Reproduction in fishes

Reproduction in fishes

INTRODUCTION

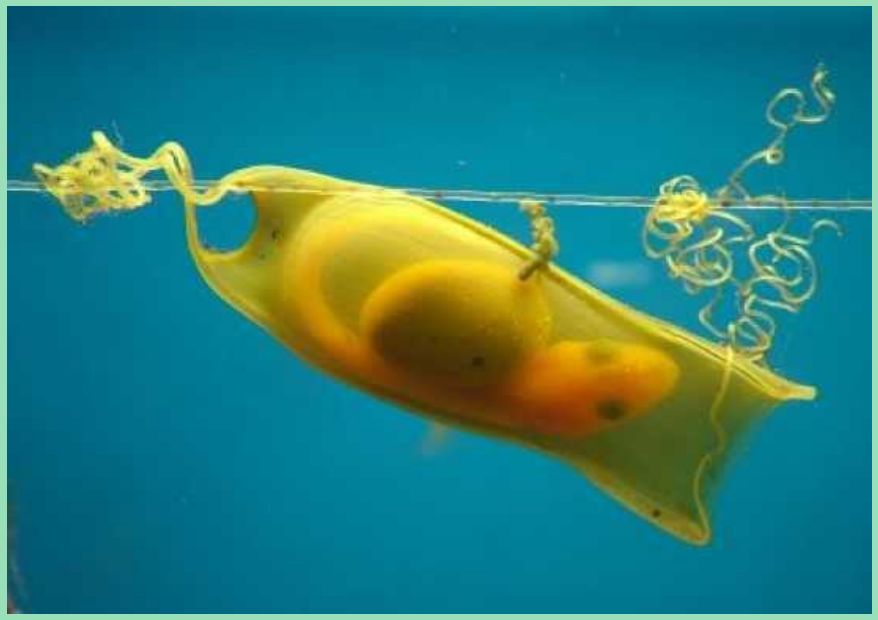
Fish are the largest phylum of living vertebrates, with around 30,000 fish species out of approximately 50,000 vertebrate species .

Fish inhabit almost every aquatic environment on the planet, which present an enormous variation in temperature, salinity, oxygen, and other chemical and physical water properties.

These environments have exerted evolutionary pressures that have resulted in the evolution of the enormous number of fishes and an immense variety of reproductive strategies.

Fish exhibit various types of sex determination, from genetic to environmental control, sex differentiation from hermaphroditism to gonochorism, age of puberty, from a few months to many years, fecundity, from a few to millions of eggs, internal or external fertilization, a wide range of egg sizes, some that float and others.

uncared eggs scattered into the environment to parental care of eggs to live “birth” (ovoviviparity)




CAVIAR PETROSSIAN PARIS

THE REPRODUCTIVE CYCLE OF FISH

The reproductive cycle is an ensemble of successive processes from immature germ cells to the production of mature gametes, with the final purpose of obtaining a fertilized egg after the insemination with spermatozoon. The process of gamete growth and differentiation is called gametogenesis, and leads to the formation of the female oocyte (oogenesis) or the male spermatozoon (spermatogenesis).

Both the female and male gametes have a common origin in the population of embryonic primordial germ cells (PGC) that migrate during embryonic development to the place of gonad formation, the germinal epithelium

The PGC proliferate through mitotic divisions to form the gonia, which differentiate into oogonia or spermatogonia depending on the sex of the individual. With the last mitotic division, gonia enter meiosis and become oocytes or spermatocytes, thus initiating gametogenesis in adult animals In both males and females.

The reproductive cycle involves two major phases:-

1- the phase of gonadal growth and development (gametogenesis).

2- the phase of maturation, which culminates in ovulation/spermiation and spawning.

Ovarian development in females: oogenesis, maturation and ovulation

The ovary of female fish is a bilateral elongated organ, localized in the abdominal cavity.

The ovarian lobules are surrounded by the mesovarium and project posterior through a pair of oviducts that connect to the genital papilla, which opens to the external environment.

