

## Chapter 5

### Cancer:

# DNA Synthesis, Mitosis, and Meiosis

## 5.1 What Is Cancer?

- **Cell division** is the process through which a cell copies itself
- **Cancer** begins when a cell divides when it should not
- Unregulated cell division leads to a **tumor**
  - a mass of cells with no apparent function in the body

# What Is Cancer?

- **Benign** tumors do not invade surrounding tissue
- **Malignant** tumors invade surrounding structures:
  - are cancer
- Cells from Malignant tumors can break away and start new cancers elsewhere
  - through the process of **metastasis**
  - Benign tumors **cannot** metastasize

# What Is Cancer?

- Cancer cells differ from normal cells:
  - Divide when they should not
  - Invade surrounding tissue
  - Move to other locations in the body

# What Is Cancer?

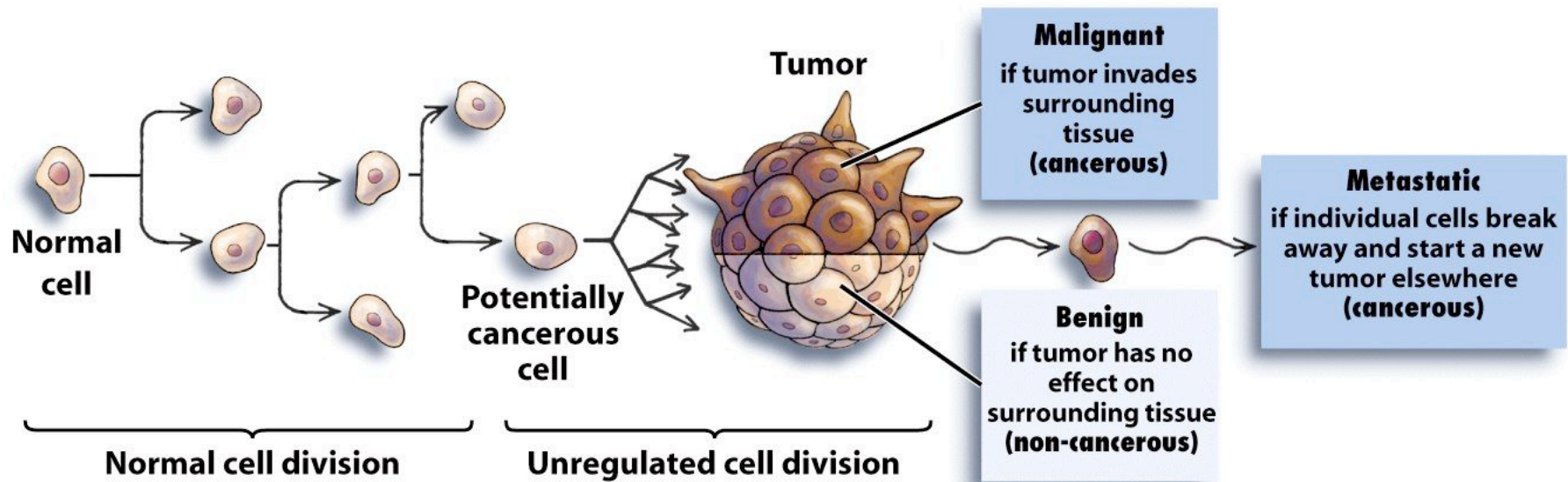


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# What Is Cancer?

- Cancer travels through the body by way of the lymphatic and circulatory systems
  - Lymphatic vessels
  - Blood vessels
- The **lymphatic vessels** collect fluids lost from Blood vessels
- **Lymph nodes** are structures that filter the lost fluids
  - Lost fluid is called lymph

# What Is Cancer?

- All tissues that undergo cell division
- such as ovarian tissue
- are susceptible to cancer

