CALIFORNIA STATE UNIVERSITY FULLERTON
OSHER LIFE LEARNING INSTITUTE

CANCER

Causes, Prevention, Screening,

Early Diagnosis, and Treatment”

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Why this new course?

- Educated people should know the true facts
- To understand the known causes of cancer
- To be able to prevent the disease
- To understand the diagnosis and treatment
- To empower ourselves through knowledge

WHY DID I GET INVOLVED WITH THIS COURSE?

- I like teaching
- I am committed to helping people understand their health problems
- I believe that it is the duty of physicians to help people know the facts and avoid false advertisement

DISCLAIMER AND CREDITS

Disclaimer: Nothing to declare

Credits:

1. Personal teaching and clinical files
2. Multiple Internet programs
3. Books and journals

PLAN OF COURSE

1. **Basic Biology and Organism Functions:**
   a. Cell and tissues
   b. What is cancer and its causes

2. **Cancer Prevention and Cancer Screening**

3. **Early Diagnosis**

4. **Cancer Treatment**

LECTURE #1

CHARACTERISTICS OF LIFE (I)

Characteristics of life are traits that all **living** organisms share

There are 11 characteristics of life that humans share with other organisms:

1. **Movement** – Self-initiated change in position, motion of the internal organs
2. **Responsiveness** - Ability to sense changes within or around the organism and react to them
3. **Growth** - Increase in body size
4. **Reproduction** - Produce offspring ⇨ producing new individuals

CHARACTERISTICS OF LIFE (II)

5. **Respiration** - Obtaining oxygen and releasing CO_2
6. **Digestion** - Chemically changing food substances, and getting rid of wastes
7. **Absorption** - Passage of digested products through membranes and into body fluids
8. **Assimilation** - Changing absorbed substances into chemically different substances
9. **Circulation** - Movement of nutrients throughout the body

CHARACTERISTICS OF LIFE (III)

10. **Excretion** - Removal of wastes

11. **Metabolism** –

- A. The acquisition of food
- B. Utilization of its energy
- C. Waste excretion

How are the characteristics of life dependent on metabolism?

- We need food and energy to be able to do all of the characteristics of life

MAINTENANCE OF LIFE: Requirements of Organisms (1)

- **Life requires certain environmental factors:**

1. **Water** - Most abundant compound in body, required for metabolic processes, transport of substances, and regulation of temperature
2. **Foods** - Provide chemicals and water, used for energy, making new living matter, or regulating chemical reactions
3. **Oxygen** - Used to release energy from food substances which drives metabolic processes
4. **Heat** - Form of energy, product of metabolic reactions

REQUIREMENTS OF ORGANISMS (2)

5. **Pressure** - Application of force to something helps humans breathe, also used inside body to push blood through blood vessels
6. **Digestion** - Chemically changing food substances , and getting rid of wastes
7. **Absorption** - Passage of digested products through membranes and into body fluids
8. **Circulation** - Movement of substances throughout the body
9. **Assimilation** - Changing absorbed substances into chemically different substances
10. **Excretion** - Removal of wastes

HOMEOSTASIS

- Maintains an internal **stable environment** (water, nutrients, oxygen, and heat)
- The body does this with **homeostatic mechanisms** which are self-regulation control systems that have 3 components:

1. **Receptor** - provides info. about specific conditions (stimuli) in the internal environment
2. **Set point** - tells what a particular value should be (temperature of body 98.6°F)
3. **Effectors** - causes responses that alters condition in the internal environment

HOMEOSTASIS

FEEDBACK MECHANISMS

Phases

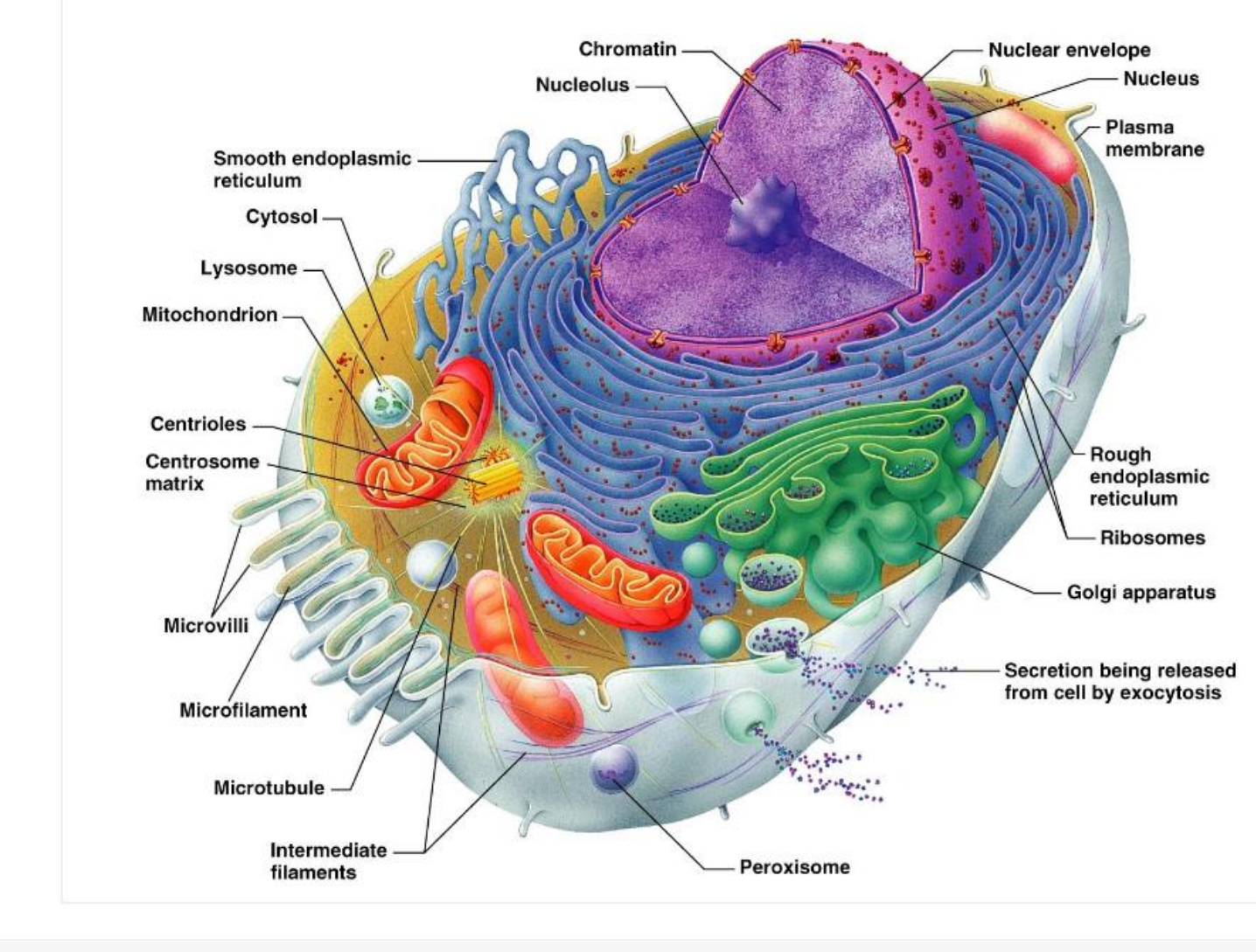
- Sensor mechanism senses disruption in homeostasis
- Control center
- Effector mechanism to restore homeostasis

Example

- High blood sugar
- Brain center
- Insulin ➢ Normal blood sugar

THE CELL

The Cell


Chromatin
Nuclear envelope
Nucleolus
Nucleus
Plasma membrane
Smooth endoplasmic reticulum
Cytosol
Lysosome
Mitochondrion
Centrioles
Centrosome matrix
Rough endoplasmic reticulum
Ribosomes
Golgi apparatus
Microvilli
Secretion being released from cell by exocytosis
Microfilament
Microtubule
Intermediate filaments
Peroxisome

THE CELL

Nucleus: Contains the DNA (genetic material)

Cytoplasm: Cell mass with organ-specific functions

Organelles: Mitochondria – cell energy (ATP)

Ribosomes – protein synthesis and fat metabolism

Golgi apparatus – processes proteins

Endoplasmic reticulum – transports proteins and lipids

Lysosomes – digestive enzymes

Cell membrane - Various constituents, biochemical and immunologic receptors

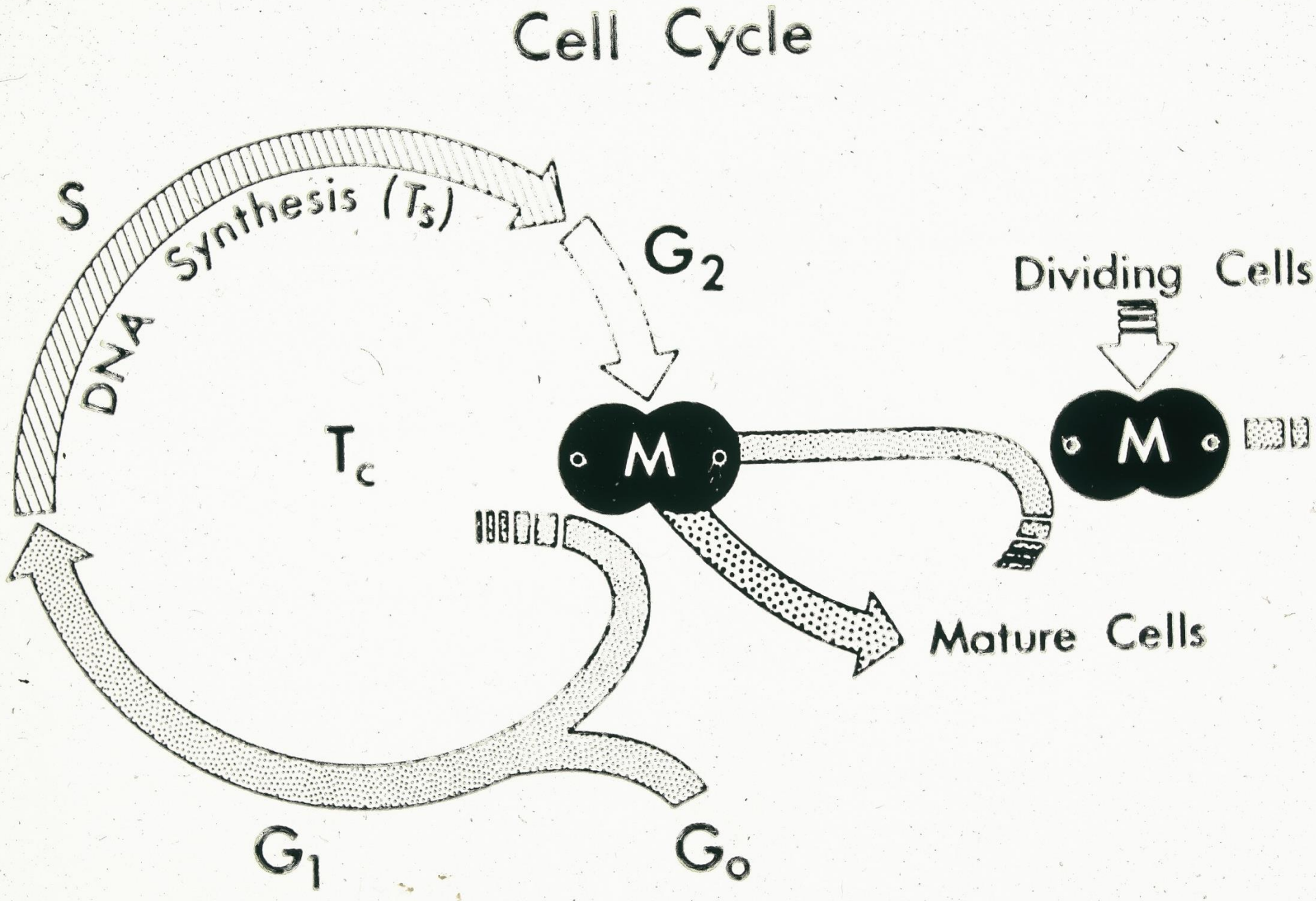
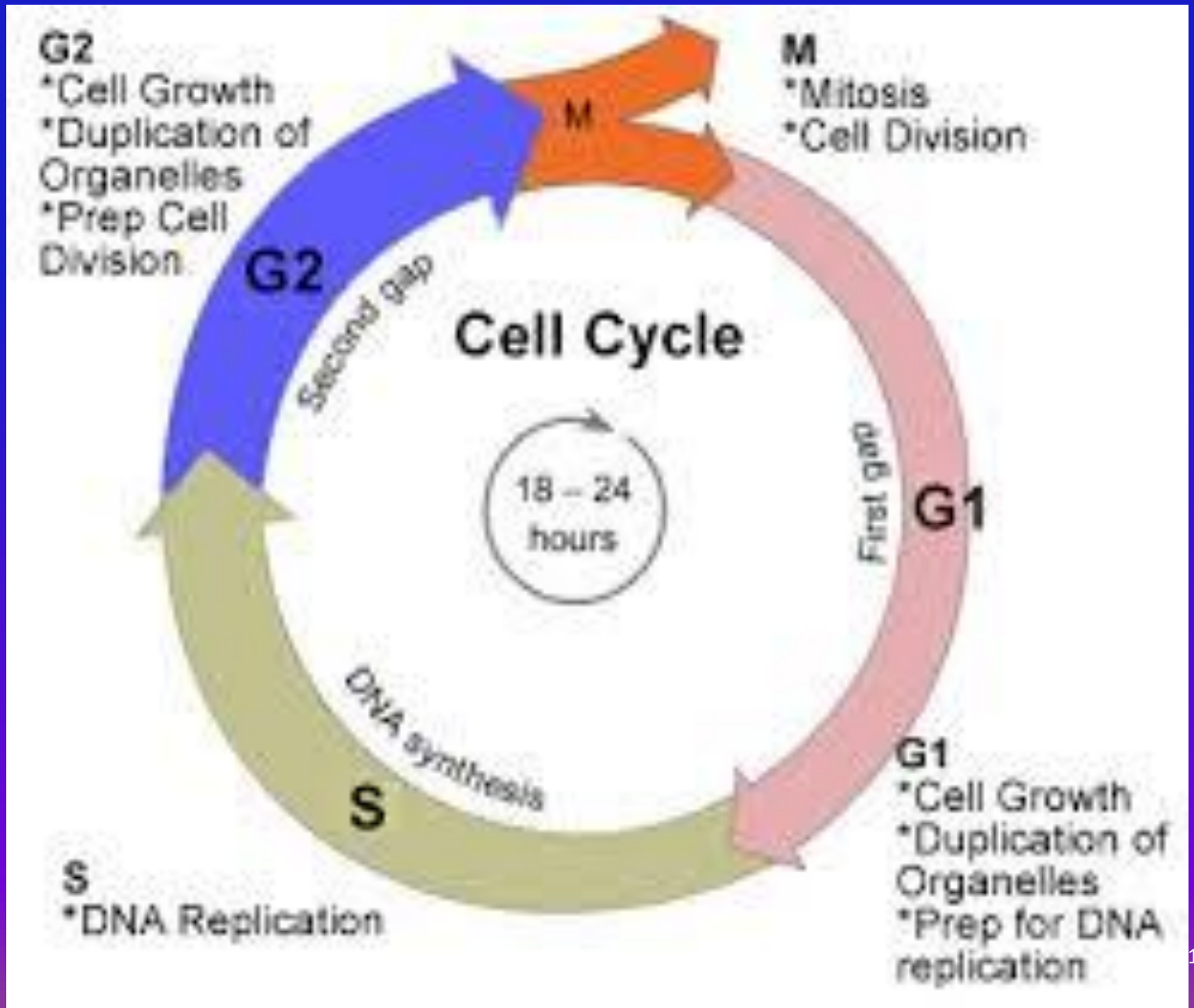
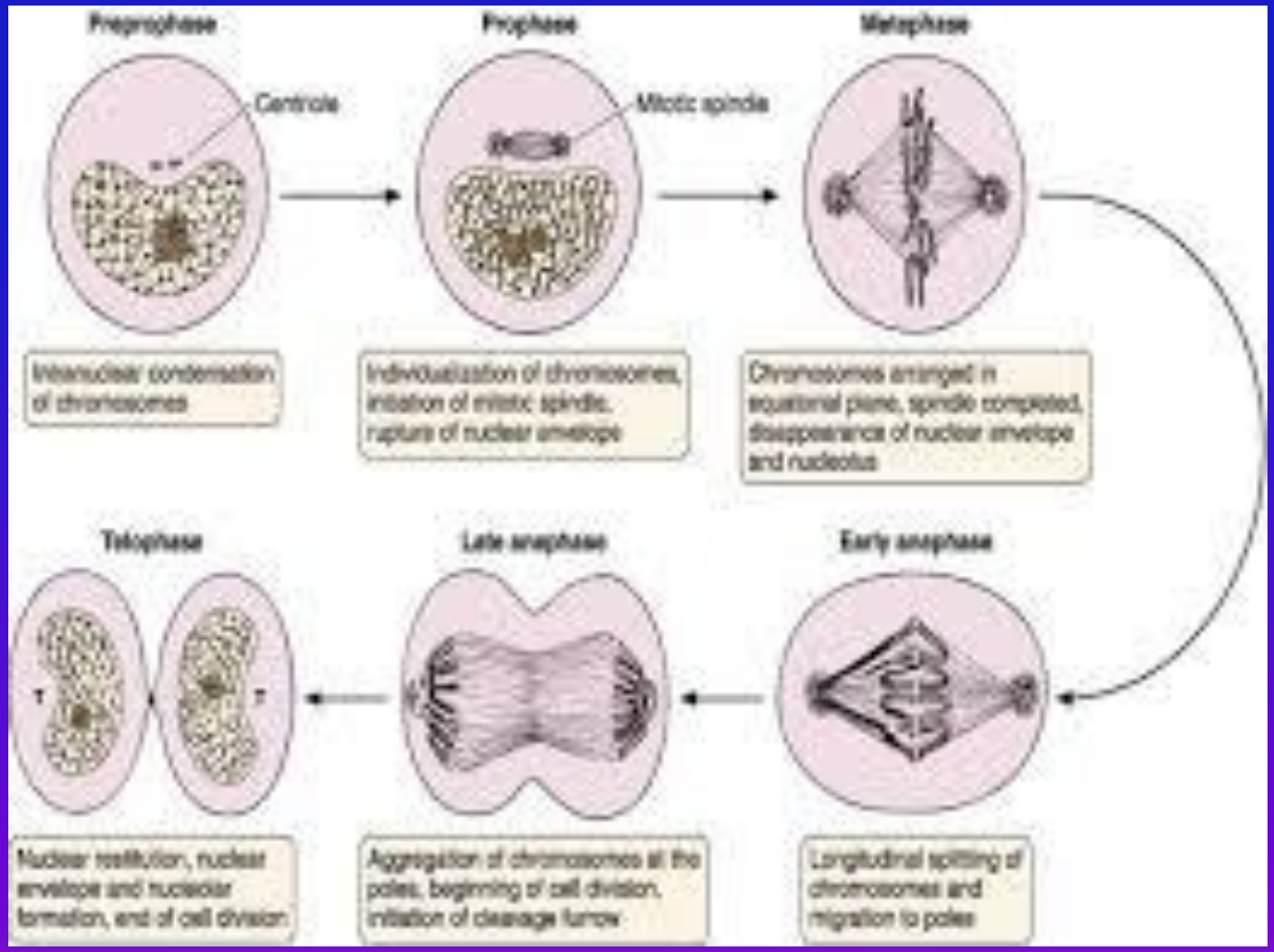