The ovaries are compartmentalized by folds of the germinal epithelium that project transversally to the ovarian lumen .
In these lamellae, the oocytes undergo the various phases of gametogenesis, until mature ova are released into the ovarian cavity or abdominal cavity at ovulation and then to the external environment during spawning.

Ovulated ova may remain in the ovarian abdominal cavity for a period of time before spawning , they maintain their maturational competence (fertilizing capacity) for a certain period of time, but if not spawned, the ova become “over-ripe” through a process of degeneration

The germinal unit of the ovary consists of an oocyte surrounded by two layers of follicular cells. These follicular cells envelop the germ cell and offer structural and functional support to the developing oocyte, mediating the internalization of external molecules and synthesizing hormones and factors necessary for the differentiation, growth and survival of the oocyte.

Each oocyte is surrounded by **an inner mono-layer of granulosa cells** and an **outer mono-layer of theca cells** Between the two follicular layers there is a thin basal membrane, which separates them. Also, a thick acellular envelop surrounds the oocyte

The reproductive cycle of female fish can be divided into :-

1- the period of oocyte growth (gametogenesis)

2- the period of oocyte maturation, along which the oocyte goes though different stages of development, before ovulation and spawning

The primary oocytes

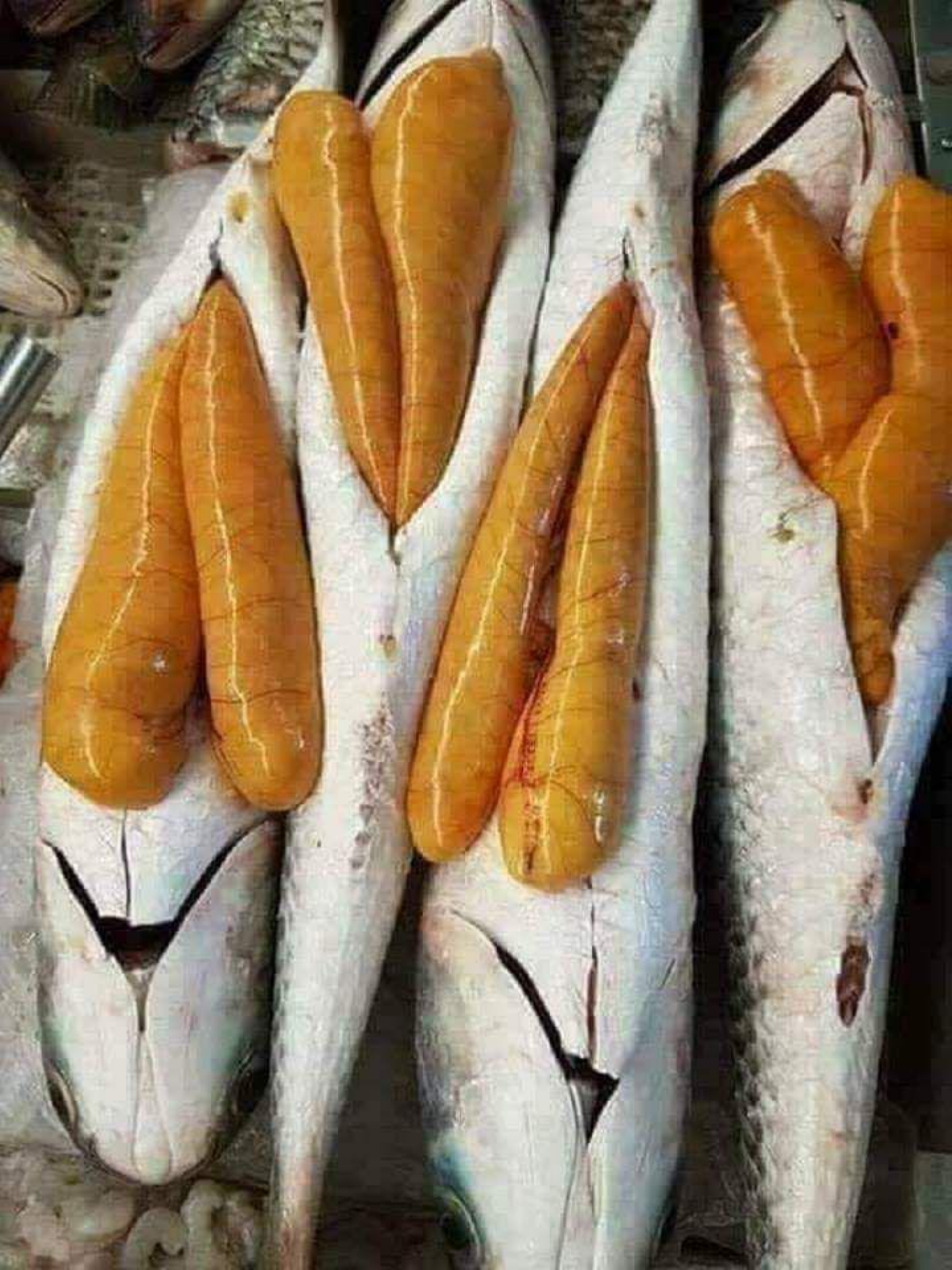
1- growth phase
2- the appearance of pale material in the cytoplasm
3- the appearance of the granulosa and theca cellular layers
4- This is a hormone-independent phase, before the period of E2-induced VTG synthesis