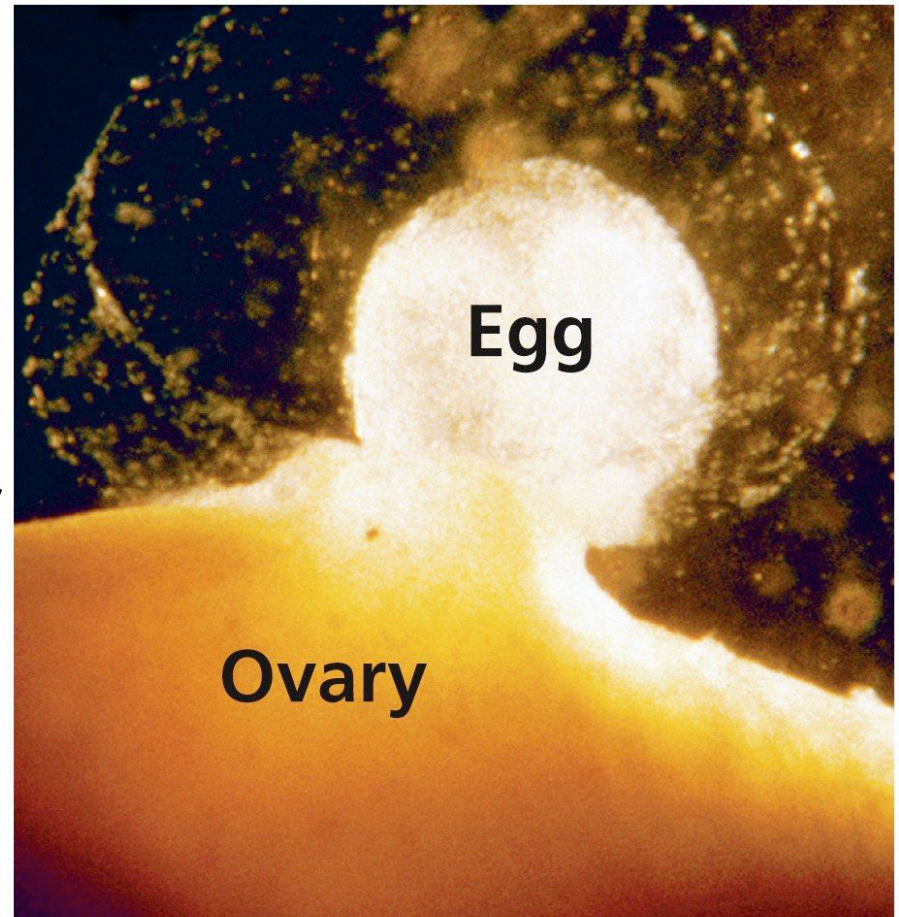


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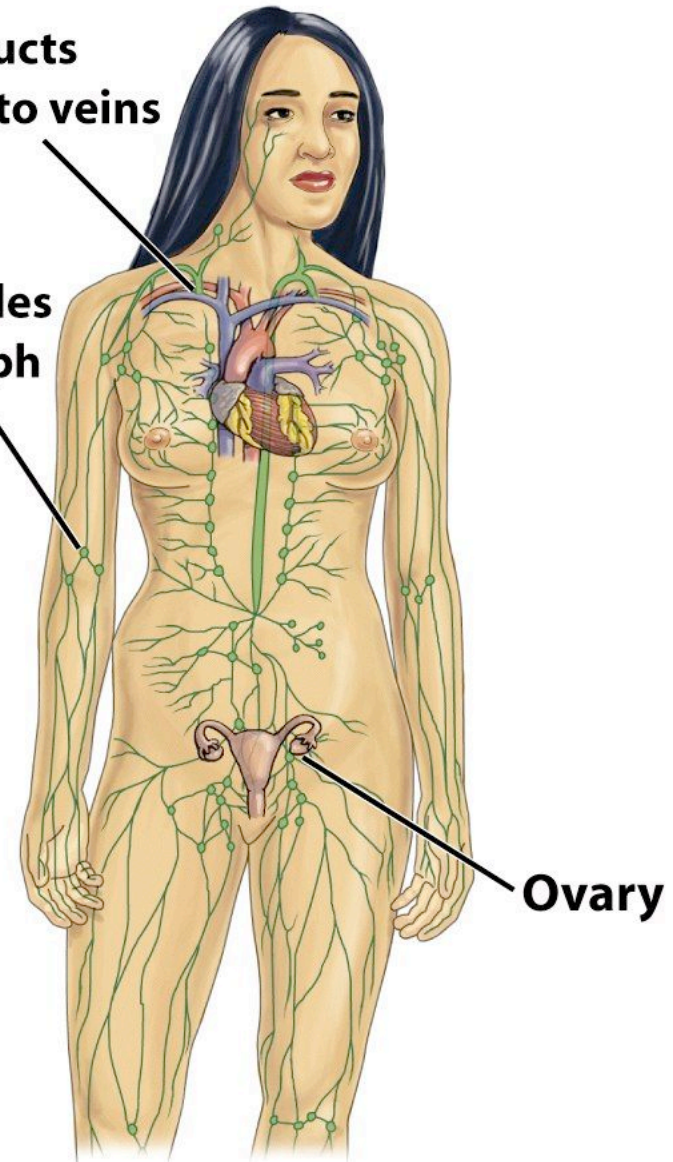


# How Can Ovarian Cancer Kill You?

## Lymphatic system

Lymph ducts  
empty into veins

Lymph nodes  
purify lymph





# How Can Ovarian Cancer Kill You?

- Ovarian tumor cells metastasize into the lymph
  - Some get stuck in lymph nodes
  - Some travel to the bloodstream
- They can travel all over the body in the bloodstream
- Set up camp in vital organs
  - The function of the organs are disrupted by ovarian cell tumors
- Cause multi-organ failure and death

