Mechanism of inheritance of traits:

Mendelian experiments suggest that during sexual reproduction, fusion of gametes takes place. Each parent of the parental generation P_1 contributes equally a copy of the same gene to the DNA of the progeny. Each pea plant has 2 sets of every gene called alleles, one received from the male parent and the other from the female parent. But each gamete has only one gene set.

In a dihybrid cross, if the progeny inherited only one gene set from each parent, then the two traits in Mendel's experiment, namely shape and colour of the seed would co-exist. But this does not happen because each gene set is not present as a single long thread of DNA, but as separate independent pieces called chromosomes.

In human beings, there are 46 chromosomes or 23 pairs of chromosomes, one from each parent. During gamete formation, the gamete takes one chromosome from each pair. When two such gametes having a single set of genes combine together, they restore the normal diploid number of chromosomes in the progeny. This is the mechanism of inheritance of traits. The results of Mendel's experiments can be explained by this mechanism.

Basic features of mechanism of inheritance of traits:

- Characters are controlled by genes.
- Each gene controls only one character.
- There may be two or more forms of a particular gene.
- One form of the gene may be dominant over the other form.
- Genes are present on chromosomes.
- An individual bears two forms of a gene, either similar or dissimilar.
- The two forms of the gene separate independently during gamete formation.
- The two forms of the gene are brought together during zygote formation.

Gametogenesis

The origin and development of gametes is called gametogenesis.

This may be divided into spermatogenesis and oogenesis. Spermatogenesis deals with the development of male sex-cells called sperms in the male gonad or testis.

Oogenesis is the development of female sex-cells called ova or eggs in the female gonad or ovary.

Introduction to Gametogenesis

We can simply call it the procedure by which sperms and ova (male and female sex cells) are designed in the male testes and female ovaries respectively. These gametes vary from all the other cells present in the

body. This is because their nuclei contain only half the count of chromosomes present in nuclei of somatic cells.

It is vital to note that, meiosis shapes the most major part of the development of gametogenesis. Further, gametogenesis associated with the formation of sperms is called as spermatogenesis whereas the formation of ova is termed as oogenesis. In addition, both oogenesis and spermatogenesis include similar stages of sequential changes; that includes:

- Multiplication phase
- Growth phase
- Maturation phase

Insights about Spermatogenesis

The formation procedure of sperms is known as spermatogenesis. This occurs primarily in the seminiferous tubules present in the testes. These seminiferous tubules are creased by germinal epithelium. Further, the germinal epithelium largely comprises of primordial germ cells or PGCs. In addition, tall somatic cells termed as Sertoli cells (nurse cells) are also present. Spermatogenesis refers to the formation of spermatids and spermatozoa.

Creation of Spermatids

This procedure covers three stages; namely:

- **Multiplication Phase**: During sexual maturity, the division of undistinguishable primordial germ cells occurs several times due to mitosis. This is majorly to produce a large count of spermatogonia. These are of two kinds: type A and type B. Type A spermatogonia act as the stem cells that divide to create additional spermatogonia. On the other hand, Type B spermatogonia can be thought as the prototypes of male sex cells.
- **Growth Phase**: Do remember that, every type B spermatogonium dynamically grows to form a superior primary spermatocyte through nourishment received from the nursing cells. This phase further concludes in the maturation stage.
- **Maturation Phase**: Under this, primary spermatocyte experiences two successive divisions. These are termed as maturation divisions, and meiotic is the first maturation disunion. Therefore, the primary spermatocyte segregates into two haploid daughter cells known as secondary spermatocytes. Further, both the secondary spermatocytes suffer second maturation separation that is a regular mitotic division. It leads to the creation of four haploid spermatids.

Creation of Spermatozoa

In simple words, the conversion of spermatids to spermatozoa is termed as spermateliosis or spermiogenesis. Further, spermatozoa are later called as sperms. Hence, four sperms are developed from a single spermatogonium. Once spermiogenesis happens, the sperm heads are fixed in the Sertoli cells, which are finally let loose from the seminiferous tubules through a process termed as spermiation.