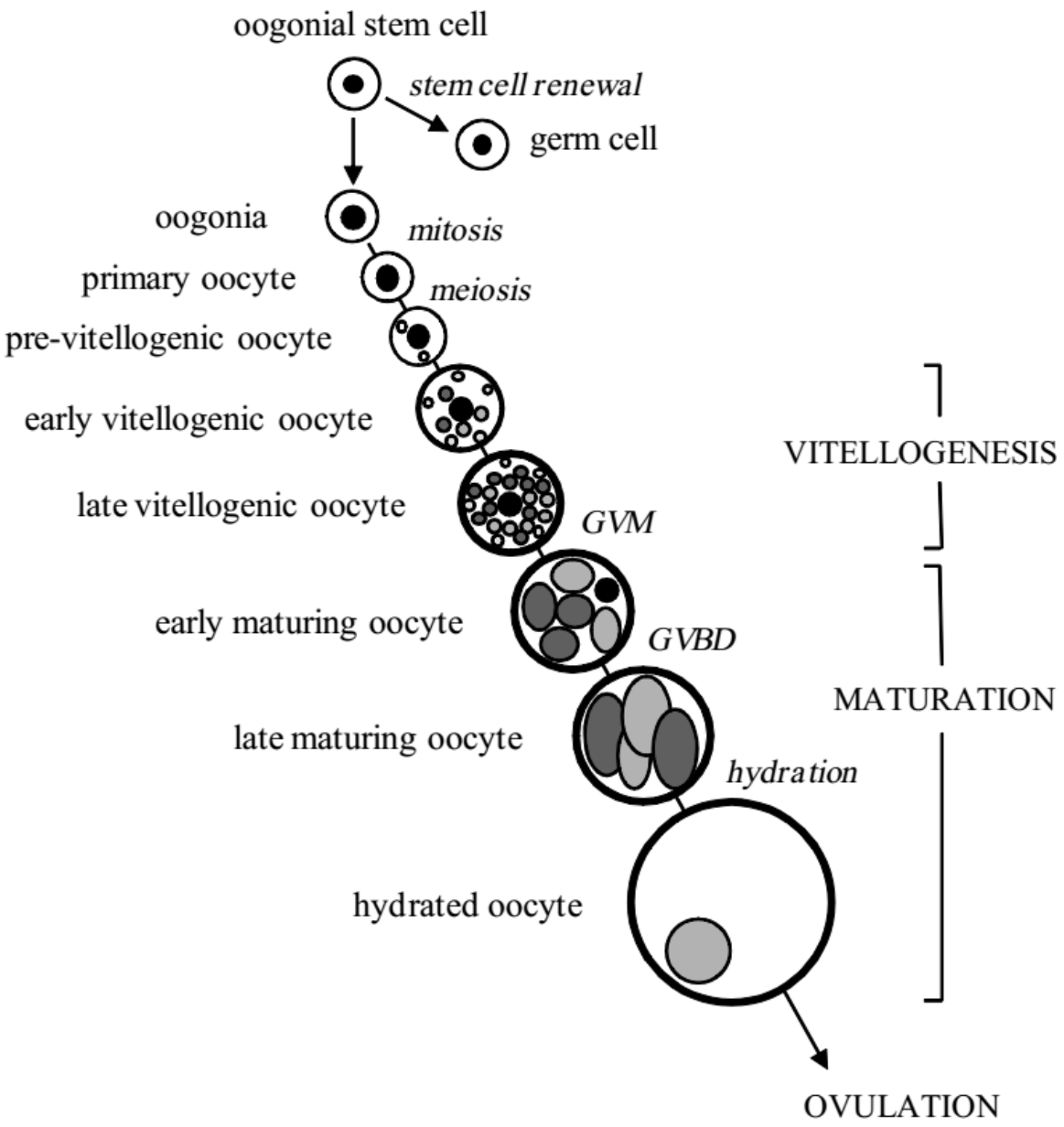
The secondary growth phase

1- characterized by the synthesis and enormous accumulation of **VTG** and **vitellin** related proteins into the oocyte.

2- resulting in a 10-fold increase in size .

3- At early vitellogenesis, the oocyte is small (around 100 μm in diameter),with an opaque cytoplasm almost deprived of inclusions, except some oil droplets. With the progression of vitellogenesis, new inclusions appear in the cytoplasm, such as the cortical alveoli, lipid globules and yolk granules.




oogonial stem cell
stem cell renewal
germ cell
oogonia
mitosis
primary oocyte
meiosis
pre-vitellogenic oocyte
early vitellogenic oocyte
late vitellogenic oocyte
GVM
early maturing oocyte
GVBD
late maturing oocyte
hydration
hydrated oocyte
VITELLOGENESIS
MATURATION
OVULATION

Testicular development in males: spermatogenesis, maturation and spermiation

The male gonad (testes) is also comprised of **germinal** and **somatic tissue** .The germinal cells develop during spermatogenesis to give rise to the gametes, the spermatozoa. The somatic tissue of the testes forms the seminiferous tubules and supporting connective tissue, as well as specialized somatic cells, **the Leydig** and **Sertoli cells** .

