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**Short note on implantation**

**Implantation is a process in which a developing embryo, moving as a** [**blastocyst**](https://embryo.asu.edu/search?text=blastocyst) **through a** [**uterus**](https://embryo.asu.edu/search?text=uterus)**, makes contact with the uterine wall and remains attached to it until birth. The lining of the** [**uterus**](https://embryo.asu.edu/search?text=uterus) **(**[**endometrium**](https://embryo.asu.edu/search?text=endometrium)**) prepares for the developing** [**blastocyst**](https://embryo.asu.edu/search?text=blastocyst) **to attach to it via many internal changes. Without these changes** [**implantation**](https://embryo.asu.edu/search?text=implantation) **will not occur, and the embryo sloughs off during** [**menstruation**](https://embryo.asu.edu/search?text=menstruation)**. Such** [**implantation**](https://embryo.asu.edu/search?text=implantation) **is unique to mammals, but not all mammals exhibit it. Furthermore, of those mammals that exhibit** [**implantation**](https://embryo.asu.edu/search?text=implantation)**, the process differs in many respects between those mammals in which the females have estrous cycles, and those mammals in which the females have menstrual cycles. Females in the different species of primates, including** [**humans**](https://embryo.asu.edu/search?text=humans)**, have menstrual cycles, and thus similar processes of** [**implantation**](https://embryo.asu.edu/search?text=implantation)**.**

**Before** [**embryogenesis**](https://embryo.asu.edu/search?text=embryogenesis) **begins, the** [**ovary**](https://embryo.asu.edu/search?text=ovary) **releases an unfertilized** [**egg**](https://embryo.asu.edu/search?text=egg) **cell, called an** [**oocyte**](https://embryo.asu.edu/search?text=oocyte)**, which then travels down the fallopian tube. The** [**egg**](https://embryo.asu.edu/search?text=egg) **is enveloped in an extracellular matrix called the** [**zona pellucida**](https://embryo.asu.edu/search?text=zona%20pellucida)**. Sperm can fertilize the** [**egg**](https://embryo.asu.edu/search?text=egg) **in the** [**zona pellucida**](https://embryo.asu.edu/search?text=zona%20pellucida) **(ZP), which prevents the** [**fertilized egg**](https://embryo.asu.edu/search?text=fertilized%20egg)**, called a** [**zygote**](https://embryo.asu.edu/search?text=zygote)**, from adhering to the wall of the fallopian tube. If the** [**zygote**](https://embryo.asu.edu/search?text=zygote) **implants in any area besides the** [**uterus**](https://embryo.asu.edu/search?text=uterus)**, the result is an** [**ectopic pregnancy**](https://embryo.asu.edu/search?text=ectopic%20pregnancy)**. This condition prevents the complete development of the embryo, and it can cause fatal hemorrhaging in the pregnant female.**

As the [zygote](https://embryo.asu.edu/search?text=zygote) moves through the fallopian tube it undergoes several rounds of cell division, a process called cleavage. These cell divisions produce the [inner cell mass](https://embryo.asu.edu/search?text=inner%20cell%20mass) (ICM), which will become the embryo, and the trophoblast, which surrounds the ICM and interacts with maternal tissues. Together, the ICM and the trophoblast are called the [blastocyst](https://embryo.asu.edu/search?text=blastocyst). A [blastocyst](https://embryo.asu.edu/search?text=blastocyst) successfully implants in the [uterus](https://embryo.asu.edu/search?text=uterus) when, as the ZP exits the fallopian tube, the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) leaves the ZP and binds to the [endometrium](https://embryo.asu.edu/search?text=endometrium).

The [endometrium](https://embryo.asu.edu/search?text=endometrium) is one of the few uterine surfaces to which a [blastocyst](https://embryo.asu.edu/search?text=blastocyst) cannot always implant. The properties of the [endometrium](https://embryo.asu.edu/search?text=endometrium) change, and only in a brief window can the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) implant on the tissue. In [humans](https://embryo.asu.edu/search?text=humans), that window includes days six through ten after [ovulation](https://embryo.asu.edu/search?text=ovulation). Just prior to [ovulation](https://embryo.asu.edu/search?text=ovulation), the [endometrium](https://embryo.asu.edu/search?text=endometrium) begins to thicken and to expand in response to the release of [estrogen](https://embryo.asu.edu/search?text=estrogen) from the ovaries. As the embryo moves through the [fallopian tubes](https://embryo.asu.edu/search?text=fallopian%20tubes), the [endometrium](https://embryo.asu.edu/search?text=endometrium) proliferates, changes in shape, becomes receptive to [implantation](https://embryo.asu.edu/search?text=implantation), and produces a hospitable environment for the embryo. Signaled by the release of [progesterone](https://embryo.asu.edu/search?text=progesterone) from the ovaries, a series of changes called **decidualization** occurs. Decidualization includes the gathering of white blood cells around endometrial arterioles, or blood vessels leading from arteries to capillary beds. As that vasculature forms, a molecule that stores energy, called glycogen, accumulates in the expanding connective tissues of the [uterus](https://embryo.asu.edu/search?text=uterus). Furthermore, the [endometrium](https://embryo.asu.edu/search?text=endometrium) swells as interstitial fluid accumulates in it. The [endometrium](https://embryo.asu.edu/search?text=endometrium), swollen with interstitial fluid, vasculature, and nutrients, provides a hospitable environment for [**embryogenesis**](https://embryo.asu.edu/search?text=embryogenesis).

