Prenatal period

There are several systems for dividing the prenatal development of a person, e.g. 10 Jirasque stages (8 embryonic, 1 fetal, 1 prenatal), or 23 Carnegie stages. We evaluate the germ according to external characteristics. When evaluating the developmental stages of the embryo, it is important to distinguish between gestational and anatomical age.

Between the 3rd and 8th weeks of pregnancy, we refer to the developing individual as an embryo, after the 9th week as a fetus until the time of birthu (after that we already speak o newborn).

7týdenní lidské embryo při mimoděložním těhotenství.

Periodization of intrauterine development

The periodization of intrauterine development can be based on several different characteristics:

- **according to time** - but usually we don't know the exact moment of fertilization;
- **according to the size of the concept** - the disadvantage here is individual differences, so it mainly applies statistically;
- **according to the number of somites** - a fairly accurate method, but it can only be used between the 20th and 35th weeks (before the 20th week there are none, after the 35th week they merge);
- **by weight** - there are also individual differences, besides embryo cannot be weighed based on ultrasound examination;
- **according to morphological characteristics** - the most accurate method, can be compared with other animal species, e.g. Jirásk's periodization.

Prenatal development can be divided into three main periods. The first period is **embryonicnal*, during this period cells, tissues and organs are created, it lasts about 8 weeks. The next period is the*** *fetal'* period. The last period is around birth and is the **perinatal** period.

Stages of development according to Jirásek

1. **Unicellular** − begins fertilizationm, ootid, zygote, **1. day**.
2. **Blastomeric** - the oocyte begins to furrow (it divides, but its volume does not increase), a structure called the morula is formed, **2.−3. day**.
3. **Blastoderms** - a blastocyst is formed (fluid begins to enter the space between the cells until a uniform cavity is formed), **4. day**.
4. **Double-layer target** - epiblast, hypoblast, **2. week**.
5. **Three-layer target with axial structures** - 3 germ sheets are formed, **3. week**.
6. **Tubular embryo** - formation of somites occurs, closure of the neural tube, **4. week**.
7. **C-shaped embryo** - the embryo bends into lordosis, the formation of limbs, **5.−6. week**.
8. **Late embryonic period** - limbs (including fingers) are formed, at the end the eye slits close → **end of embryonic period**.
9. **Fetal period** - end of the first trimester (after the end of the embryonic period), **second and third trimester**.
10. **Perinatal period**[1][2].

First week of human development

Zygote

A fertilized egg turns into a zygote, in which repeated mitotic divisions (striating) take place. The zygote first divides into two blastomeres, then into four, etc. Growing takes place in the fallopian tube, the blastomeres are surrounded by the *zona pellucida* (transparent under the microscope, therefore pellucida).

As soon as the nine-cell stage is reached, the blastomeres adhere to each other and form a compact cell sphere (so-called compaction, it is conditioned by adhesive molecules (E-cadherins – glycoproteins, compaction is initiated in the 16-cell embryo). An embryo consisting of 12-15 blastomeres is referred to as [[morula]], is formed about 3 days after fertilization.

Blastogenesis

Around day 4, the morula enters the womb and a fluid-filled cavity - the blastocyst cavity - begins to appear. This is because the zona pellucida disappears and fluid enters from the uterine cavity. The cavity enlarges and the blastocyst separates into two parts:

- thin outer layer of cells – **trophoblast** (gives rise to the embryonic part of the placenta);
- a group of centrally located blastomeres, the inner cell mass (ICM) (*embryoblast*). These cells are **pluripotent** - they can give rise to any cell structure outside the trophoblast (these cells are used precisely as stem cells - embryonic stem cells - ESC).

The blastocyst floats freely in the uterine secretions for two days, and the zona pellucida gradually degrades and disappears, allowing the blastocyst to rapidly increase in volume. Usually, on the 6th day after fertilization, the blastocyst attaches to the epithelium of the endometrium, most often by its embryonic pole. The trophoblast begins to proliferate and differentiate into two layers:

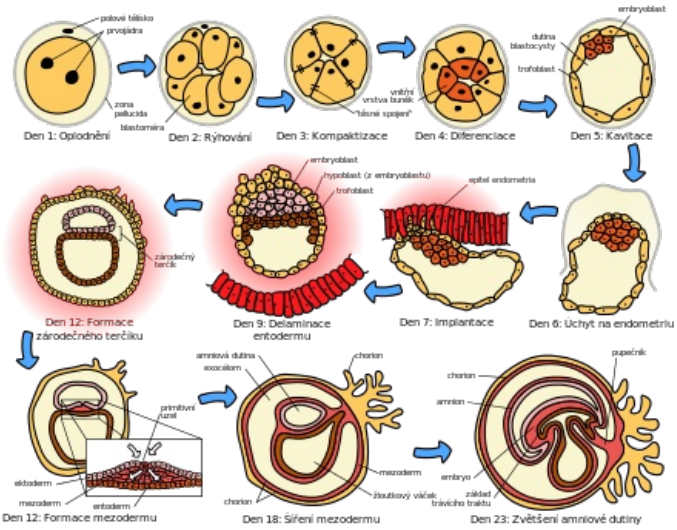
- inner layer: consists of individual cells and is referred to as **cytotrophoblast**';
- outer mass: **syncytiotrophoblast** - a multinucleated cytoplasmic mass (syncytium) where the boundaries between cells are lost (these cells are polyploid (mammals).

On the 7th day, it is formed by delamination on the surface of the cytotrophoblast (or epiblast) - **hypoblast.** *The syncytiotrophoblast produces* ***hormone human chorionic gonadotropin (hCG) –*** *it then gets into the surrounding lacunae and thus into the maternal blood, where it can be measured* **(pregnancy marker**) , its function is to maintain the function of the corpus luteum gravidarum[3].

Second week of human development

8. day

The **blastocyst** is partially incorporated into the endometrium of the uterus (into which it penetrates thanks to the proteolytic enzymes of syncytiotrophoblast cells) and in order to be inserted there, the blastocyst must partially collapse.



První 3 týdny vývoje

- **Trophoblast** differentiates into two layers (in the area around the inner cell mass) - inner layer = **cytotrophoblast** and outer multinucleated layer without visible boundaries between cells = **syncytiotrophoblast**. The cells of the "cytotrophoblast" divide, we find mitotic figures here. The cells of the "cytotrophoblast" migrate to the "syncytiotrophoblast" where they fuse and lose their individual plasma membrane. We do not find mitotic figures in the cells of the "syncytiotrophoblast".
- The cells of the **embryoblast** (inner cell mass) also differentiate into two layers - a layer of cuboidal cells adjacent to the blastocyte cavity = **hypoblast** and a layer of tall cylindrical cells = **epiblast**.

Together, the hypoblast and epiblast form a flat patty. A cavity is formed inside the epiblast, it enlarges and becomes the **amniotic cavity.** Epiblast cells adjacent to the *cytotrophoblast* are called***amnioblast***. The amniotic cavity is bordered by the amnioblast together with the epiblast. ***Stromal cells*** in the endometrium are filled with glycogen and lipids, take on a polyhedral shape and thus transform the endometrium into decidua (themselves into decidual cells). The decidual cells near the syntitiotrophoblast degenerate, then are absorbed by the embryo (so-called ***histiotrophy***).

Day 9

The blastocyst is deeper in the endometrium. The place where the blastocyst entered the endometrium was closed with a fibrin coagulum = ***operculum***. The *trophoblast* develops further mainly at the embryonic pole, where sinuses are formed in the syncytium. Eventually, these cysts coalesce to form larger lacunae. At the same time, at the **abembryonic pole**, *flat cells form a thin* **exocelomic** ***= Heuser's membrane,*** which lines the inner surface of the cytotrophoblast. Heuser's membrane, together with the hypoblast, delimits the **exocelomic cavity** = **primitive yolk sac**.