FIG. 3. Events in the cell cycle.

The Cell Cycle



Cell Division (Mitosis)



CELL DIVISION (MITOSIS)

Prophase: Nuclear membrane dissolves

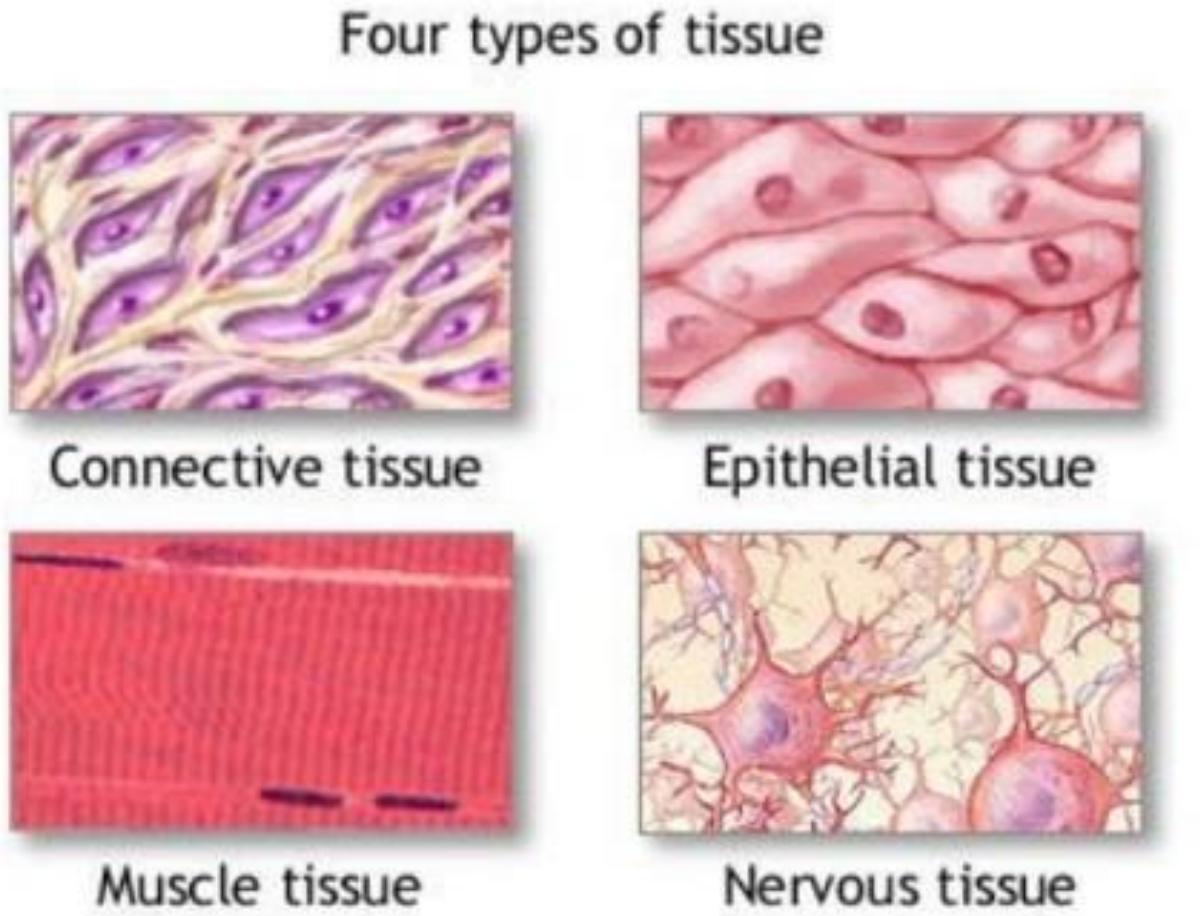
Nuclear DNA ➢ Chromosomes. Each has a pair of chromatids connected to a centromere by a spindle of fibers

Metaphase: Centromeres divide pulling the chromosomes apart

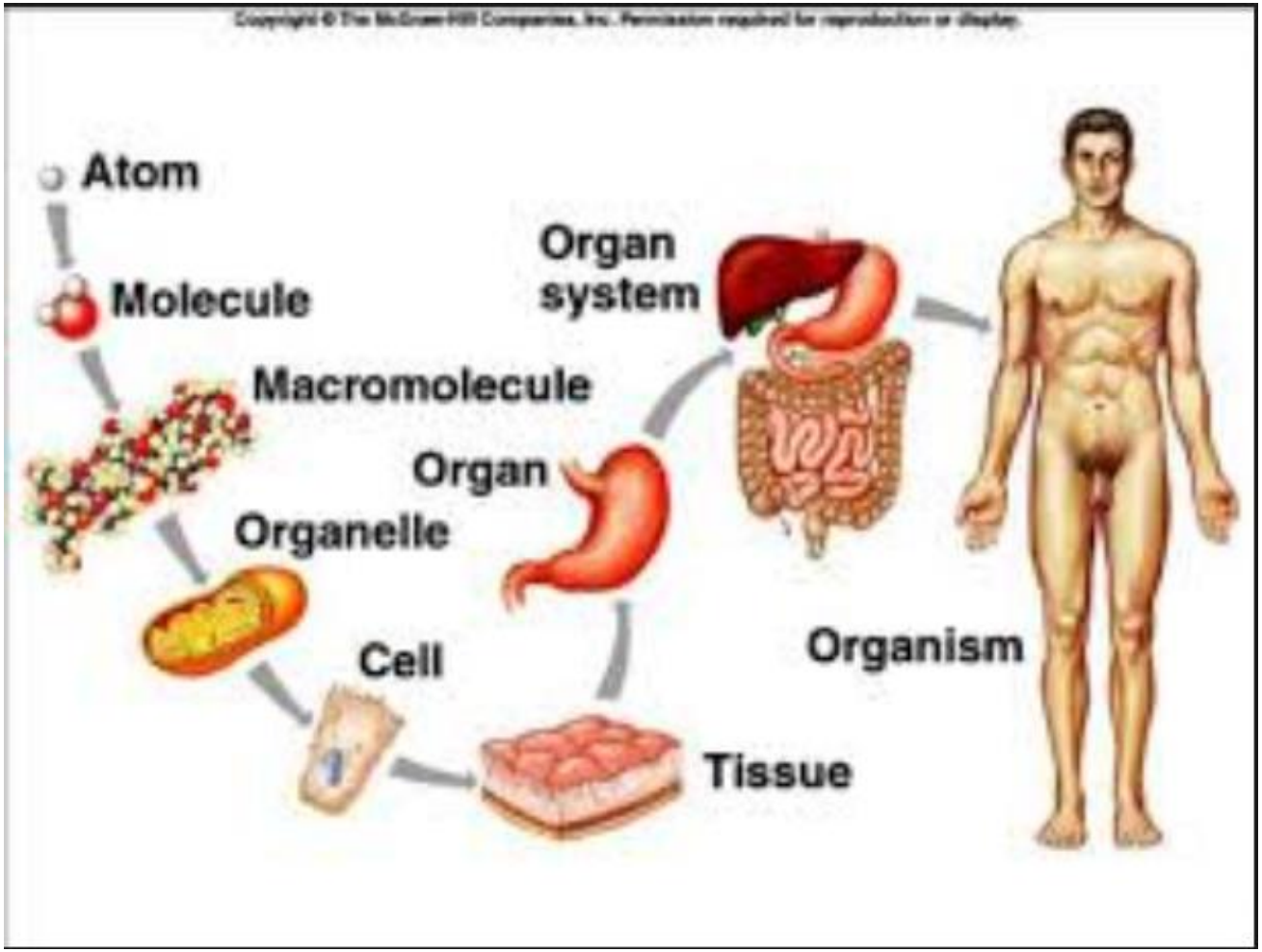
Anaphase: Centromeres separate and chromosomes are puled toward opposite sides of the cell ➢ 46 chromosomes on each side of the cell

Telophase: New membrane around each set of 46 chromosomes., Spindle fibers disappear, cytoplasm divides. Two daughter cells

Tissues


Four types of tissue
Connective tissue
Epithelial tissue
Muscle tissue
Nervous tissue
A.D.A.M.