As the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) moves through the [uterus](https://embryo.asu.edu/search?text=uterus) it realigns itself so that the [inner cell mass](https://embryo.asu.edu/search?text=inner%20cell%20mass) is adjacent to the uterine wall, and the trophoblast contacts the [endometrium](https://embryo.asu.edu/search?text=endometrium). The position of the ICM in relation to the [endometrium](https://embryo.asu.edu/search?text=endometrium) establishes the head to tail, or dorsal-ventral, axis of the embryo, with the dorsal side of the embryo facing the uterine wall. This is the first embryonic event that dictates the [organization](https://embryo.asu.edu/search?text=organization) of the future body.

Successful [implantation](https://embryo.asu.edu/search?text=implantation) depends on the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) binding to the [endometrium](https://embryo.asu.edu/search?text=endometrium). There are many molecules that are thought to dictate this interaction, but integrins, a type of cell-adhesion molecule, have been identified as a primary component. Integrins extend from the lining of the [uterus](https://embryo.asu.edu/search?text=uterus) and from the surface of the [**blastula**](https://embryo.asu.edu/search?text=blastula). Integrins have many functions in nearly all tissue types, and they have a role in cell adhesion, conveying information about the extracellular environment to the [nucleus](https://embryo.asu.edu/search?text=nucleus), and modulating the local immune response. Immediately following [implantation](https://embryo.asu.edu/search?text=implantation), integrin help regulate gene expression in the embryo. Doctors also look for high concentrations of integrin when they look for areas of uteruses receptive to [implantation](https://embryo.asu.edu/search?text=implantation) in assisted reproductive therapy (ART), and they use the lack of such concentrations to identify women who may be infertile.

Despite the contact between the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) and the [endometrium](https://embryo.asu.edu/search?text=endometrium), [implantation](https://embryo.asu.edu/search?text=implantation) can fail. There are many potential causes of errors. If [implantation](https://embryo.asu.edu/search?text=implantation) does not occur, the [endometrium](https://embryo.asu.edu/search?text=endometrium) breaks down and sheds, along with the [blastocyst](https://embryo.asu.edu/search?text=blastocyst), as part of the menstrual cycle. However, if a [blastocyst](https://embryo.asu.edu/search?text=blastocyst) does implant, then the [endometrium](https://embryo.asu.edu/search?text=endometrium) remains in the [uterus](https://embryo.asu.edu/search?text=uterus), and together with uterine tissue, becomes the maternal portion of the [placenta](https://embryo.asu.edu/search?text=placenta), called the **deciduas**.

Once the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) adheres to the uterine wall, the trophoblast secretes enzymes that digest the extracellular matrix of endometrial tissue. The trophoblast cells then begin to intrude between the endometrial cells, attaching the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) to the uterine surface. Further secretions of enzymes allow the [blastocyst](https://embryo.asu.edu/search?text=blastocyst) to bury itself deeply among the uterine stromal cells that form the structural components of the [uterus](https://embryo.asu.edu/search?text=uterus). Subsequently, trophoblast cells continue to divide and form two [**extraembryonic membranes**](https://embryo.asu.edu/search?text=extraembryonic%20membranes). These membranes form the fetal portion of the [**placenta**](https://embryo.asu.edu/search?text=placenta) called the [**chorion**](https://embryo.asu.edu/search?text=chorion). Additional enzymes and signaling factors secreted by these membranes remodel the uterine vasculature to bathe the fetal or embryonic blood vessels in maternal blood. Chorionic villi are the folds of tissue and blood vessels that connect maternal and fetal blood pools. Maternal blood diffuses into the villi, and it travels through them into the [**fetus**](https://embryo.asu.edu/search?text=fetus)**'s** vasculature. Similarly, fetal blood diffuses from the villi and into the maternal vasculature. Normally fetal and maternal blood do not mix, but the relationship between the two circulatory systems enables the transfer of nutrients and oxygen to the [**fetus**](https://embryo.asu.edu/search?text=fetus) or embryo, and carbon dioxide and urea from the [**fetus**](https://embryo.asu.edu/search?text=fetus) to the mother.