Sperms are motile and microscopic cells that remain alive and recollect their capability to fertilize an egg (ovum) from 24 -48 hours right after being free in the female genital tract. For a typical mammalian sperm, the head, neck, together with middle piece and tail are the prime sections.

Sperm

Oogenesis

The effect of gametogenesis in females is associated with the mature female gamete. This is created through a process called oogenesis. This happens in the ovaries or female gonads. There are three phases to Oogenesis; namely, multiplication phase, growth phase and maturation phase. Let us try to understand these phases in a precise manner.

- **Multiplication Phase:** During foetal development, it should be noticed that certain cells present in the germinal epithelium of the female ovary are bigger than others. Hence, these cells split by mitosis, creating a couple of million oogonia or mother egg cells in each ovary present in the foetus. There are no more oogonia which are formed or augmented after birth.
- **Growth Phase:** This particular procedure of the primary oocyte tends to be very long. In this, the oogonium nurtures into bigger primary oocytes. After this, each primary oocyte gets surrounded by a granulosa cells layer to create primary follicle. Later, a large number of follicles get debased during the duration from birth to puberty. Therefore, at puberty around 60,000 to 80,000 primary follicles can be found in each ovary.
- **Maturation Phase:** Similar to a primary spermatocyte, every primary oocyte experiences two maturation divisions. However, the outcomes of maturation divisions under oogenesis are quite different to those which occur in spermatogenesis. Considering the first meiotic division, the

primary oocyte segregates into two uneven haploid daughter cells. These are known as the large secondary oocyte and a small polocyte.

Later, considering the second maturation separation, the initial polar body might split to create two, second polar bodies. Here, the secondary oocyte once again divides to form unfit daughter cells.