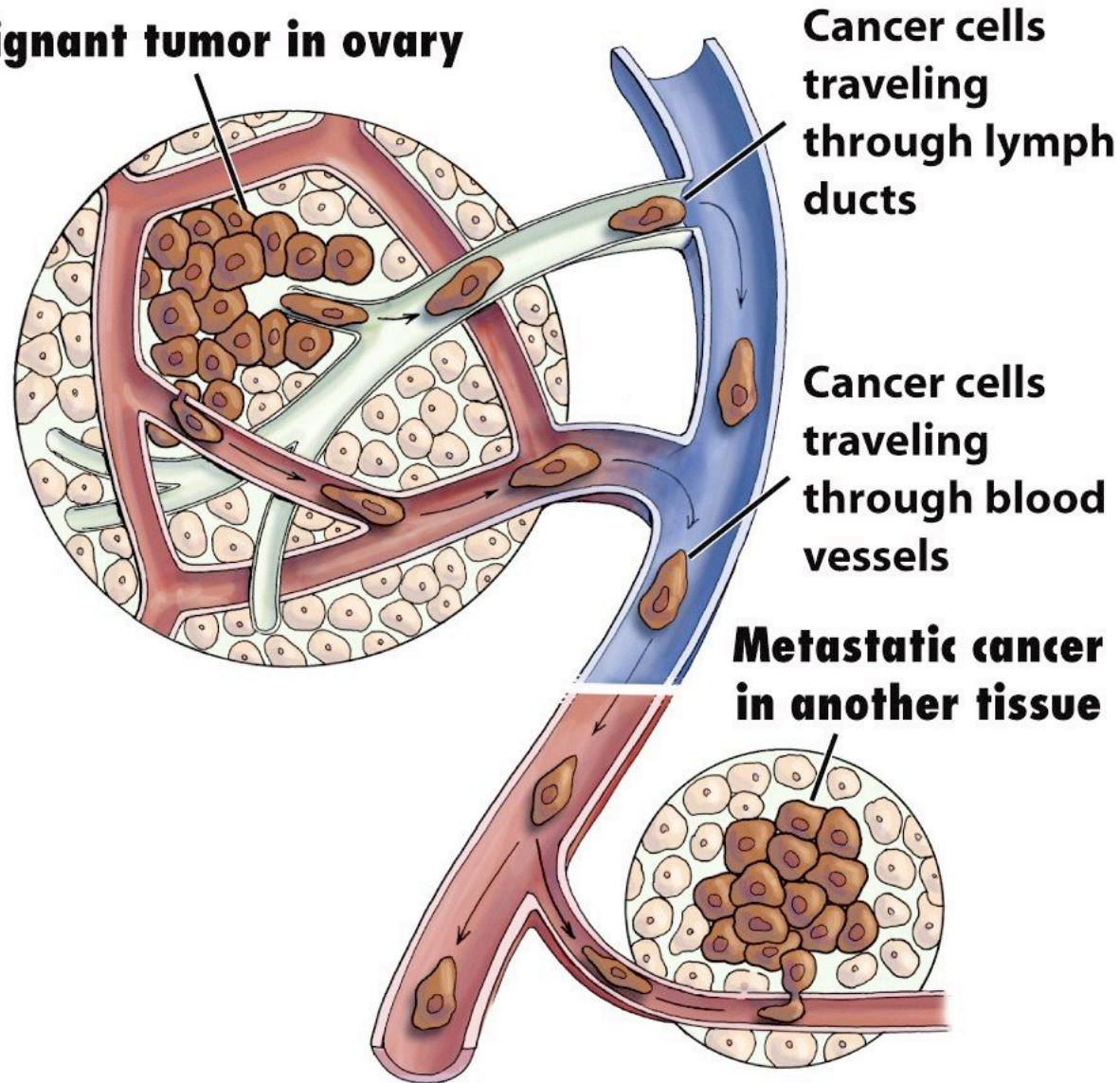
# Why is ovarian cancer so deadly?

- Rarely causes symptoms until tumor is quite large
- No good “early detection” test
  - CA125 tumor marker bloodtest
    - Does not catch half of the early stage ovarian cancers
    - Does catch 90% of advanced
    - False positive tests from endometriosis, fibroids, pelvic inflammatory disease, pregnancy
- Usually metastasizes before detected
  - 70% of cases
  - Stage 2, 3, and 4
- Usually highly aggressive cancer cells
  - Grades 2 and 3
- Overall “5 year survival rate” is (live at least 5 years from diagnosis)
  - Stage 1 = 87%
  - Stage 2 = 59%
  - Stage 3 = 27%
  - Stage 4 = 11.5%

(Rosenthal and Jacobs, 1998)  
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# Cancer cells travel in lymph and blood

