THE NUCLEUS
The **nucleus** is the 'control center' of the cell. The nucleus contains nucleic acids, DNA, and RNA, which in turn contain C, H, O, N, and P. The nucleus controls cell functions via DNA, which contains the instructions. The DNA can be compared to computer software, controlling the cell organelles, which are comparable to computer hardware. DNA provides the code for protein synthesis.

Chromosome

- Somatic cells of each species contain a specific number of chromosomes
  - Human cells have 46, making up 23 pairs of homologous chromosomes

MITOSIS AND MEIOSIS LEAD TO DIFFERENT OUTCOMES
Although **mitosis** and **meiosis** share many similar events, specific differences between these processes result in the formation of different types of cells.

Whether a cell is formed by mitosis or meiosis dictates how many chromosomes each daughter cell will contain.

- A complete set of chromosomes (*n*) is one of each chromosome number, or one member of each homologous pair. This is the set contained in **haploid** cells.

- **Diploid** cells contain two sets of chromosomes (*2n*).

The cell cycle – somatic cells

Interphase

Growth and DNA replicated

(G1 S1 G2 phase)

- Chromosomes have **not** formed… chromatin

- Not in mitosis the cell is getting ready to divide

M- mitosis

- Chromosomes now distinct

C- cytokinesis

- The division cell contents outside of the nucleus
- Resulting cells identical
- 2N in number of chromosomes (humans 2N= 46 chromosomes)

Control over cell cycle – programmed cell death

Copy errors in mitotic division

- Chromosomes come in homologous pairs in diploid organisms.

- At the beginning of cell division the DNA replicates and each chromosome is now a pair of identical sister chromatids

- Meiosis

- DNA replicated homologous chromosomes with sister chromatids

- 1 homologous chromosome in each cell

- 1 sister chromatid in cell
- Final cells 1N (humans 23)

Meiosis in action

Reproduction
Chapter 28
Asexual and Sexual Reproduction

- Genetically identical cells are produced from a single parent cell by mitosis.
  - Fission or Budding

- Sexual reproduction occurs when new individual is formed through union of two sex cells (gametes).
  - Produce zygote.
  - Haploid gametes formed by meiosis in sex organs (gonads).

Asexual and Sexual Reproduction

- Different Approaches to Sex
  - Parthogenesis - Virgin birth
    - Exclusive
    - Switching

  - Sexual Reproduction
    - monoecious / dioecious
    - Hermaphroditism - Both Sex organs

Evolution of Reproduction

- Three Strategies of Internal Fertilization:
  - Oviparity - Eggs are fertilized internally and deposited outside mother's body to complete development.
  - Ovoviviparity - Fertilized eggs are retained within mother to complete development, but all nourishment gained from yolk sac.
  - Viviparity - Young develop within mother and obtain nourishment directly from mother's blood.

Porifera and Cnidaria

- Sponges reproduce by both asexual and sexual means. Most poriferans that reproduce by sexual means are hermaphroditic and produce eggs and sperm at different times.

- Cnidarians reproduce by both asexual and sexual means.

Arthropoda

- **reproduction**
  - dioecious - many dimorphic
  - oviparous, or ovoviviparous
  - metamorphosis - complete / incomplete
  - some parthenogenic – development from a unfertilized ovum.
    - Fertilization can be internal- males have an ovipositor

Annelida

- **reproduction**
  - monoecious / dioecious
  - trochophore larva
  - asexual - budding
  - Fertilization external
  - Gametes passed into the coelom (body cavity)

Evolution of Vertebrate Reproduction

- Vertebrate sexual reproduction evolved in the ocean before vertebrates colonized land.

  - Most marine bony fish utilize external fertilization.
  - Most other vertebrates utilize internal fertilization.
    - Gametes could not be released on dry land without significant mortality.

Sexual Reproduction

- Sex Determination
  - In some organisms, environmental conditions can determine sex of offspring.

- In mammals, sex is determined early in embryonic development.
  - Embryonic gonads are indifferent.
    - Y chromosome produce males.

Sex Determination

Evolution of Vertebrate Reproduction

- Fish
  - Eggs of most bony fish fertilized externally, and eggs contain small yolk sac.
  - Fertilization in most cartilaginous fish is internal.
- Amphibians
  - Fertilization is usually external.
  - Eggs of most species develop in water.
  - Development divided into stages.

Evolution of Vertebrate Reproduction

- Reptiles
  - Most reptiles are oviparous, and lay amniotic eggs.
    - Other species are ovoviviparous, or vivaparous.
  - Most males use penis to inject sperm into females.

Evolution of Vertebrate Reproduction

- Birds
  - All birds practice internal fertilization.
    - As eggs pass along oviduct, glands secrete albumin proteins and hard calcareous shell.
  - Homeothermic - Must keep eggs warm.
  - Young cared for and nurtured by parents.

Evolution of Vertebrate Reproduction

- Mammals
  - Females generally undergo reproductive cycles (estrous cycles).
    - Periodic release of mature ovum.
    - Changes in secretion of follicle stimulating hormone (FSH) and lutenizing hormone (LH) by pituitary gland drive cycle.

- Induced Ovulators - Females ovulate only after copulation as a result of LH secretion.
  - Cats and rabbits.

Evolution of Vertebrate Reproduction

- Monotremes
  - Oviparous (duck-billed platypus).
  - Incubate eggs
  - Lack nipples
- Marsupials
  - Give birth to incompletely developed fetuses that complete development in mother's pouch.

Evolution of Vertebrate Reproduction

- Placental Mammals - Retain young for relatively long period of development within mother's uterus.
  - Nourished by placenta.

Human Males

- Sperm acts as carrier of genetic information.
  - Haploid (23 chromosomes)
  - Produced in testes within the scrotum.
    - Packed with seminiferous tubules.
    - Contain cells that secrete testosterone.
  - Transferred to epididymis for maturation and storage.
  - Delivered to vas deferens and then urethra before exiting penis.

Male Reproductive Organs

Male Reproductive Organs

- Penis
  - Two long cylinders of spongy tissue.
    - Inflates with blood to form erection.
  - Third tube (urethra) transports semen and urine.
    - Typical ejaculate produces about 5 ml of semen containing several hundred million sperm.- less than 20 million per ml is classified as infertile

Human Females

- Eggs develop from oocytes in ovaries.
  - During ovulation, one or a few oocytes initiates maturation.

- At birth, female's ovaries contain 2 million primary oocytes.
  - At onset of puberty, FSH release resumes first meiotic division in a few oocytes.
    - Single oocyte becomes dominant.
      - 28 day cycle

Human Females

- Fertilization Occurs in Oviducts
  - Fallopian tubes (oviducts) transport ova (mature egg cells) from ovaries to uterus.
    - Lined with stratified epithelial membrane (endometrium).
    - Smooth muscles lining fallopian tubes contract rhythmically, moving egg down tube to uterus.
      - Takes 5-7 days to arrive at uterus.

Female Reproductive System

Human Females

- Any egg that arrives at uterus unfertilized, can never become fertilized.
  - Outer layer of endometrial lining is shed if egg is not fertilized.
- Sperm entering uterus must swim against current generated by tubal contractions to reach fallopian tube.
  - If a sperm reaches and fertilizes an egg, the embryo continues down fallopian tube and attaches to endometrial lining.