Day 11 to 12

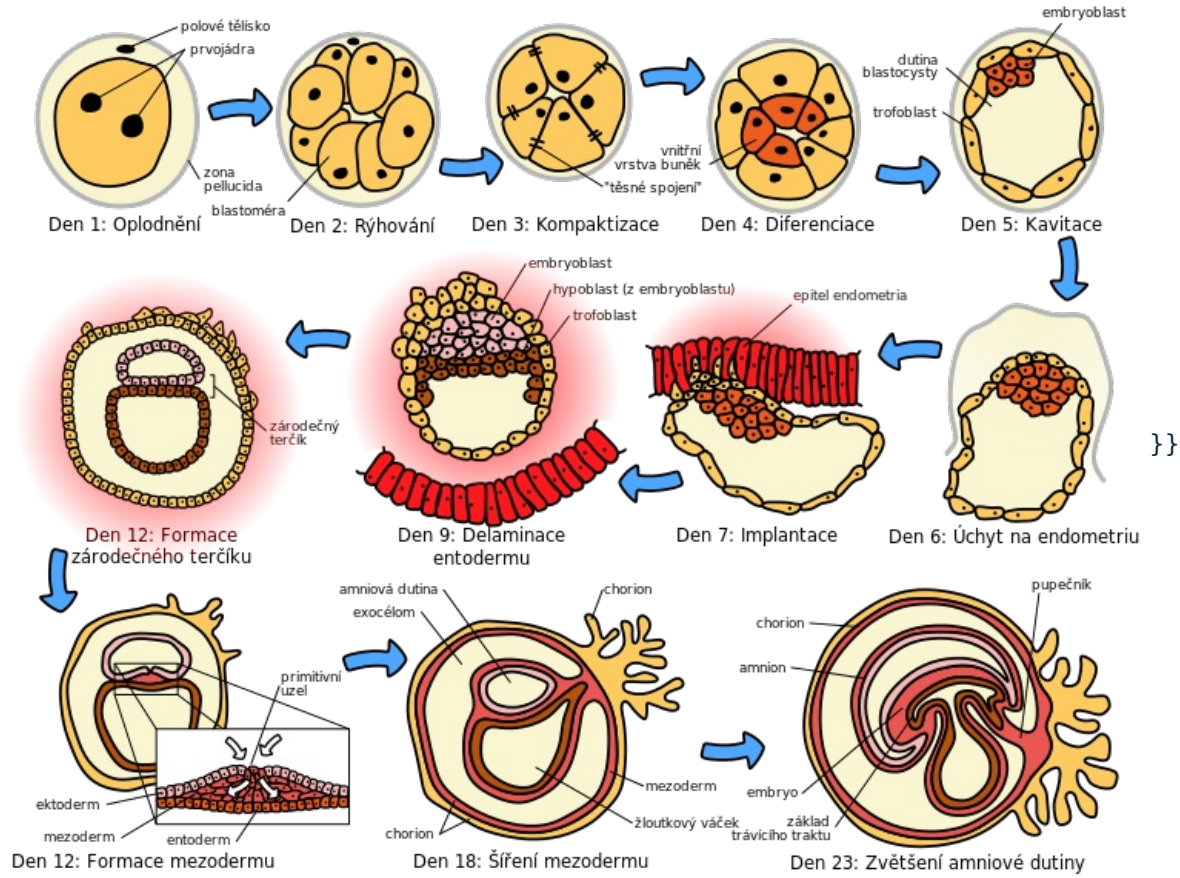
From 11/12 on the day the blastocyst is completely embedded in the endometrial stroma and the surface epithelium of the endometrium is completely re-epithelialized at the site of blastocyst penetration. The lacunae in the syncytium create a mutual communicating network, mainly at the embryonic pole, at the abembryonic (opposite) pole, the trophoblast is made up mainly of cells of the cytotrophoblast. Cells of the **syncytiotrophoblast** penetrate deeper into the stroma of the endometrium, where they disrupt the endothelial layer of the blood capillaries (congested and dilated *sinusoids*). Eventually, the sinusoids connect with the lacunae and maternal blood enters the lacunar system. Maternal blood begins to flow through the trophoblastic system of lacunae, the uteroplacental circulation begins. Meanwhile, a new population of cells derived from yolk sac cells appears between the inner surface of the cytotrophoblast and the outer surface of the exocoelomic cavity. These cells will form fine fibrous tissue = **extraembryonic mesoderm**. In the extraembryonic mesoderm, large cavities are formed relatively quickly, when these cavities fuse, a cavity is formed = **extraembryonic coelom** = **chorionic cavity**. The chorionic cavity surrounds the primitive yolk sac and the amniotic cavity, except where the *embryonic target* is connected to the trophoblast (connecting stalk)).

- Extraembryonic mesoderm below the *cytotrophoblast* and around the amniotic sac is referred to as *extraembryonic somatopleural mesoderm*.
- Extraembryonic mesoderm covering the yolk sac is referred to as extraembryonic splanchnopleural mesoderm.

The target remains relatively small.