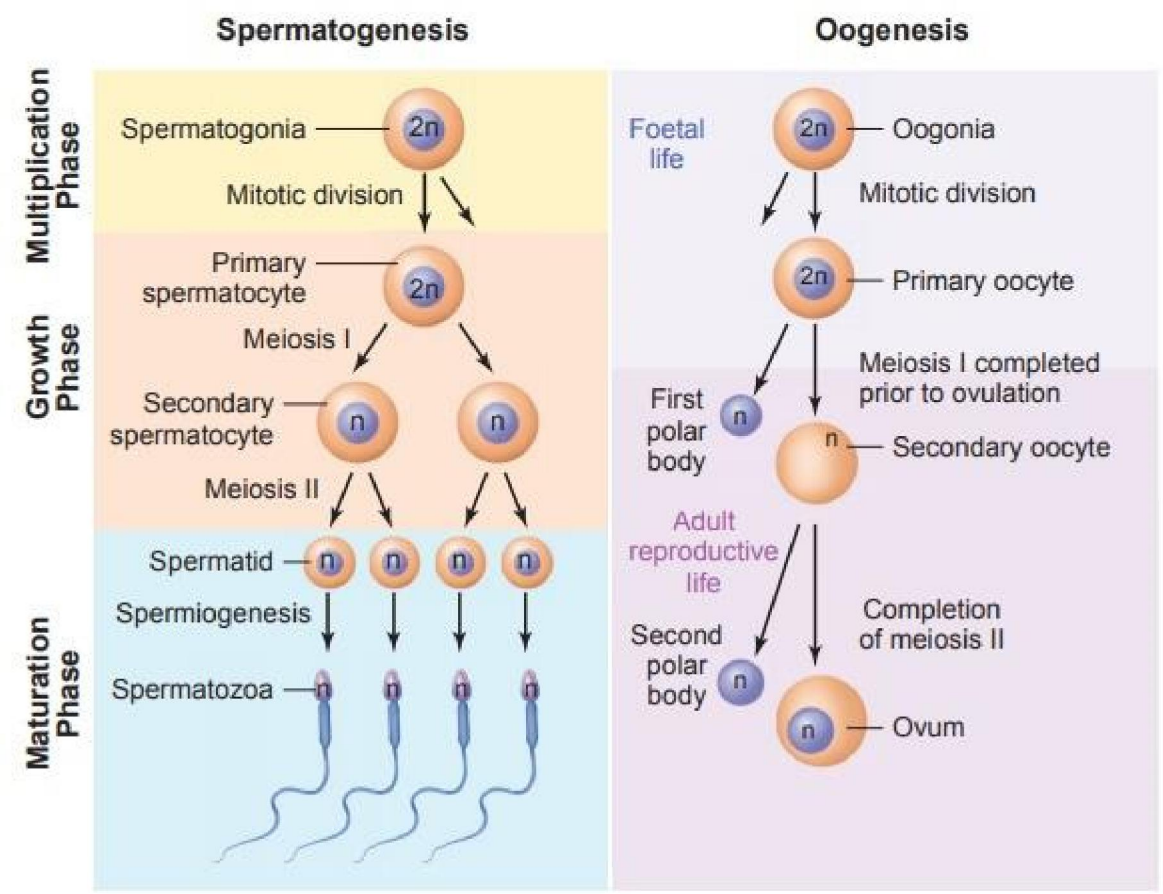

Fig. 2.5 Gametogenesis

Significance of Gametogenesis:

1. The process leads to formation of germ cells or gametes.
2. The normal body cells known as somatic cells are diploid (2n) where as the germ cells are haploid (n).
3. During fertilization one haploid sperm unites with one haploid ovum to form a normal diploid somatic cell thus keeping the chromosome number constant generation after generation.
4. During meiosis first crossing over takes which brings about variation.

Fertilization and post fertilization events in humans

In human beings, there are certain events that take place before and after the fertilization. It casts an impact on the entire process. The entire process of fertilization in humans gives rise to new life, which is essential to carry forward the human race. So let's learn about this essential process.

Pre-fertilization Phase in Humans

Before fertilization in humans can take place, certain conditions need to exist, in order to support the process. In females and males, the process of gametes formation is the process of gametogenesis. Gametes are generally haploid cells. Some of the organisms have a haploid type of parental body. Some examples of such organisms are monerans, algae, fungi, and bryophytes.

It is known that these organisms produce gamete cells by the division of the body through mitosis. In case the body of the parent is diploid, the same gametes form through a process of meiosis.

Male and Female Gametes

Sometimes the male and female gametes are similar in appearance. It becomes impossible to point out the difference between them as male and female gametes. Therefore, they are homogametic or isogametes.

In case the male and female gametes look dissimilar, they come to be called heterogametes. Among the heterogametes, the male reproductive unit is called sperm and the female reproductive unit is known as the ovum. Specialised cells, present in the diploid parent body are responsible for taking part in the production process of gametes. This is known as meiocytes.

At the instance of gamete formation, such meiocytes undergo division. As a result of this meiotic division, the number of chromosomes in the gametes reduces to a half and form the diploid meiocytes.

In case of humans, the male gametes are motile while the female gametes are stationary in action. After the formation of gametes, the male and female gametes ideally come in physical bond, so that they can be fused with each other for fertilization. During such transfer, a large number of gametes do not reach the female gametes.

To fulfil the loss, the ratio of male gametes produced is several thousand in number to the quantum of female gametes. After this, the male gametes are carried to the point of fertilization through a special tube that ensures that the male gametes can pass through without undergoing any damage.

Fertilization in Humans

When male gametes fuse with the female gametes, the entire process is fertilization in humans. This process results in the formation of a diploid zygote. In most animals, external fertilization takes place in an environment that is like their natural surroundings.

External fertilization in humans helps in allowing the male gametes to reach the female gametes. During the process of development, the resulting cells tend to divide and specialise. A sperm cell comes to fertilise the ovum. If fertilised, the resulting zygote will further undergo mitotic division and growth.

Ultimately, a multicellular embryo will form, which will grow and develop over time. After the fertilization in humans, the major events which will take place include early embryonic development, establishing multicellularity, the formation of the blastula, and formation of embryonic germ layer. One process after the other will lead to the establishment of several germ layers, which will help the tissues to form and interact with each other.

Post-fertilization Events

Gastrulation is the process of highly coordinated cell and tissue movements whereby the cells of the blastula undergo dramatic rearrangement. During gastrulation, the cells get specified new positions and the multi-layered body plan of the organism is specified. At the early stages of development, the embryo acquires a disc which consists of three layers. These layers are the ectoderm, mesoderm and endoderm.