From an Atom to a Man

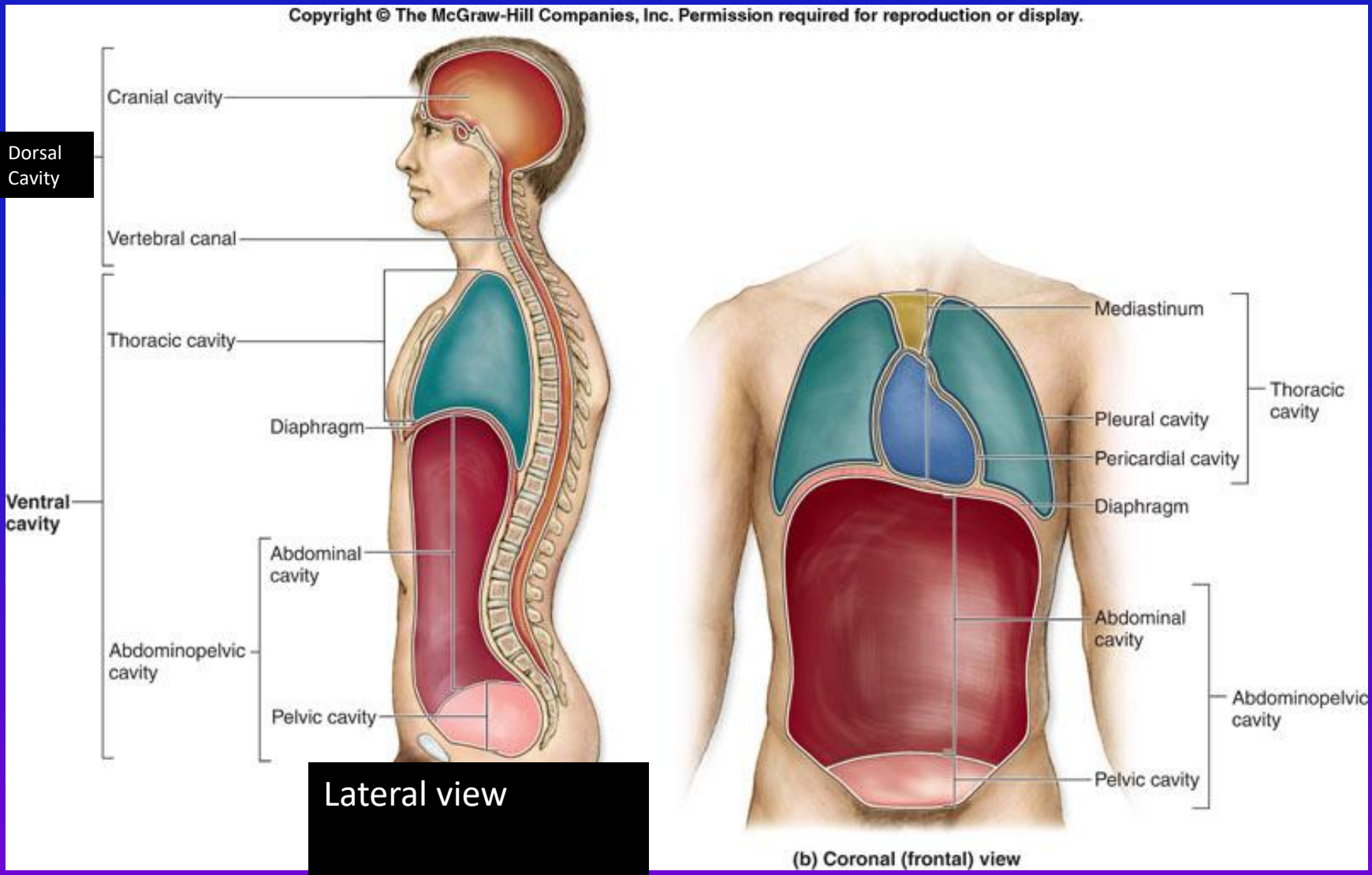


ORGANIZATION OF THE HUMAN BODY

- Human organism is a complex structure composed of many
- parts

- It has several body cavities lined by membranes

- A variety of organ systems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Dorsal Cavity
Cranial cavity
Vertebral canal
Ventral cavity
Thoracic cavity
Diaphragm
Abdominopelvic cavity
Abdominal cavity
Pelvic cavity
Lateral view
Mediastinum
Pleural cavity
Pericardial cavity
Diaphragm
Thoracic cavity
Abdominal cavity
Pelvic cavity
Abdominopelvic cavity
(b) Coronal (frontal) view

ORGAN SYSTEMS (1)

- Body Covering:
  - **Integumentary system**

- Support and Movement:
  - **Skeletal system; Joints and Muscular system**

- Integration and Coordination:
  - **Nervous system; endocrine system** (hormones -secreting glands)
- Transport:
  - **Cardiovascular system; Lymphatic system**

ORGAN SYSTEMS (2)

- Absorption and Excretion:
  - **Digestive system; respiratory system; urinary system**

- Reproduction:
  - **Reproductive system**

Some Terms Used In These Lectures

Mitosis = Cell (nucleus) divides. Four phases.

Metabolism = Life-long biochemical processes

Atrophy = Cells shrink (skin, brain)

Hypertrophy = Cells increase its size (uterus in pregnancy)

Hyperplasia = Cells multiply (trained muscle)

Dysplasia = Changes due to chronic irritation (skin, bladder)

Degeneration = Changes in cytoplasmic components (water, fats, pigment, calcium)

Necrosis = Cell death

CELL INJURY

TYPES OF CELL INJURY

Cell aging – natural event

Toxic - endotoxic: diabetes, gout

- exotoxic: Alcohol, CO, lead, medications

Infections - viral, bacterial, protozoan, fungal

Physical - wounds, thermal (U/V, radiation, electrical)

Deficit: H_2O, O_2, nutrients, vitamins

Vascular - Lack of blood supply

CELL AGING

A normal biological process, with individual variances in absence of pathologic events

Skin and its glands and elastic tissue atrophy ➢ dry skin and wrinkles

Muscles atrophy, reduced muscle mass ➢ strength

Arteries lose their elastic tissue ➢ hardening of their wall ➢ high blood pressure and decreased blood supply

Digestive glands atrophy ➢ ➢secretions ➢ impaired digestion and motility ➢ constipation

Nerve cells atrophy and death ➢ mental dysfunctions

PROTECTIVE MECHANISMS

Natural:

- **Skin and mucous membranes** integrity
- **Lysozymes**
- **Cilia** (hair-like threads) in the nose and pulmonary airways
- **Blood** white blood cells (granulocytes and lymphocytes)
- **Humoral:** Antibodies

Acquired: Vaccinations

CELL INJURY - REACTION

- Exposure to injury ➢
- Cell may adapt its structure and function ➢
- Homeostasis is disturbed ➢
- Cell degeneration ➢
- Cell death ➢
- Disease (occult) → Illness (signs & symptoms)

CAUSES OF DISEASES

Intrinsic: Age, gender, heredity, habits, lifestyle

Diseases: Atherosclerosis, Diabetes mellitus, Cancer

Extrinsic: Infections, accidents

Environment

Stress

DISEASE EVOLUTION

1. Exposure to injury
2. Incubation
3. Prodromal signs
4. Acute phase of signs and symptoms
5. Recovery
6. Convalescence
7. Healing (?)

ONSET, COURSE, AND RECOVERY

Acute disease – End point is healing

Chronic disease – No healing , Exacerbations

STRESS AND DISEASE

Stress: Physiologic or psychologic ➢ Alarm reaction – "flight-or-fight" ➢ Central nervous system and hormones activity ➢ End of Stress, homeostasis restored

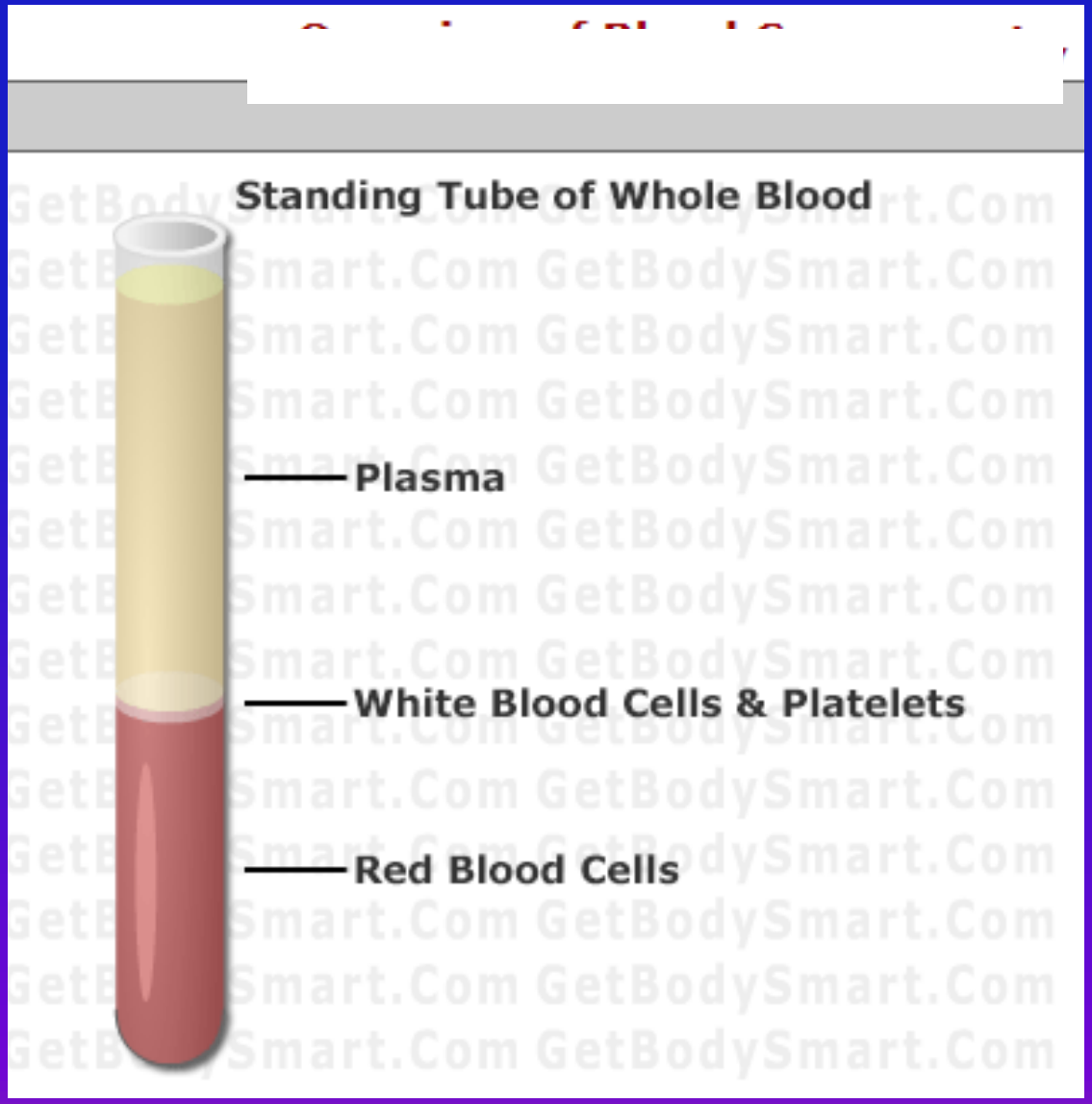
If stress continues:

Coping mechanisms activated ➢ Recovery

If no recovery:

Exhaustion of homeostasis ➢ Onset of disease

BLOOD


Standing Tube of Whole Blood
Plasma
White Blood Cells & Platelets
Red Blood Cells

BLOOD COMPONENTS

- **Plasma**
- **Cells:**
  - Red blood cells (RBC or erythrocytes)
  - White blood cells (WBC):
    - *Granulocytes: neutrophils, eosinophils, basophils*
    - *Lymphocytes*
    - *Monocytes*
  - Platelets