**Malignant tumor in ovary**



Cancer cells traveling through lymph ducts

Cancer cells traveling through blood vessels

**Metastatic cancer in another tissue**

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## 5.2 Cell Division Overview

- Cell division produces new cells in order to:
  - Heal wounds
  - Replace damaged cells
  - For growth
  
- Also for reproduction

# Cell Division Overview

## **Asexual reproduction:**

- Make exact copies
- Does not need two parents
- Single celled organisms, like amoebas, carry out asexual reproduction



# Amoeba

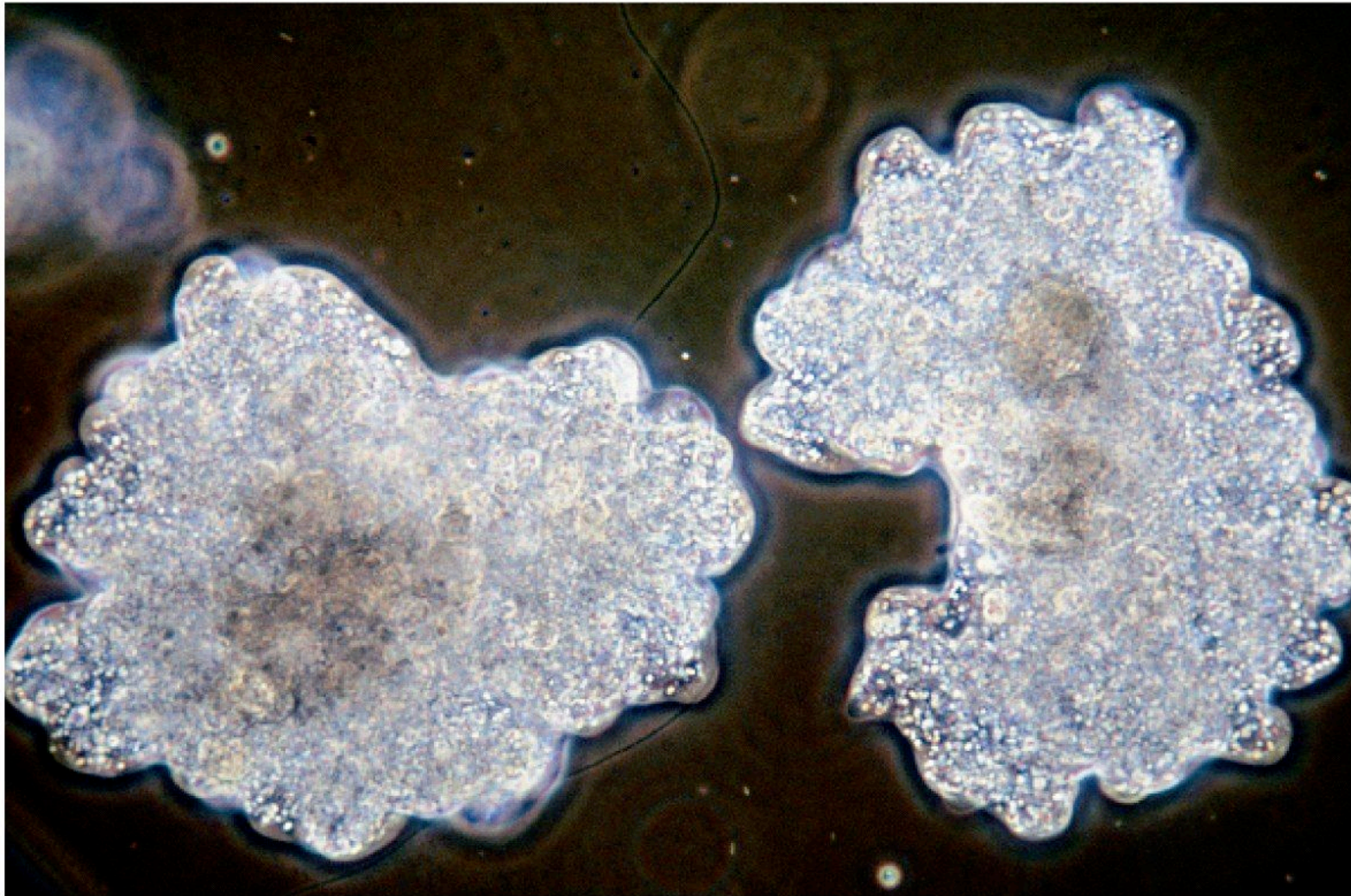


Figure 5-4a *Biology: Science for Life, 2/e*  
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# Cell Division Overview

- Before dividing, a copy of **DNA (deoxyribonucleic acid)** must first be made
- DNA is located within the nucleus and carries **genes** – instructions for building the proteins that cells require



# Cell Division Overview

- DNA is organized into structures called **chromosomes** which can carry hundreds of genes along their length
- The number of in each cell depends on the organism: humans have 46

# Cell Division Overview

- DNA starts out in an string-like, uncondensed form...

