Not Yourosis, but Meiosis
Meiosis

Discovery of Meiosis

- **Gametes** are reproductive cells (eggs and sperm) that contain half the complement of chromosomes found in somatic cells
  - the gametes fuse to form a new cell called a **zygote**, which contains two complete copies of each chromosome
    - the fusion of gametes is called **fertilization**, or **syngamy**

- The formation of gametes must involve some mechanism to halve the number of chromosomes found in somatic cells
  - if not the number of chromosomes would double with each fertilization
  - **meiosis** is a process of reduction division in forming gametes
    - this ensures a consistent chromosome number across generations

- Meiosis and fertilization constitute a cycle of sexual reproduction

- Somatic cells have two sets of chromosomes making them **diploid**

- Gametes have only one set of chromosomes, making them **haploid**

- Some organisms reproduce by mitotic division and do not involve gametes
  - this is called **asexual reproduction**
  - an example is binary fission in prokaryotes

- Other organisms are able to reproduce both sexually and asexually
  - for example, strawberry plants flower (sexual reproduction) and send out runners (asexual reproduction)

The Sexual Life Cycle

- In sexual reproduction, haploid cells or organisms alternate with diploid cells or organisms

- In animals, the cells that will eventually undergo meiosis are reserved early on for the purpose of reproduction
  - these cells are referred to as **germ-line** cells and are diploid like somatic cells
  - but only the germ-line cells will undergo meiosis to produce haploid gametes

The sexual life cycle in animals

The Stages of Meiosis

- Meiosis involves two divisions, meiosis I and meiosis II
  - meiosis I separates the homologues in a homologous pair
  - DNA is replicated only before meiosis I

- meiosis II separates the replicate sister chromatids
- when meiosis is complete, the result is that one diploid cell has become four haploid cells

How meiosis works

- Meiosis I is traditionally divided into four sequential stages

1. Prophase I
   - Homologues pair up and exchange segments
2. Metaphase I
   - The paired homologous chromosomes align on a central plane
3. Anaphase I
   - Homologues separate from the pairing and move to opposite poles
4. Telophase I
   - Individual chromosomes gather at each of the two poles

- During prophase I, homologous chromosomes line up together as a pair
  - **crossing over** occurs between two nonsister chromatids of homologous chromosomes
    - the chromatids break in the same place and section of chromosomes are swapped
    - the result is a hybrid chromosome
  - the pairing is held together by the cohesion between sister chromatids and the crossovers

Crossing over

- During metaphase I, the orientation of the homologous chromosome pairing is a matter of chance
  - per homologous chromosome, each possible orientation of which homologue faces which pole results in gametes with different combinations of parental chromosomes
  - this process is called **independent assortment**

Independent assortment

- In anaphase I, the chromosome pairs separate and individual homologues move to each pole

- In telophase I, the chromosomes gather at their respective poles to form two chromosome clusters

Meiosis (just Meiosis I)

- After Meiosis I, a brief interphase occurs where there is no replication of DNA

- Meiosis II follows and is basically a mitotic division of the products of meiosis I
  - except that the sister chromatids are non-identical because of crossing over in meiosis I

- Meiosis II is also divided into four stages

1. Prophase II
   - new spindle forms to attach to chromosome clusters

2. Metaphase II
   - spindle fibers bind to both sides of the centromere and individual chromosomes align along a central plane

3. Anaphase II
   - sister chromatids move to opposite poles

4. Telophase II
   - the nuclear envelope is reformed around each of the four sets of daughter chromosomes

Meiosis (Meiosis II only)

How Meiosis Differs from Mitosis

- Meiosis has two unique features not found in mitosis
  - **synapsis**
    - this is the process of drawing together homologous chromosomes down their entire lengths so that crossing over can occur
  - **reduction division**
    - because meiosis involves two nuclear divisions but only one replication of DNA, the final amount of genetic material passed to the gametes is halved

Unique features of meiosis

A comparison of meiosis and mitosis

Evolutionary Consequences of Sex

- Sexual reproduction has an enormous impact on how species evolve because it generates rapidly new genetic combinations

- Three mechanisms help produce this variety
  1. Independent assortment
  2. Crossing over
  3. Random fertilization