CELLULAR BLOOD COMPONENTS

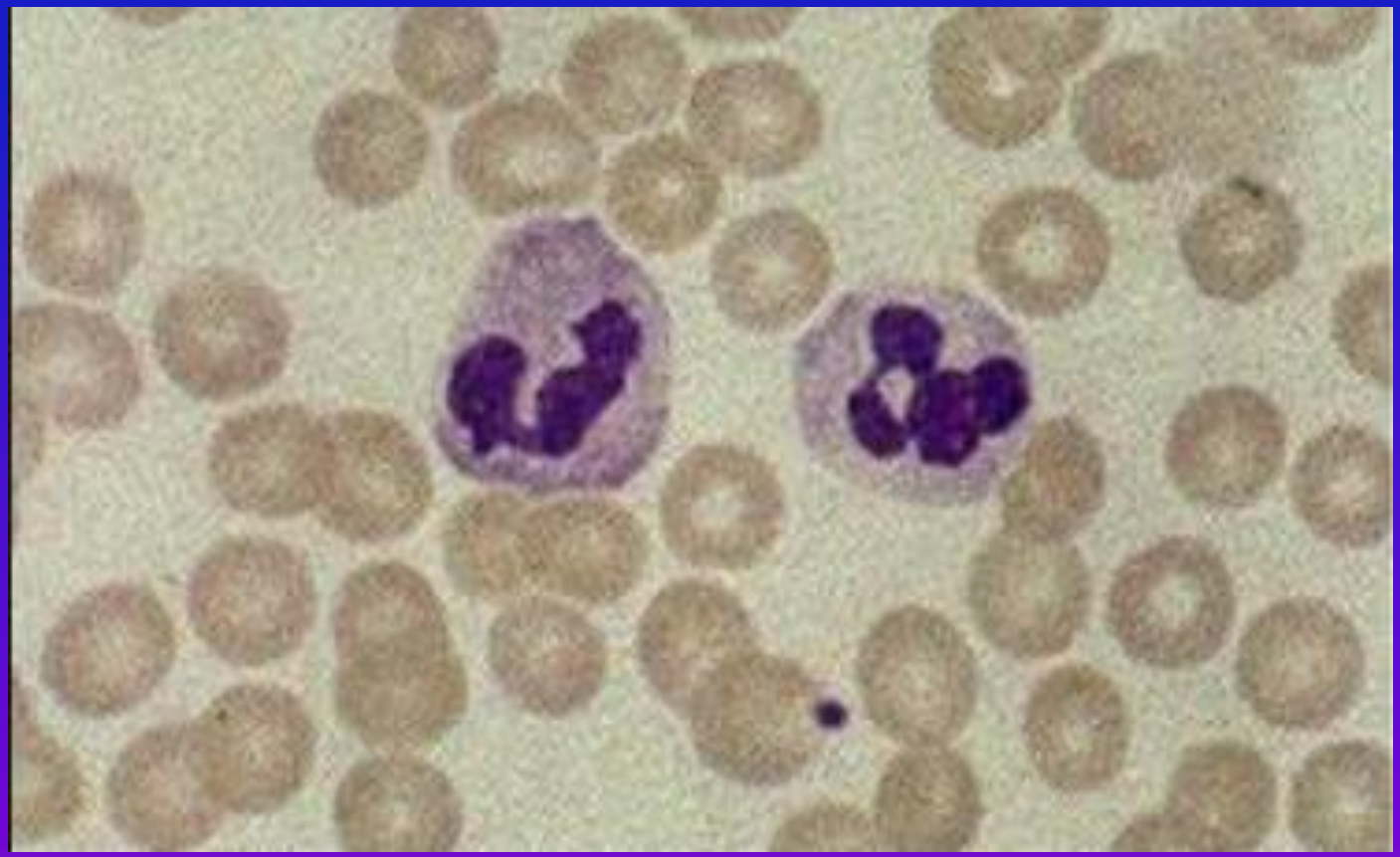
RBC - Carry Oxygen and CO_2

WBC - Various functions

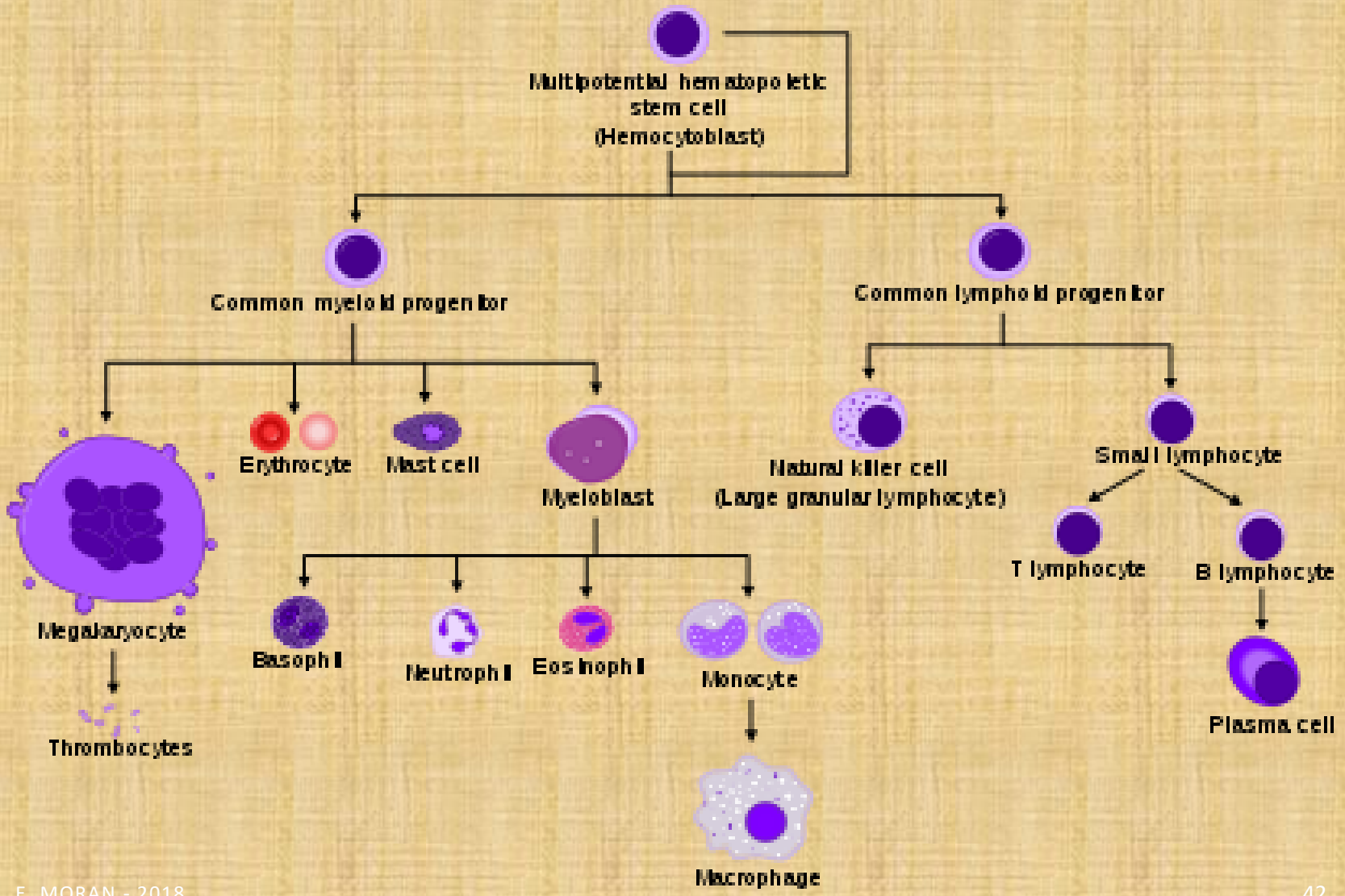
- Neutrophils - Fight infections
- Lymphocytes - Active in immune responses
- Monocytes - Promote neutrophils
- Eosinophils - Active in allergy

Platelets - Essential in initiating blood clotting

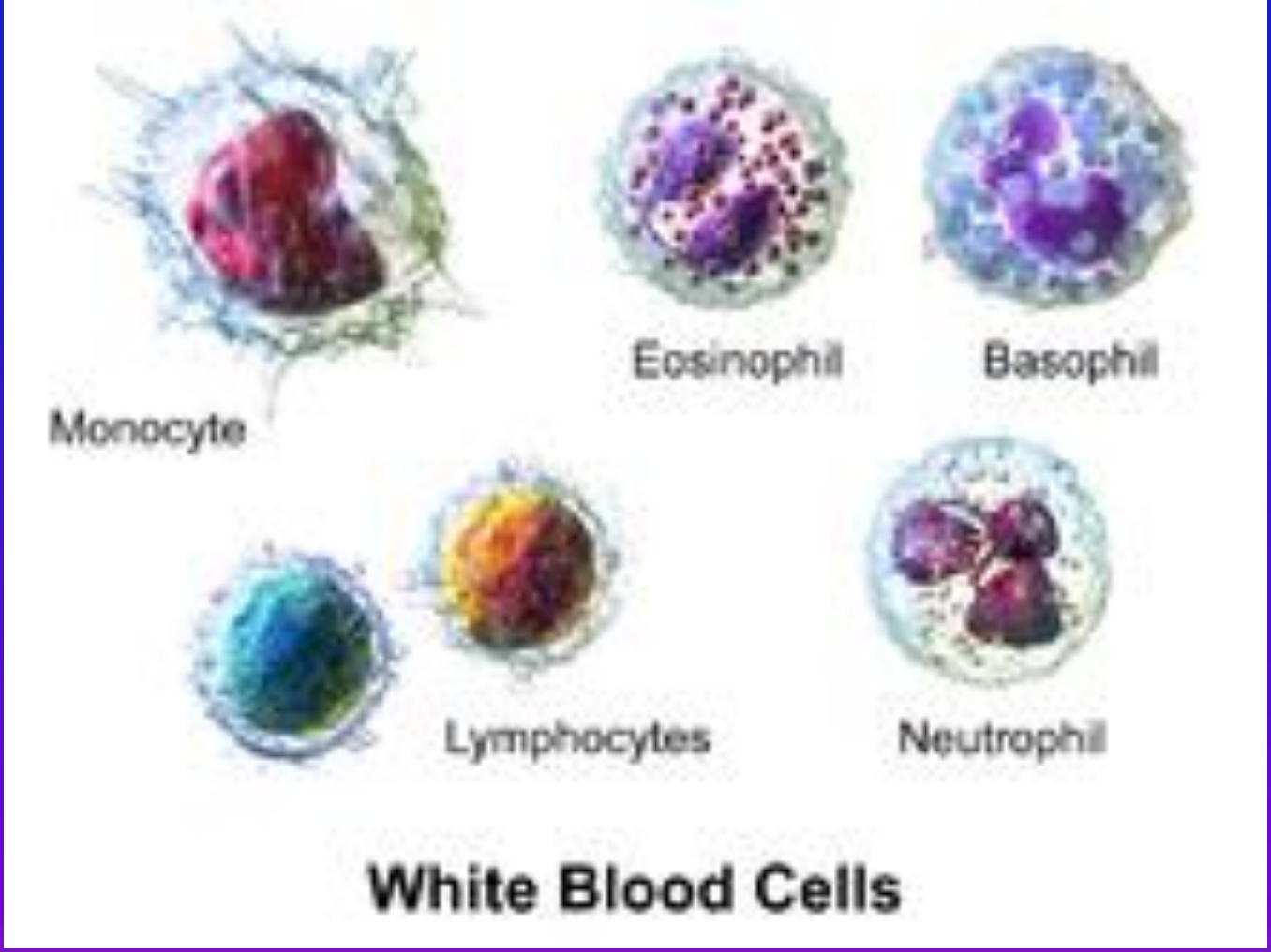
Blood film (smear) to show: Red blood cells, white blood cells (neutrophils), and a platelet