## Uncondensed DNA

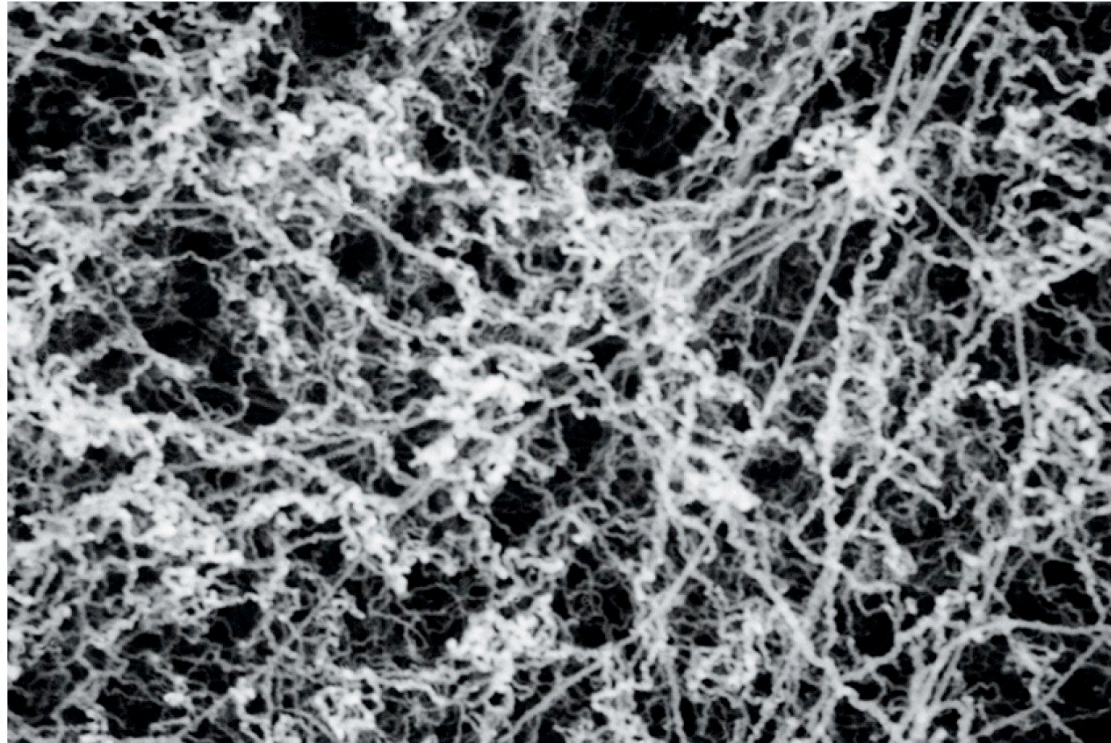
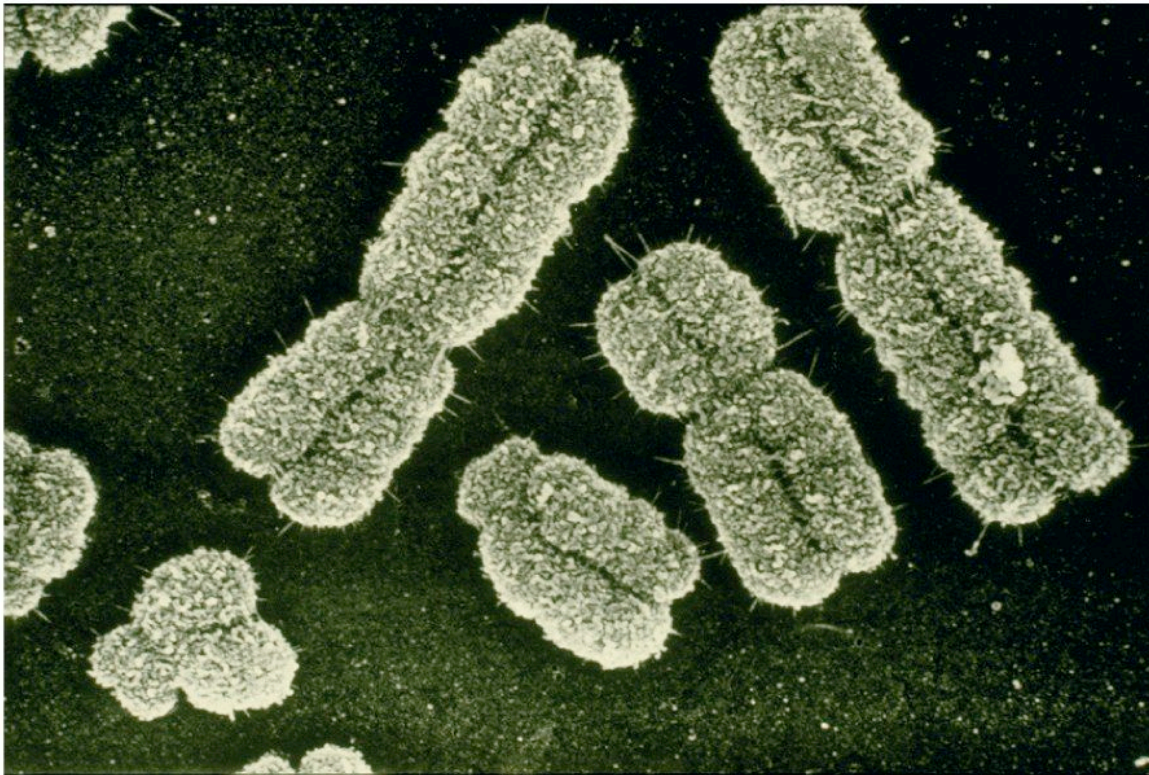