Day 13

From the 13th day, the surface defect in the endometrium is usually healed. Sometimes there is bleeding at the site of *implantation* (increased blood flow in the lacunar spaces). This bleeding can occur around *28. day* of the menstrual cycle and can therefore be mistaken for normal menstrual bleeding. The *trophoblast* has a characteristic *villous* structure. Cells of the *cytotrophoblast* locally proliferate and penetrate the *syncytiotrophoblast* to form cell columns surrounded by syncytia = ***primary villi*.** The *hypoblast* produces other cells, which migrate along the inner wall of the *Heuser's membrane*. These cells proliferate and eventually form a cavity within the *exocelomic cavity* the **secondary yolk sac** (the *definitive yolk sac*). The latter is much smaller than the *exocelomic cavity (primitive yolk sac)*. During the formation of the definitive yolk sac, a large part of the *exocelomic cavity* is separated. The detached part represents the **exocelomic cyst**, which is often found in the *extraembryonic coelom (chorionic cavity)*. While the extraembryonic coelom *expands to form a large cavity (chorionic cavity), the extraembryonic mesoderm* lies on the inside of the cytotrophoblast *as a* ***chorionic plate***. Only seats where the *extraembryonic mesoderm* intersects the *chorionic cavity* is the **germoid**. With the development of blood vessels, the germ tube becomes the ***umbilical cord***.[4]



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Embryonic period (3rd-8th week)

🔎 *For more information see Fourth to eighth weeks of embryo development.*

Scoring in week 4 (overview) Embryo furrowing in week 4

Week 3

The main process of the third week of development is **gastrulation**, i.e. the invagination of the epiblast cells, which thus become the source of all three layers of the three-layered germ target. The formation of notochord (chorda dorsalis) occurs through the stage of the chordomesoderm process. We observe the formation of the tail tubercle, the first somites, the neural plate and the neural furrow.

Week 4

Creases occur:

- **Headfold**:
  - arching of the brain into the amniotic cavity, then overhanging the heart;

    - septum transversum, base of the heart, pericardial cavity, oropharyngeal;
    - the membrane passes to the ventral side of the embryo;
    - between the region of the brain and the heart comes the anterior gut (separated by the oropharyngeal membrane);
    - there is a change in the shape of the intraembryonic coelom.
- **Caudal fold**:
    - growth of spinal cord bases in length;
    - the rear intestine with a widened end - the cloaca is taken here;
    - allantois is partially incorporated.
- **Lateral folds**:
    - rapid growth of spinal cord and somites;
    - the edges bend and wrap the edges of the germinal target ventrally – the embryo thus acquires a cylindrical shape;
    - midgut involved – connection limited to yolk sac volcano.

The anterior (25th day) and posterior (27th day) neuropores close, forebrain and somites emerge.

Other structures emerging during the 4th week:

- pharyngeal arches;
- limb buds;
- the heart begins to pump blood;
- the foundations of the liver, lungs, gall bladder, pancreas, urorectal septum are formed;
- auditory sacs, lens placodes appear;
- the oropharyngeal membrane breaks;
- facial protrusions.

Week 5

- Head development (brain grows), facial processes come into contact with the heart;
- sinus cervicalis – the 2nd arch outgrows the 3rd and 4th;
- limb buds – upper paddle-like, lower fin-like;
- mesonephric bar.

Week 6

- Palmar discs - digital rays;
- ear bumps merge, meatus acusticus externus;
- pigment to the retina – the eye can see;
- the head continues to enlarge and overlaps the cardiac hump;
- the torso and neck begin to straighten;
- first spontaneous movements, umbilical hernia.

Week 7

- Notches appear between digital beams, limbs rotate;
- yolk stalk, umbilical herniation;
- Ossification of upper extremity begins, face formed.

Week 8

- Fingers of upper extremity are separated, Fingers of lower extremity not yet;
- typically human appearance;
- vascular plexus of the scalp;
- the eyelids begin to fuse, the eye slits close, which is considered the end of the embryonic period.

Fetal period

The fetal period begins at the 9th week, when all body structures are already established, and lasts until birthu, i.e. until the 38th week. From the 25th week of pregnancy (perinatal stages), in the case of a possible premature birth, we no longer generally speak of a fetus, but of a premature child.

Links

Related links

- Gametogenesis
- Fertilization
- Egg scoring
- First week of embryo development
- Second week of embryo development
- Third week of embryo development
- Fourth to Eighth Embryo Development Week

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2. VAJNER, Luděk. *Obecná embryologie I.* Embryologie a vývojová biologie edition. 2.lékařská fakulta UK, Praha. 2011. ISBN https://dl1.cuni.cz/course/view.php?id=1055.
3. KEITH L., Moore – T. V. N., Persaud. *Zrození člověka: embryologie s klinickým zaměřením.* 1. edition. Praha : ISV, 2002. 564 pp. ISBN 80-85866-94-3.
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