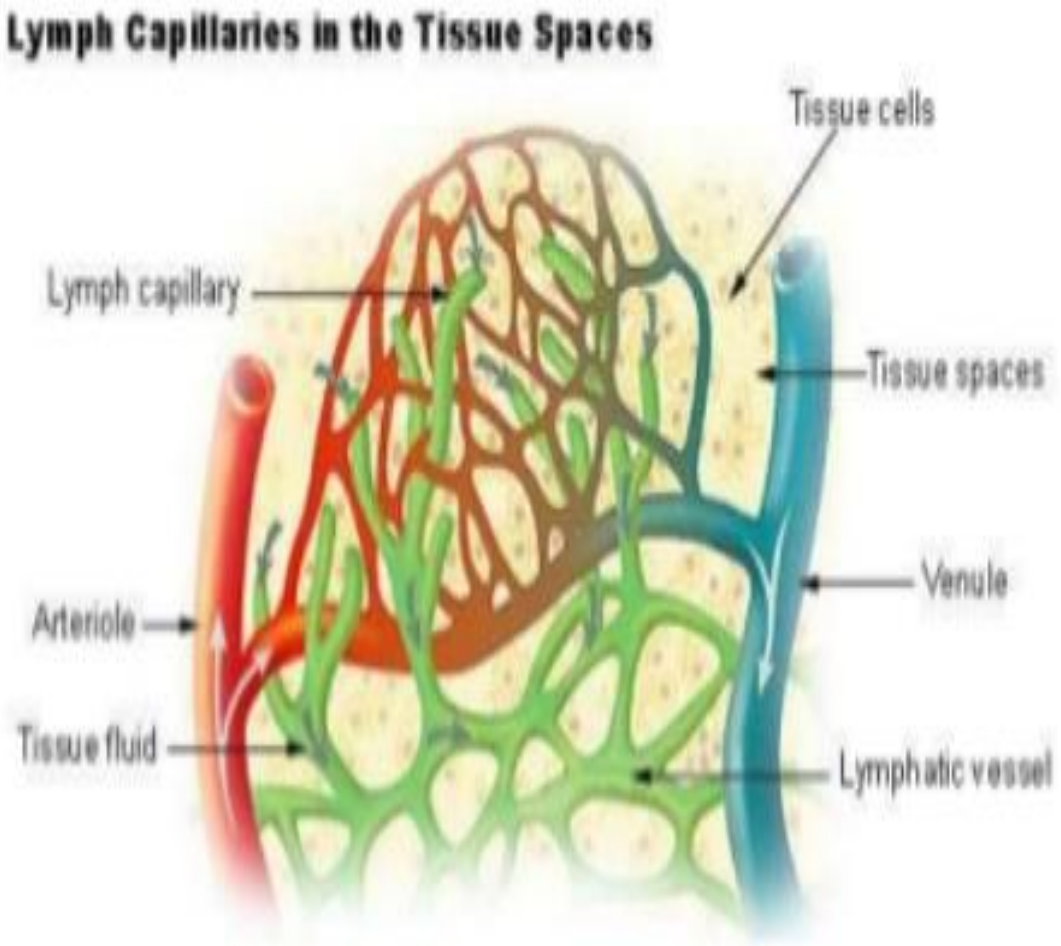
Stem Cell and Blood Cells



White Blood Cells



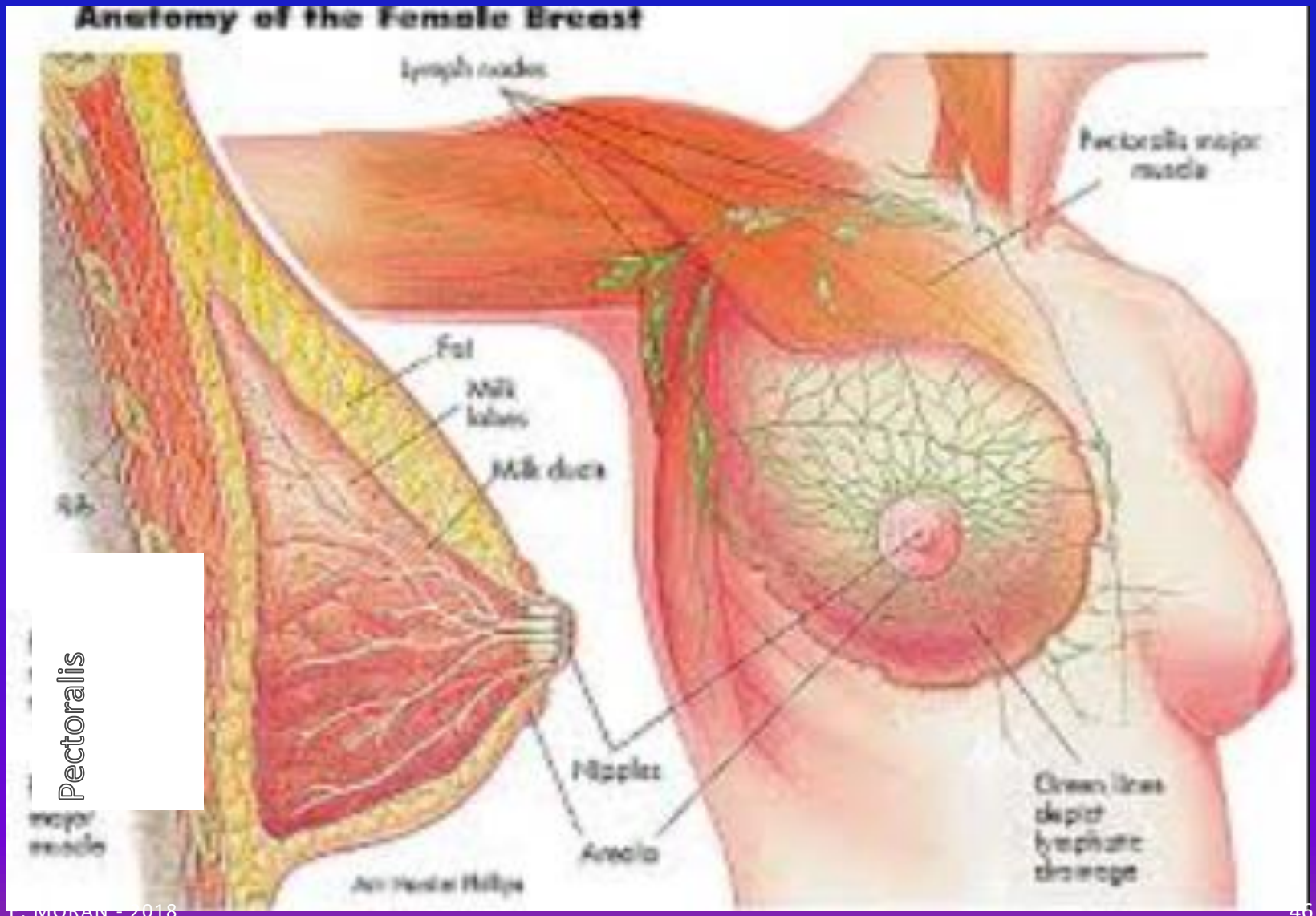
LYMPHATIC SYSTEM



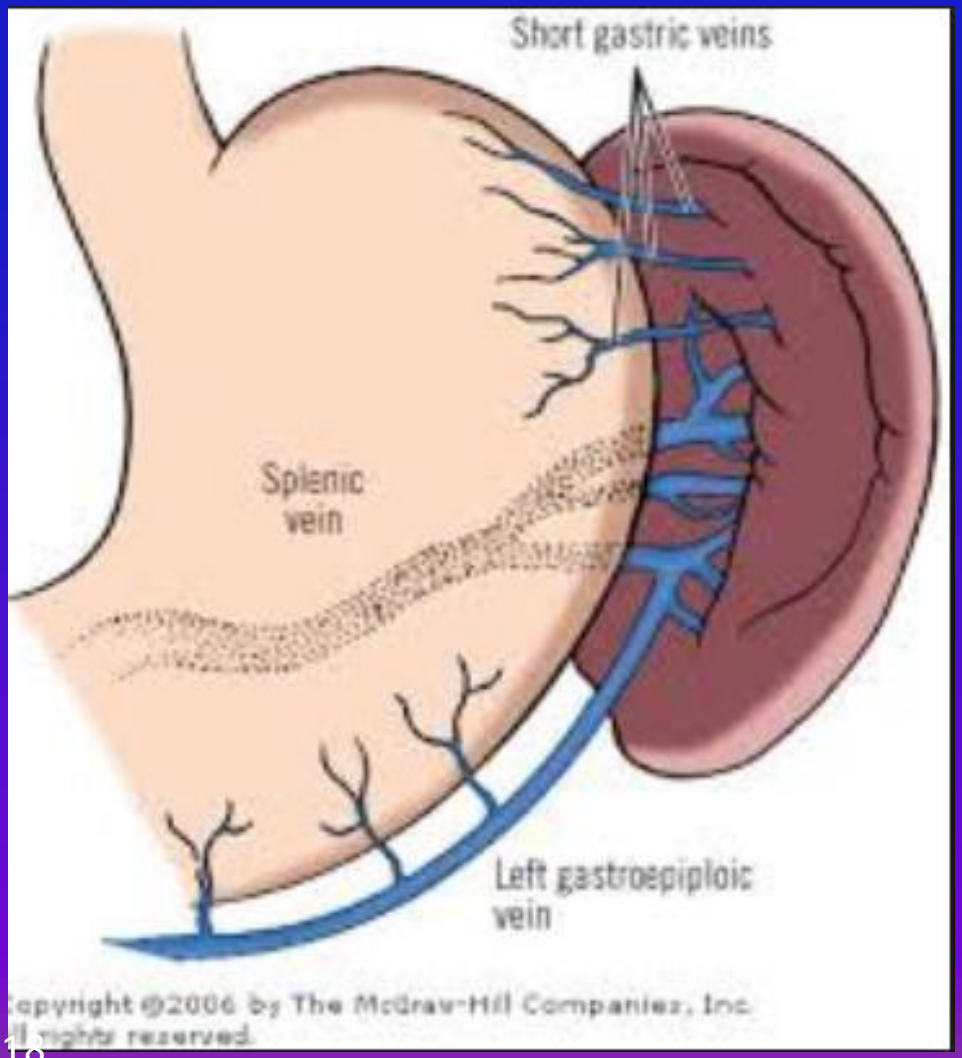
THE LYMPHATIC SYSTEM

- Intercellular space
- Lymphatic capillaries
- Lymphatic vessels (afferent and efferent)
- Lymph nodes, spleen (see the Immune System)
- Thoracic duct
- Blood
- Thymus
- Spleen

The Female Breast



The Spleen


Short gastric veins
Splenic vein
Left gastroepiploic vein
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THE HOST DEFENCES

Physical barriers: Integrity of skin and mucous membranes (lining of the GI and GU system), conjunctiva, nasal membranes

Chemical barriers: Lysozymes (antibacterial substances) in tears, in the secretions of stomach, prostate, and vagina

THE INFLAMMATORY RESPONSE

The IMMUNE RESPONSE

THE INFLAMMATORY RESPONSE

Vascular and cellular changes in presence of a change in homeostasis (physical or chemical injuries, infections, foreign bodies)

1. Vasodilation ➢ redness, local warmth
2. WBC infiltration
3. Swelling ➢ nerve irritation ➢
4. Pain

WOUND HEALING

A surgical cut is sutured:

1. Small amount of blood escapes from the blood vessels
2. Platelets from the blood arrest the bleeding
3. Blood clots on site
4. White blood cells and macrophages (scavenger cells) move to the site
5. Bacteria and any foreign matter are removed by these cells
6. Collagen is laid into the wound
7. Healing ensues in 10-14 days

THE IMMUNE SYSTEM

CELLULAR COMPONENTS OF THE IMMUNE SYSTEM

- Lymph nodes
- Spleen
- Thymus
- Tonsils and lymphatic tissue in the pharynx
- Lymphatic tissue in the GI tract

CELL-MEDIATED IMMUNITY

T-lymphocytes (activated in the thymus) identify aggressors and try to destroy them through the production of **lymphokines** (synthesized proteins)

- Killer T-cells
- Helper T-cells
- Suppressor cells

HUMORAL IMMUNITY

B-lymphocytes (from the bone marrow) synthesize immunoglobulins which function as **antibodies** combining with foreign **antigens** (bacteria and viruses):

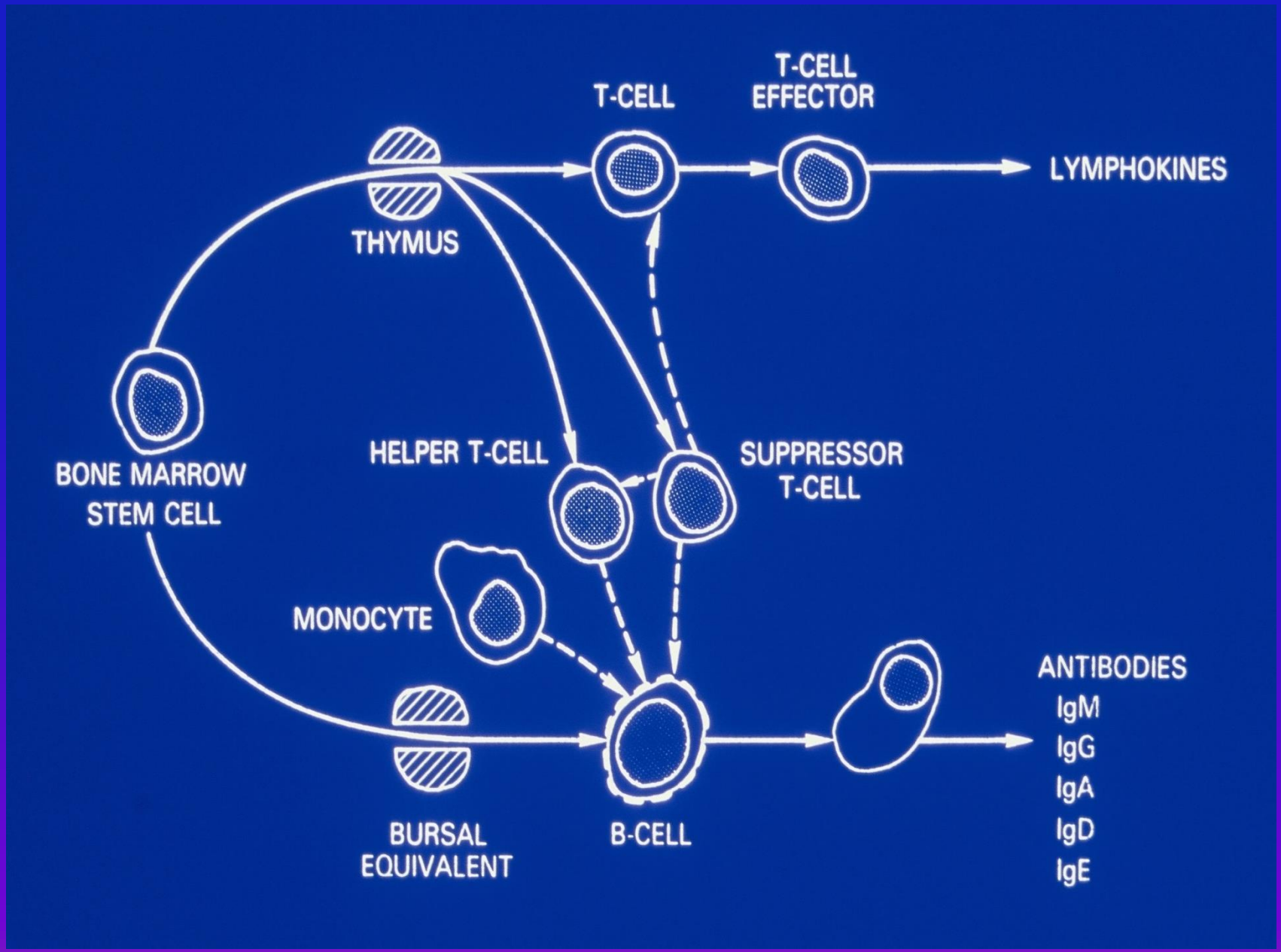
IgG – major immunoglobulin (80%)

IgM – mostly intravascular

IgA – in body secretions, GI and respiratory tract

IgE – active in hypersensitivity (allergy)

IgD


T-CELL
T-CELL EFFECTOR
LYMPHOKINES
THYMUS
BONE MARROW STEM CELL
HELPER T-CELL
SUPPRESSOR T-CELL
MONOCYTE
ANTIBODIES
IgM
IgG
IgA
IgD
IgE
BURSAL EQUIVALENT
B-CELL

DISEASES THAT COMPROMISE THE HOST DEFENCE MECHANISM

Hodgkin's disease

Lymphomas

Leukemias

Multiple myeloma

Carcinomas and sarcomas

Inherited or acquired primary immunodeficiency disease

GENETICS

GENETICS – STUDY OF HEREDITY

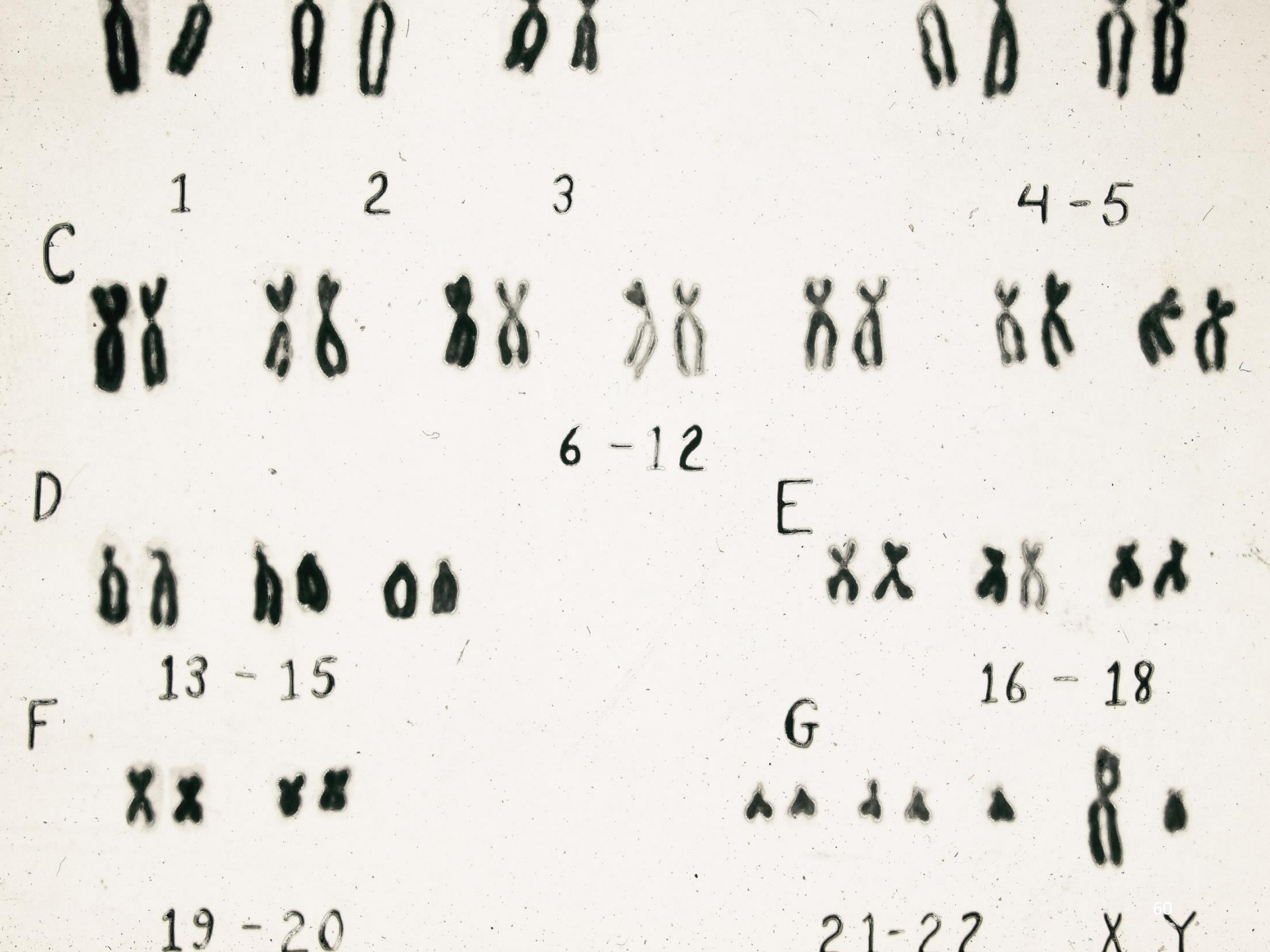
- Human gametes: Ovum (ova) and Spermatozoa
- Genetic material: DNA
- Chromosomes: 46 chromosomes in all body cells
  - 23 chromosomes in ova and spermatozoa (meiosis)

  - 46 chromosomes in the fertilized egg
- Genes: **Dominant genes** and **Recessive genes** on sites of
- the chromosomes

GENES AND ALLELES

- Genes control the transmitted traits through the alleles
- Alleles are the variations of genes (eye color)

- Alleles may be **dominant** or **recessive**
- **Dominant** alleles transmit the heredity even if on **one parental chromosome** (heterozygous)
- **Recessive** alleles transmit only if homozygous (on **both parental chromosomes)**


1
2
3
4-5
C
6-12
D
13-15
E
16-18
F
19-20
G
21-22
X Y

CHROMOSOMES XX OR XY ?