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# Cell Division Overview

- Before cell division begins:
  - DNA is condensed into short, linear chromosomes



# Cell Division Overview

- A chromosome is replicated during cell division
  - the copy carries the same genes
- Each chromosome is copied
  - the copy is called a **sister chromatid**
- The sister chromatid
  - is connected to the original DNA by a **centromere**



# Cell Division Overview

## DNA condensed into chromosomes

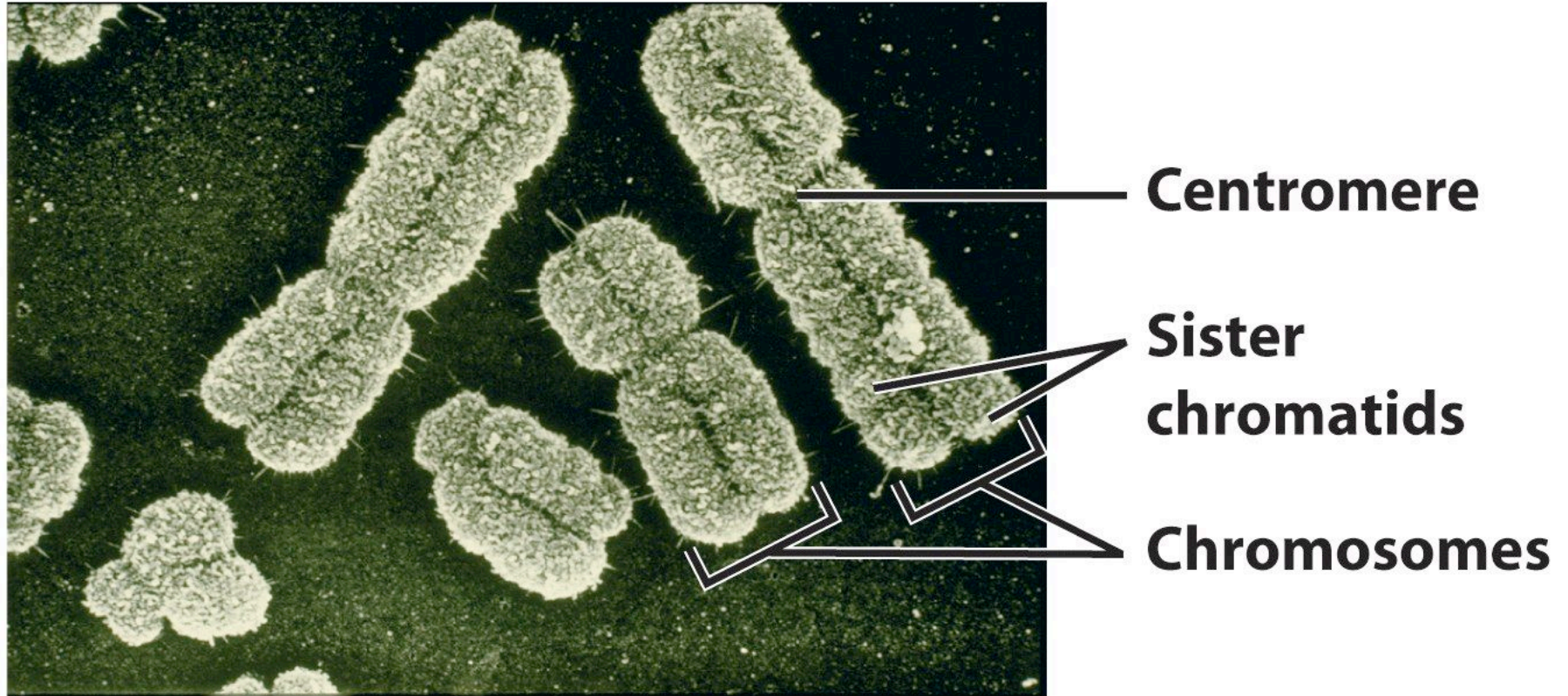
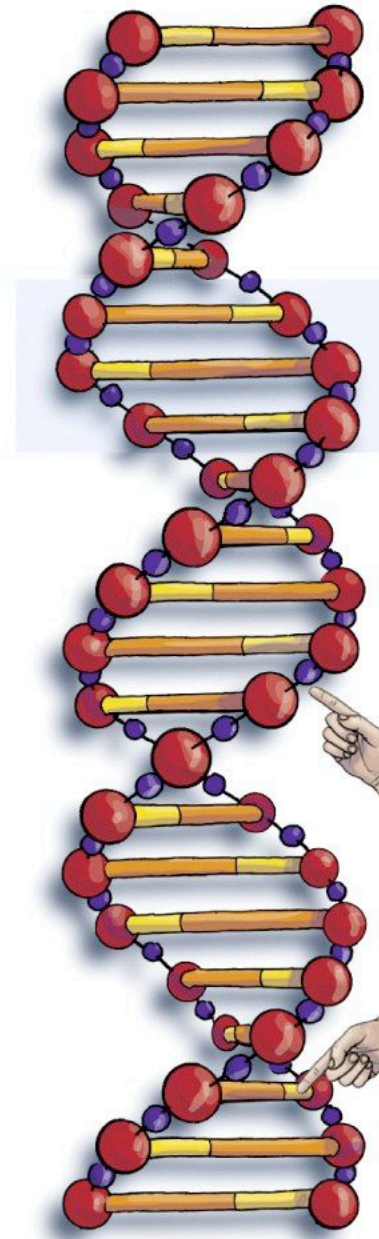