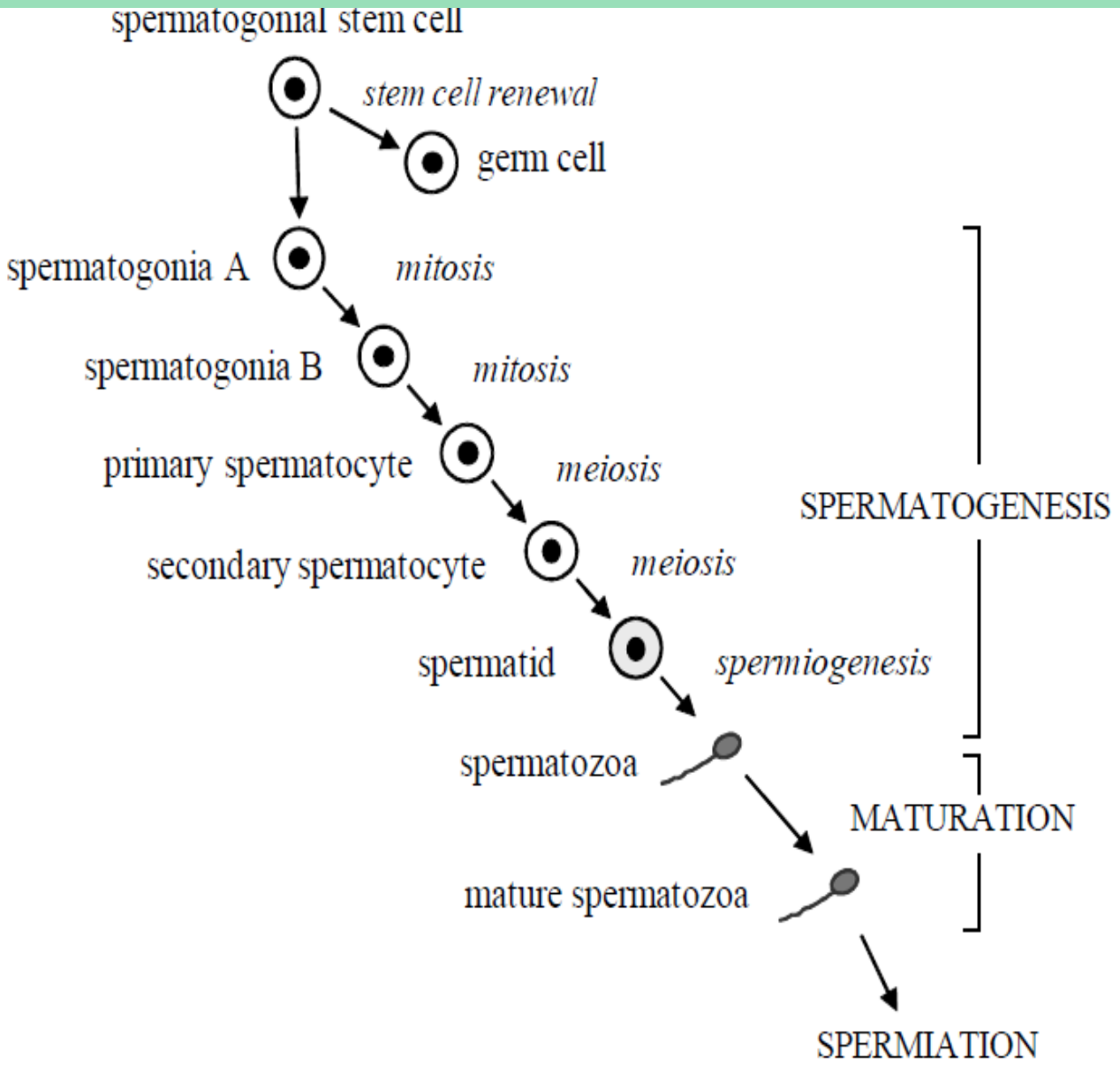
These somatic cells offer structural and functional support to the germinal cells and play a crucial role in the production of hormones and other factors necessary for germ cell differentiation, development and survival.

The Sertoli cells envelop the germ cells to form units called cysts or **spermatocysts**. The sum of all cysts constitutes the **germinal epithelium** of the testes.

The process of spermatogenesis can be divided in three major phases :-

1- the mitotic proliferation of the spermatogonia.
2 - the meiotic division of the spermatocytes.
3- the transformation of the haploid spermatids into flagellated spermatozoa (spermiogenesis).

The spermatids enter the process of spermiogenesis in which the haploid spermatids differentiate into flagellated spermatozoa. This process does not involve cellular proliferation, but only cell transformation, which includes a drastic reduction.
in size (>80%) due to nucleus condensation and extrusion of the cytoplasmic content to the surrounding Sertoli cells.


spermatogonial stem cell
stem cell renewal
germ cell
spermatogonia A
mitosis
spermatogonia B
mitosis
primary spermatocyte
meiosis
secondary spermatocyte
meiosis
spermatid
spermiogenesis
spermatozoa
mature spermatozoa
SPERMATOGENESIS
MATURATION
SPERMIATION

ENVIRONMENTAL REGULATION OF FISH REPRODUCTION

The aim of reproduction is to have offspring that survive. It has been recognized for a long time that :-

1- food availability flow of energy (energetics) have been acknowledged

2- and environmental such as temperature - photoperiod, tides, latitude, water depth, salinity .