23 pairs of chromosomes

21 are autosomes

2 are x-linked: **XX** = Female offspring

XY = Male offspring

MODES OF GENETIC INHERITANCE GENE ABNORMALITIES

Autosomal dominant - Produce abnormal traits in offspring even if only one parent has the gene.

Autosomal recessive - Don't produce abnormal traits unless both parents have the gene.

X-linked dominant

X-linked recessive

INTERMISSION

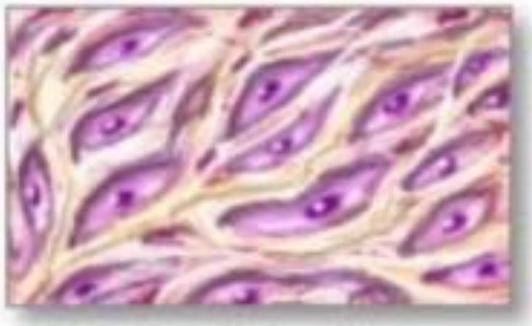
CANCER = Malignant Tumor = Malignant Neoplasm

A tissue growth:

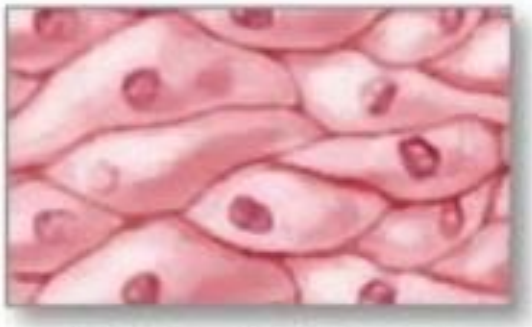
- Not necessary for body's development or repair
- Invading healthy tissues
- Spreading to other sites of the body (metastasizing)
- Lethal because of its invasion, metabolism, and complications

Tissues

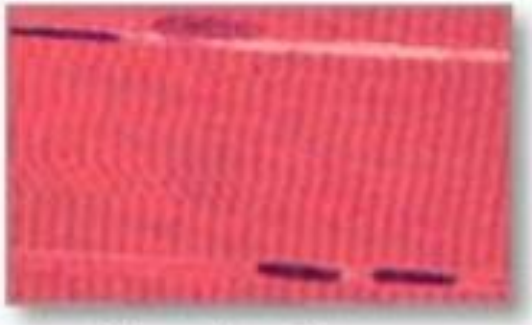
Four types of tissue



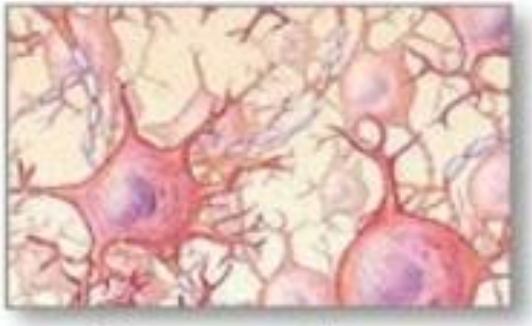
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

Cancer Terms to Know

Origin	Name
• Epithelium (lining tissue)	• Carcinoma
• Glands	• Adenocarcinoma
• Connective tissue	• Sarcoma
• Bones	• Osteosarcoma
• Muscles	• Rhabdomyosarcoma
• Brain tissue (glial cells)	• Glioma
• Lymphatic glands, spleen	• Lymphoma
• Blood cells	• Leukemia

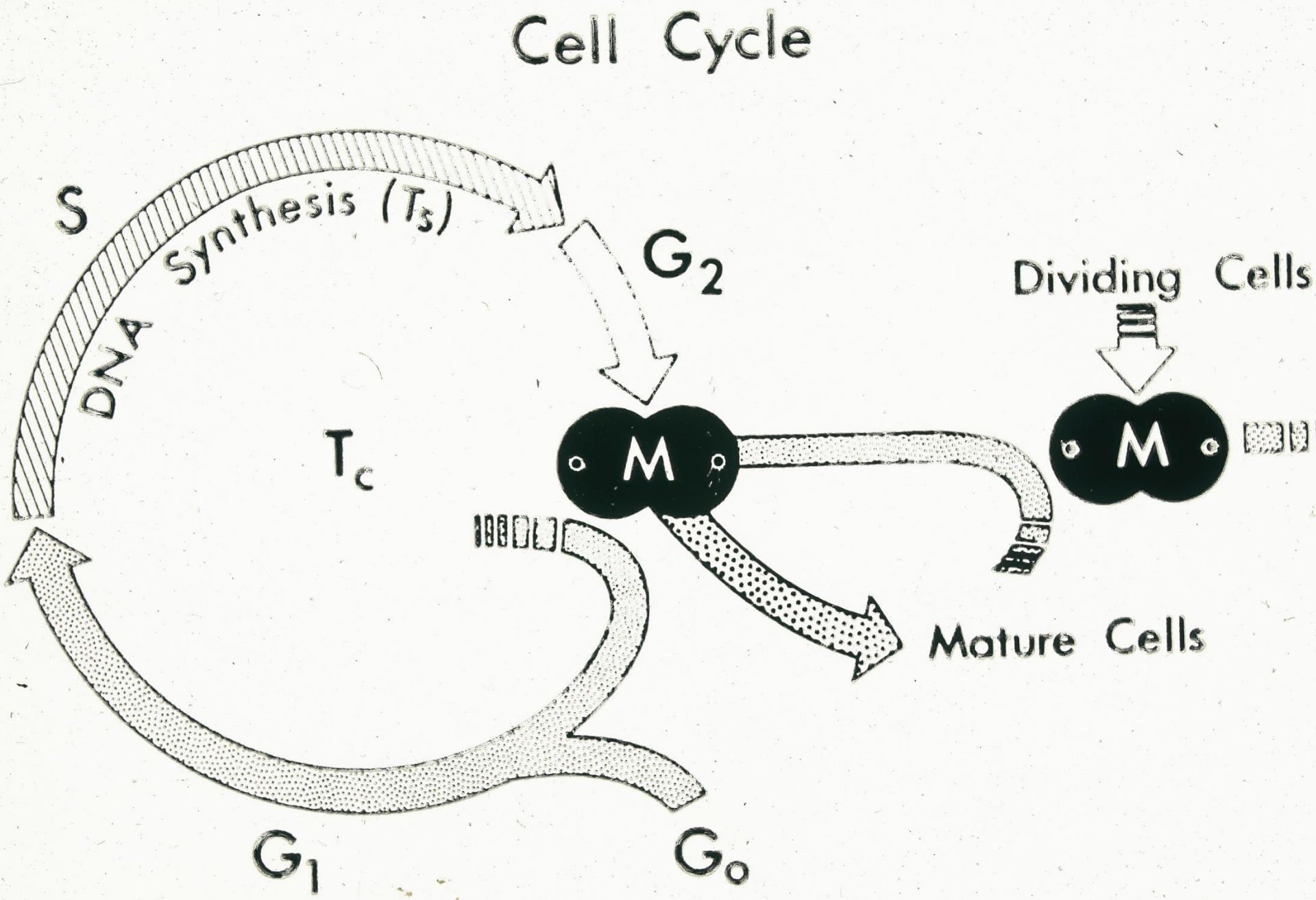
BENIGN TUMORS

Benign tumors do not invade surrounding healthy tissues

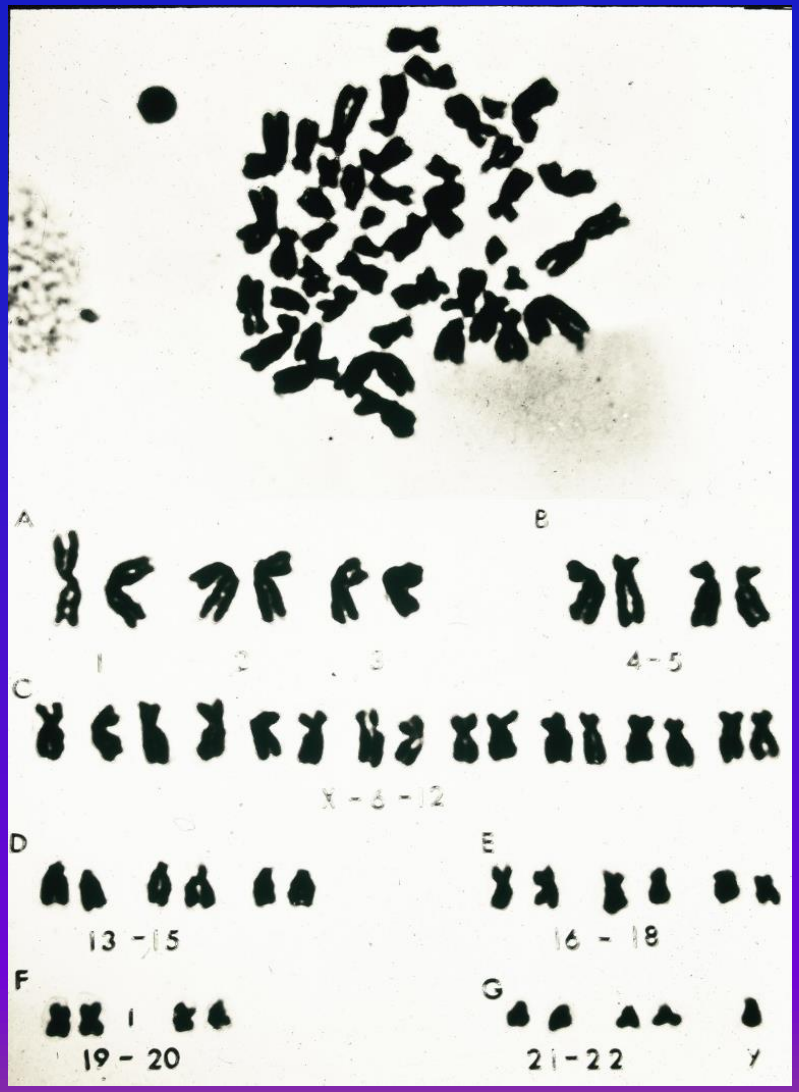
Benign tumors do not spread out

Benign tumors may cause complications due to obstruction of natural conduits [bronchi (airways), intestine]

Terms: Adenoma, lipoma


Cell Cycle
S
DNA Synthesis (T_s)
G_2
Dividing Cells
T_c
M
M
Mature Cells
G_1
G_o

Abnormal Karyotype of a Patient With Leukemia



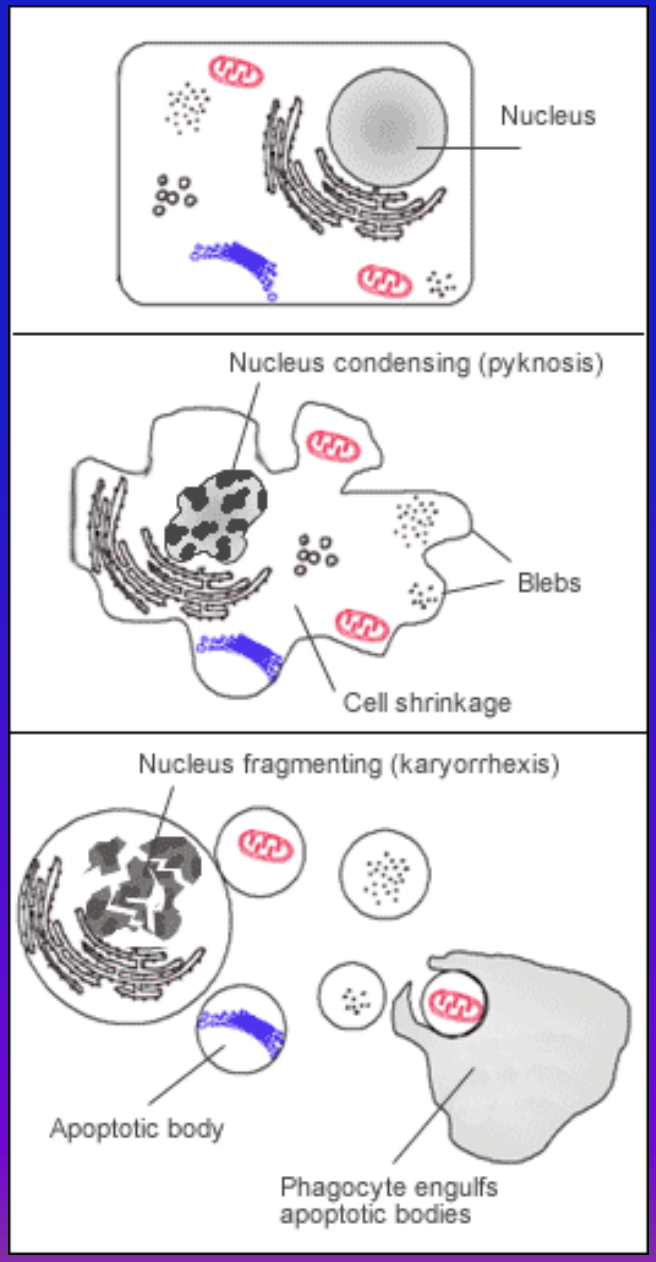
APOPTOSIS = PROGRAMMED CELL DEATH

A highly regulated and controlled cell death. It results in changes that include, cell shrinkage, nuclear breakage, chromatin and chromosomal breakage, and global messenger RNA decay.