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# DNA Structure

- DNA is a double stranded molecule made of
  - two single strands of nucleotides that are bonded together
- The DNA molecule looks a lot like
  - a twisted rope ladder



**DNA double helix is made of two strands.**

**“Handrails”  
made of sugars  
and phosphates**

**“Rungs” made  
of nitrogenous  
bases**

# DNA structure

- The “rungs” of the molecule are the bases:
  - A (adenine)
  - T (thymine)
  - G (guanine)
  - C (cytosine)
- The bases across the “ladder” are connected in a specific way:
  - A always bonds with T
  - C always bonds with G
- This is complementary base pairing



# Each strand is a chain of nucleotides.

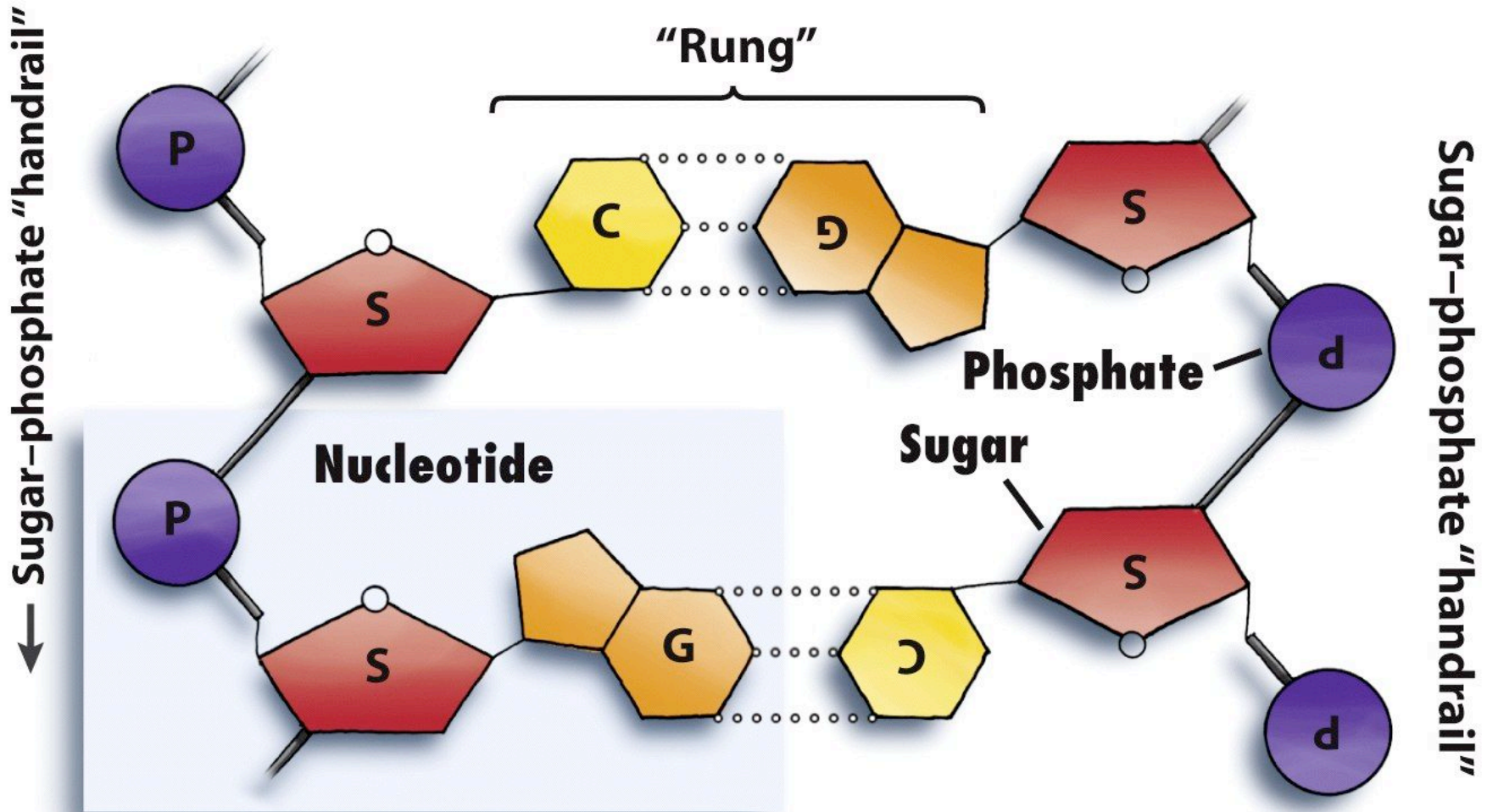


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# Cell Division Overview