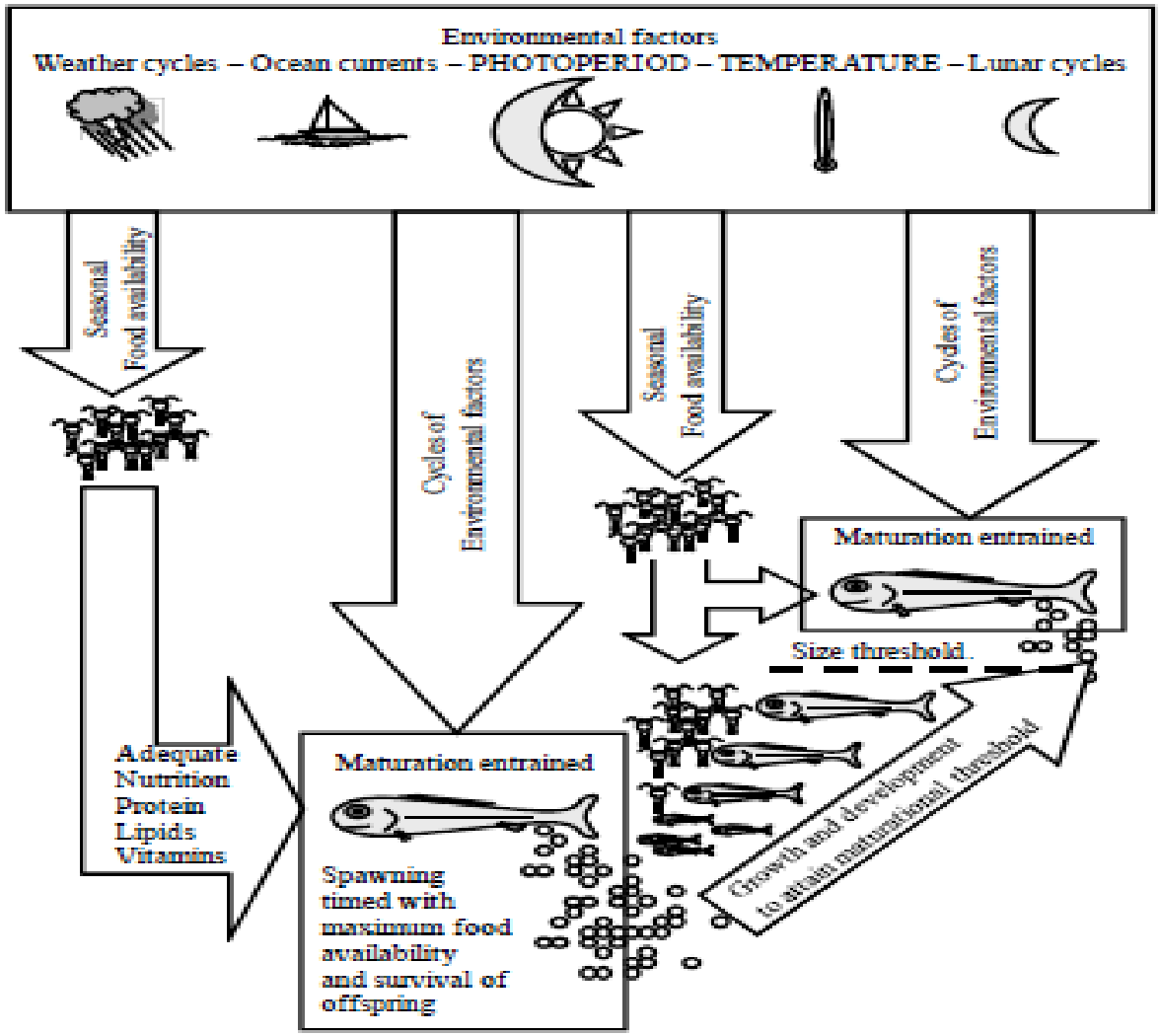


Figure 3 - Diagram of environmental factors affecting fish. The environmental factors such as photoperiod, temperature, lunar cycles, weather cycles and ocean currents, control the seasonality of food availability and entrain maturational development of fish. Food availability and the ability to store energy determine when a fish attains a genetical threshold and proceeds to the completion of maturation. Maturational development of the fish is entrained by environmental factors to ensure that critical off-spring feeding periods coincide with peaks in food availability which are months or years after maturation is initiated.


Thank you for listening