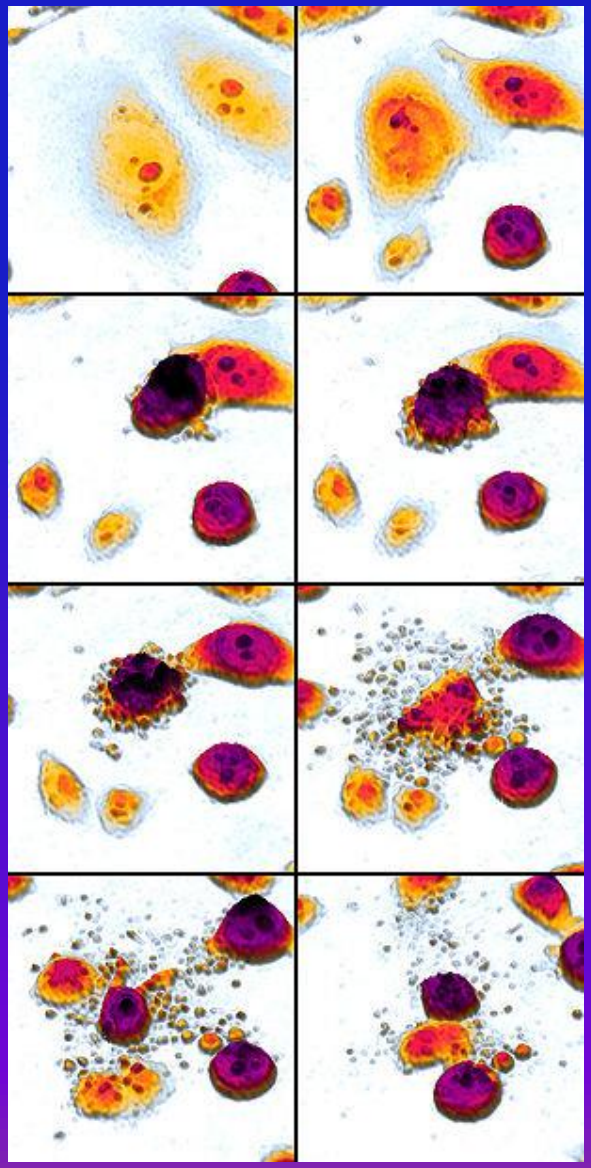
Defective apoptotic processes have been implicated in a wide variety of diseases. An insufficient amount results in uncontrolled cell proliferation, such as **cancer.**

Between 50 and 70 billion cells die each day due to apoptosis in the average human adult.

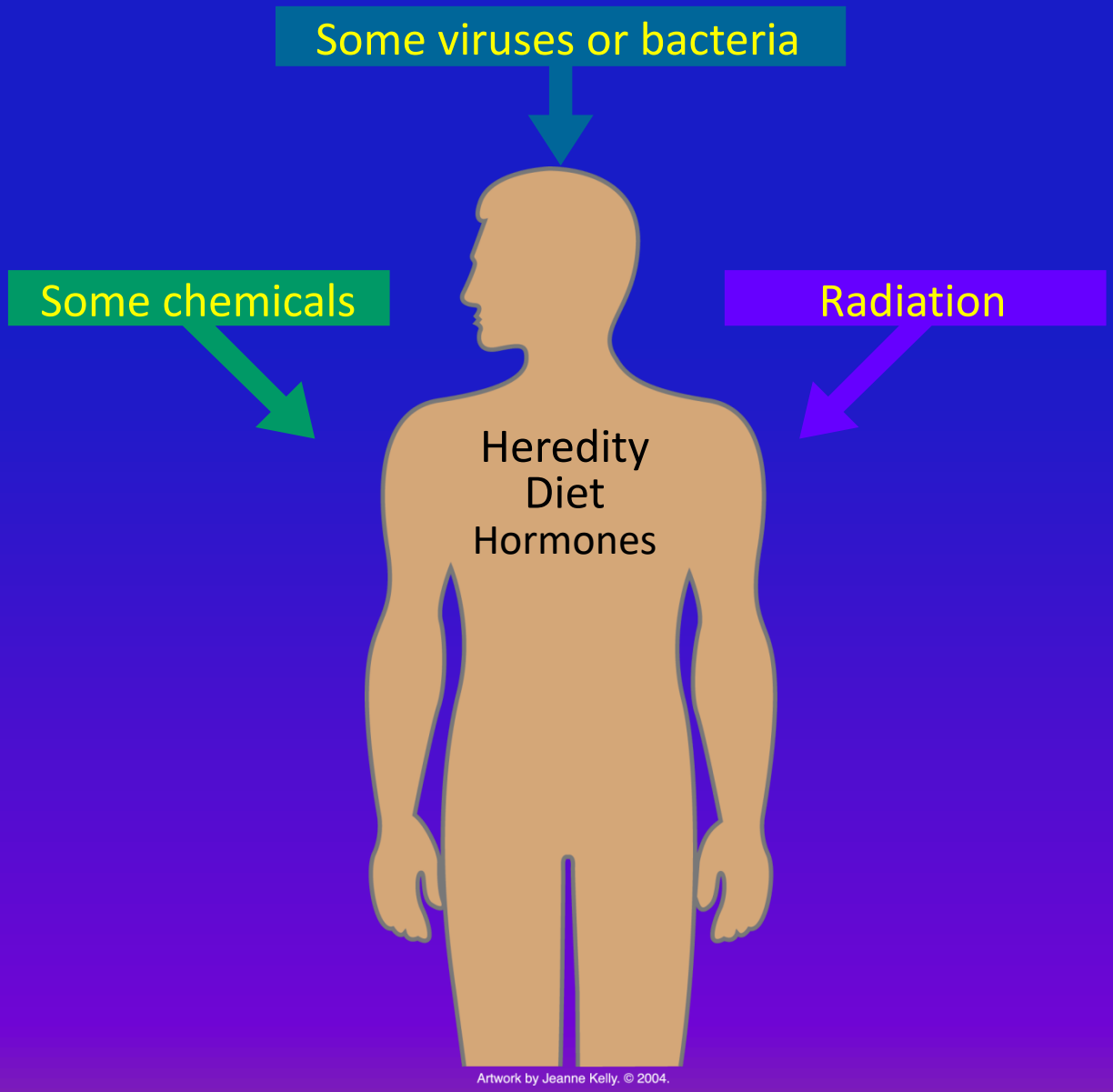
Phases of Apoptosis



APOPTOSIS



What Causes Cancer?



Heredity and Cancer

All Breast Cancer Patients

Inherited factor(s)
Other factor(s)

CANCER SUSCEPTIBILITY

INTERINDIVIDUAL DIFFERENCES

Aryl Hydrocarbon Hydroxylase Inducibility

Debrisoquine Metabolic Phenotype

SPONTANEOUS MUTATIONS

OXYDATIVE DNA DAMAGE

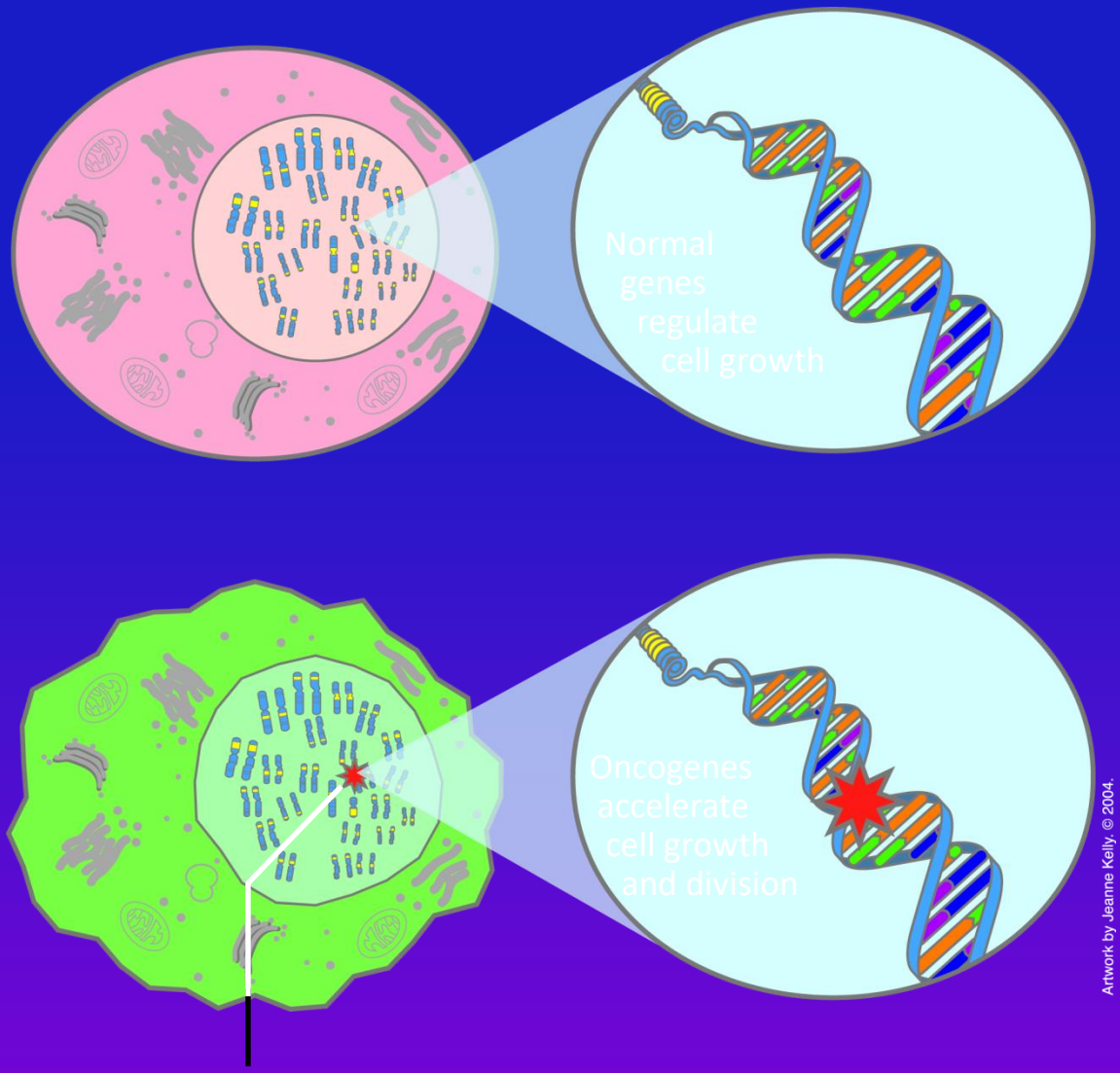
POLYMERASE INFIDELITY

CHROMOSOMAL

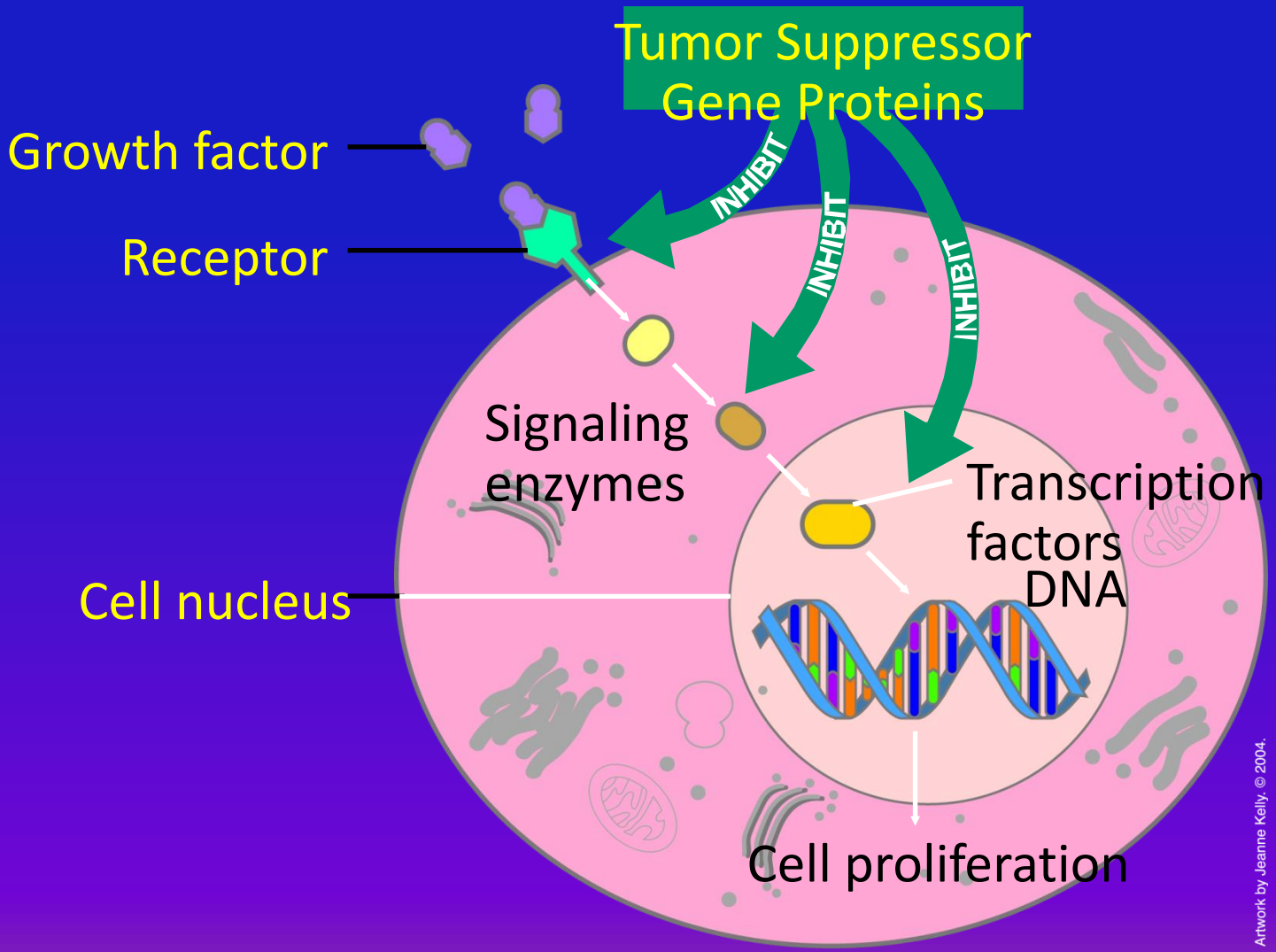
REARRANGEMENT

RECOMBINASE INFIDELITY

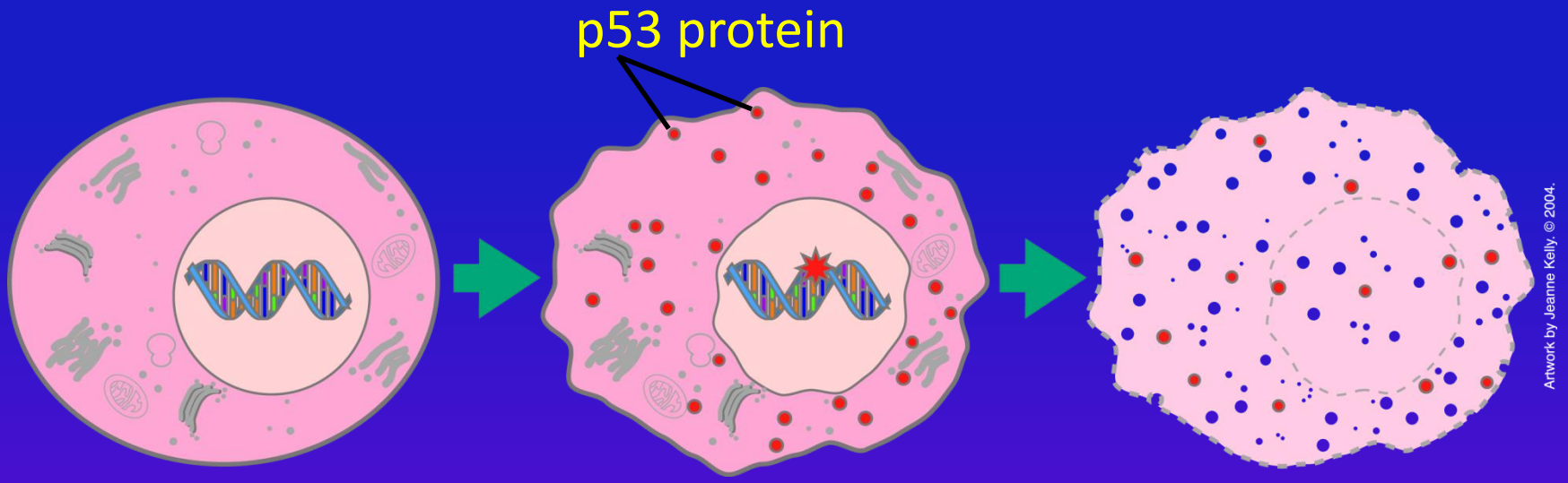
Oncogenes


Normal cell
Normal genes regulate cell growth
Cancer cell
Oncogenes accelerate cell growth and division
Artwork by Jeanne Kelly. © 2004.
Mutated/damaged oncogene

