, even though he has neither [uterus](#) [20] nor a baby inside him.

Once [implantation](#) [22] has occurred, the [blastocyst](#) [21] undergoes a number of transformations through the process of [gastrulation](#) [23]; this is the beginning of section five, "The Embryo Takes Shape." While *Miracle* is able to depict [frog](#) [24] [gastrulation](#) [23] since it occurs in a transparent [egg](#) [12], human [gastrulation](#) [23] remains invisible and is explained through animation. The formation of the three [germ layers](#) [25] and an explanation of their future structures serve as a prelude to a more in-depth examination of [differentiation](#) [26]. In utero photos of a three-week-old embryo show the beginnings of the [neural tube](#) [27], and subsequent photos of a four-and-a-half-week old embryo show early development of the brain. Other developments around this time, such as the formation of blood vessels, a beating heart, the primitive backbone, and appendage buds, are also depicted. Recognizing the incredible complexity of such a cascade of events, *Miracle* once again turns to the micro?the DNA?to explain the macro?the formation of a complex organism. The film explains that

various cells in the body are different because different [genes](#) [28] turn on; the turning on of [genes](#) [28] by certain proteins is animated for clarification. It is thought that once a basic body plan has formed, the cells develop in accordance with their location in this layout. The cells communicate with each other using chemical signals, and the resultant gene expression allows for the production of different proteins that serve various functions in the body; an explanation of some of these proteins is also provided.

The next section, "Messages in the Genes," highlights the importance of the [genes](#) [28] to the development of various features of the embryo, including its sex. An [ultrasound](#) [29] of the Iruegas' [fetus](#) [10] shows it moving around and its heart beating, while the couple discusses their decision not to find out the sex of their child. At this early stage of development, males and females are anatomically identical. In fact, before the formation of distinct sex organs, the only way to tell is by looking at the twenty-third pair of chromosomes: if both are X chromosomes, it's a girl; if an X and a Y, it's a boy. *Miracle* demonstrates how the *SRY* gene, which is found on the Y-chromosome and is only active for a couple days during the sixth week of development, initiates a cascade of reactions that produce a male child. If the Y chromosome—and thus the *SRY* gene—is not present, the embryo will develop into a female. Other [genes](#) [28], such as those directing growth or cell death, are also described. By the end of section six, two months have passed since [fertilization](#) [11] and the embryo is now considered a [fetus](#) [10]. It has taken shape, but still needs to grow and develop into a full-fledged baby.

As the [fetus](#) [10] continues to mature, section seven, "Feeding the Growing Fetus," discusses the nutrition of both the mother and the [fetus](#) [10]. Melinda describes her need to smell and approve of any food before she consumes it, making it somewhat difficult to make dinner plans. Meanwhile, the [fetus](#) [10] gets all of its nutrients and oxygen from its mother's blood, via the [placenta](#) [30] and [umbilical cord](#) [31]. Images of the placenta's villi, which absorb materials from pools of enriched maternal blood, help explain how the [fetus](#) [10] is fed without contact between its own blood and the mother's.

Bone replaces some of the fetus's cartilage during the fourth month of development, and the [fetus](#) [10] also begins to hear sounds. Melinda and Sergio Iruegas therefore take pleasure in playing different types of music and sounds to their child and gauging its reactions. The final part of this section consists of a succession of photos of the developmental process, documenting various features from different angles. This timeline intricately illustrates the unfolding human form and emphasizes the details of each stage.

The final section, "The Third Trimester," details the progression of events leading up to birth, and the "miracle" of birth itself. By the third [trimester](#) [32], the [fetus](#) [10] has formed all of its organ systems and is primarily growing in size. In preparation for birth, fat reserves are established throughout the fetus's body, and myelination (deposition of myelin on the axons of the [nerve cells](#) [33]) begins. Myelination greatly increases the speed and efficiency of brain and nerve impulses. *Miracle* points out that as the third [trimester](#) [32] nears its end, the baby's hunger for fat becomes so great that the supply coming through the [placenta](#) [30] becomes inadequate. It is at this point that the baby needs to leave the womb—in other words, to be born. The film shows the birth of Melinda's baby and explains the process. It also states that since human births are extremely dangerous due to the size of the baby's skull and the narrowness of the birth canal, [humans](#) [34] are the only [mammal](#) [35] that regularly gives birth in the company of others. In showing the birth, *Miracle* involves the viewer in the emotion and joy felt by the family upon the arrival of their child.

Life's Greatest Miracle is available on the PBS website, along with a number of other related resources. These include "Windows on the Womb," a discussion of the various modern screening techniques used by medical professionals to assess the progress of the baby while in the [uterus](#) [20]; a discussion of the stem cell debate; an explanation of how cells divide and how sex is determined; and a journal by a woman describing the various aspects of her [pregnancy](#) [9]. The companion website to the film also provides other resources for curious minds.

Miracle's prestige comes not only from its content, but also from its being a NOVA production. It has earned countless awards, among them numerous Peabody and Emmy awards. Julia Cort, the writer and producer of the documentary, won the 2001 Science in Society Journalism Award for her work on it. Since it follows the entire process of human [procreation](#) [36], *Life's Greatest Miracle* is a useful resource, providing the public with accurate information about what goes on in the world of the embryo and [fetus](#) [10].

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Topic

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