James Watson and Francis Crick:

- Determined the structure of the DNA molecule
- Published in *Nature* in 1953
- Based on Rosalind Franklin's experiments

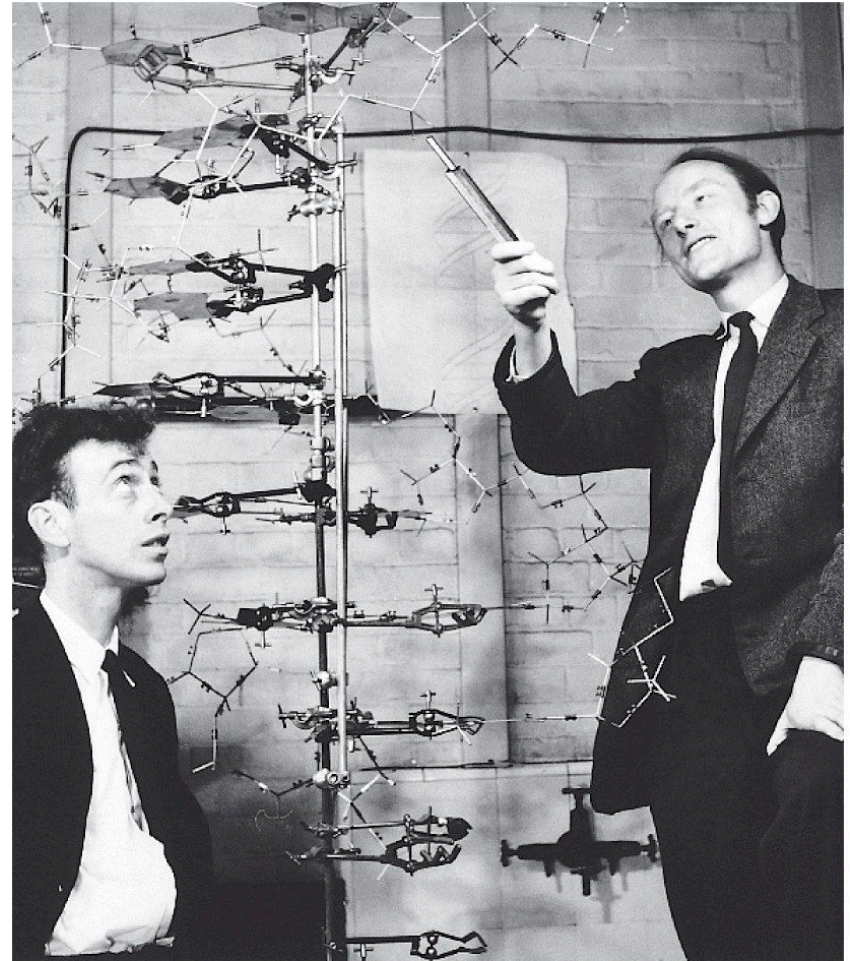


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# Why do we care about DNA structure?

- Because the structure of DNA allows life as we know it to exist
- Because complementary base pairing allows
  - new cells to be made with exactly the same DNA as the original cell
    - If you can't do this, you will die!
    - A brain cell makes another brain cell, not a liver cell in your head
- Because complementary base pairing allows
  - DNA to make an exactly correct RNA
  - that then can make an exactly correct protein
    - People need to make insulin, stomach digestive enzymes, etc
    - If you can't do this, you will die!
- Because it is Nerdy fun...