Tumor Suppressor Genes Act Like a Brake Pedal



p53 Tumor Suppressor Protein Triggers Cell Suicide



Normal cell

Excessive DNA damage

Cell suicide (Apoptosis)

Chances of Genomic Instability

Human Body Cells ~ 10^{14}

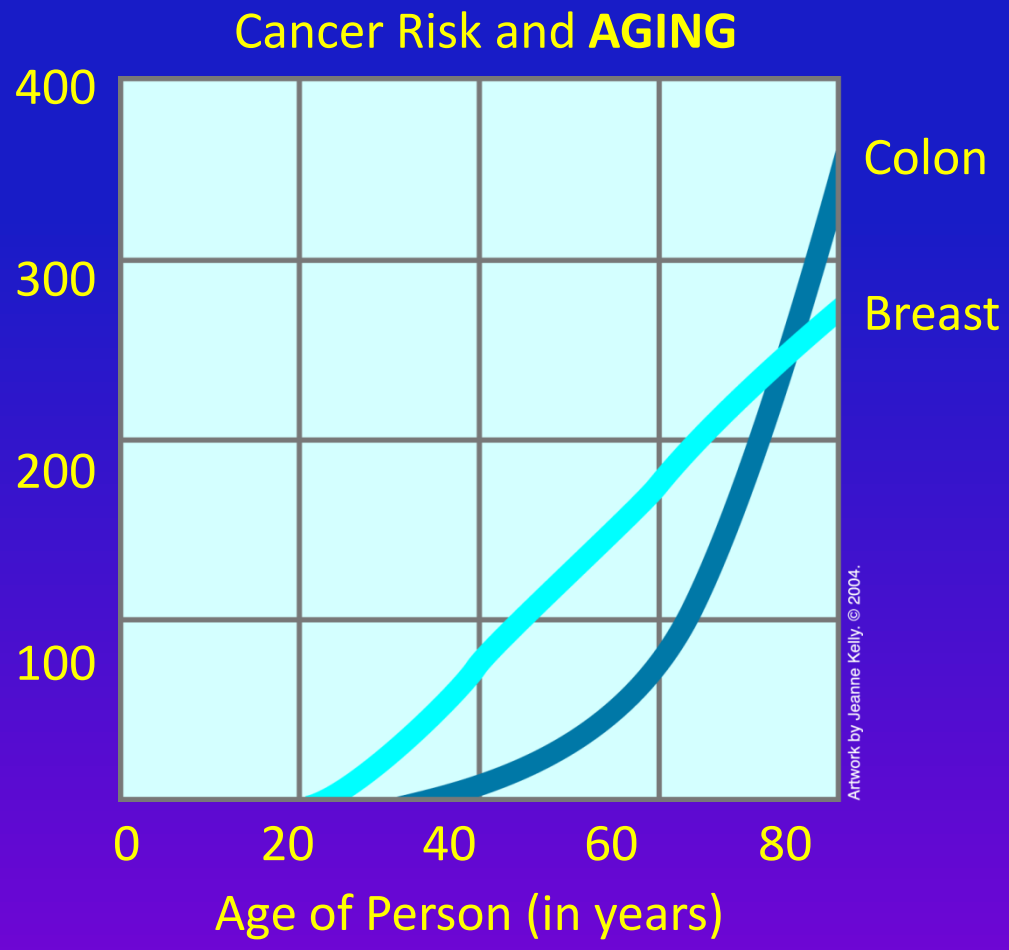
Lifetime Cell Divisions ~ 10^{16}

Chances of Mutation ~ 10^{124}

EVENTS IN CARCINOGENESIS

- METABOLIC ACTIVATION OF CARCINOGEN
  - Cytochrome P-450 enzymes
- PROTOONCOGENES ACTIVATION
  - Hepatocellular carcinoma c/w Aflatoxin B_1 exposure
- LOSS OF TUMOR SUPPRESSOR GENES
  - p53 on chromosome 17
- LOSS OF ANTIMETASTASIS GENES

Cancer Risk and Aging

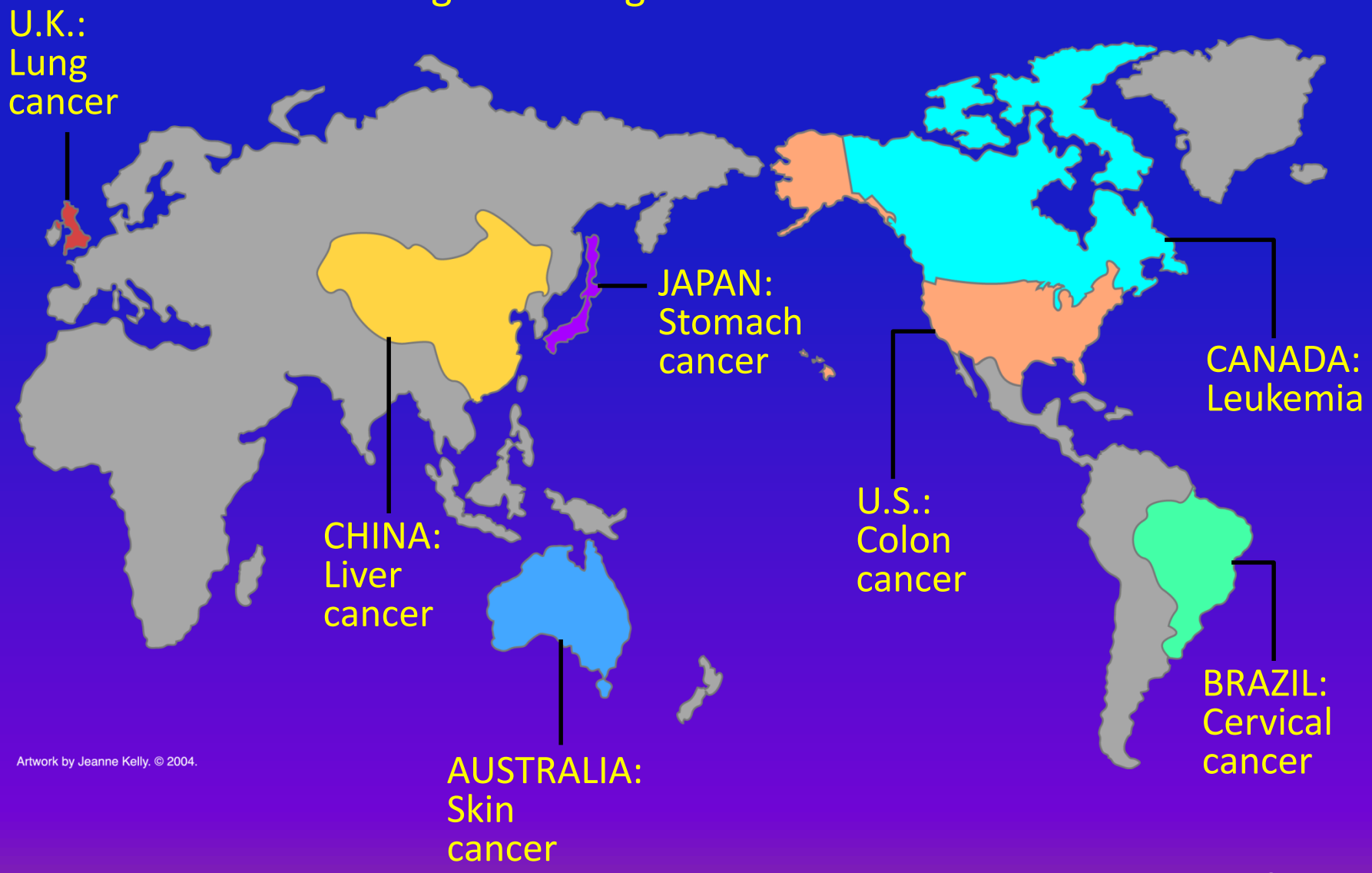


Known Factors Associated with Cancer Development*

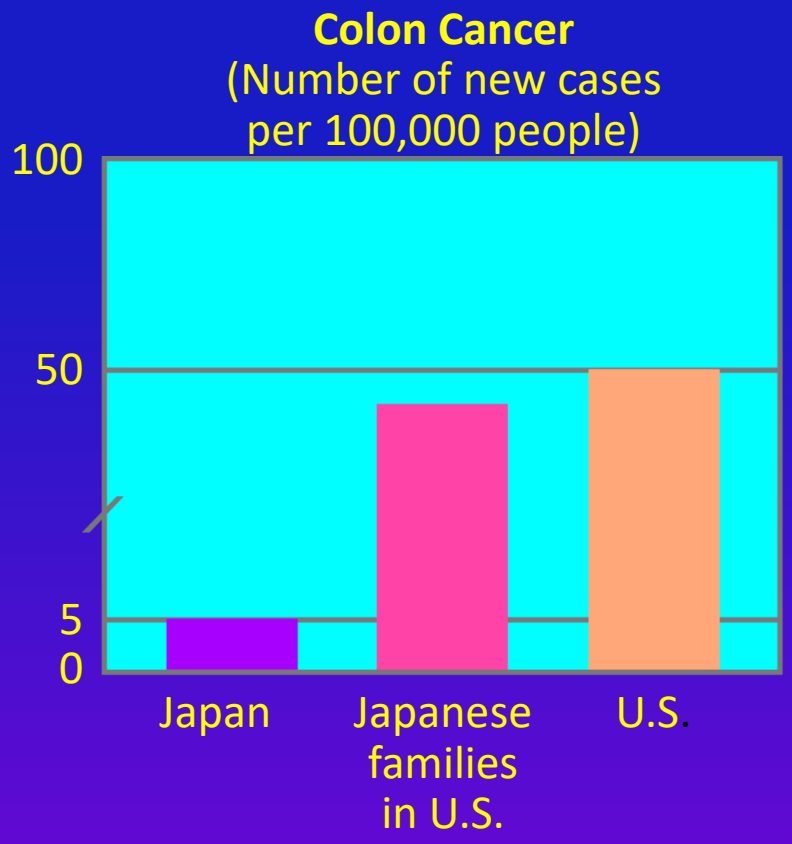
	%		%
Diet	30	Occupation	4
Smoking	30	Family History	2
Infection	10	Pollution	2
Sunlight	8	Food Additives	1
Alcohol	5	Industrial Products	1

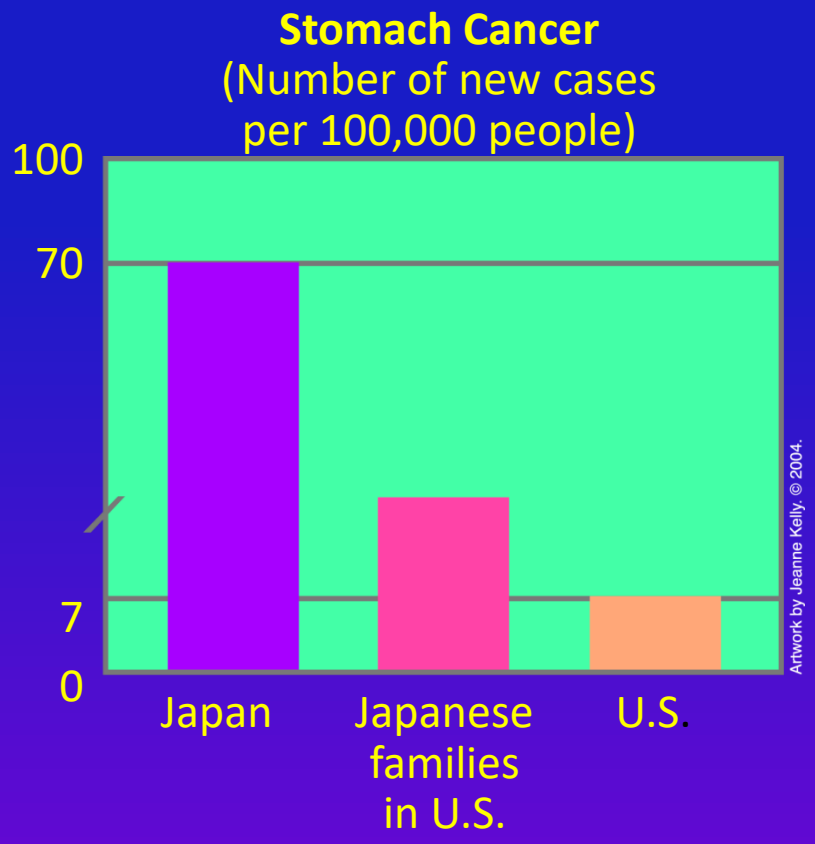
*** Modified from Doll, R. et al, 1981**

Population - Based Studies



Heredity? Behavior? "Acculturation"?





CANCER IN CALIFORNIA
ETHNIC FACTORS

CHINESE FEMALES

SHANGHAI-BORN	S.F.-BORN	U.S. WHITES
CERVIX	BREAST	BREAST
STOMACH	CERVIX	COLORECTAL
BREAST	COLORECTAL	CERVIX
LUNG	LUNG	OVARY
LIVER	STOMACH	LUNG

CANCER IN CALIFORNIA
ETHNIC FACTORS

CHINESE MALES

SHANGHAI-BORN	S.F.-BORN	U.S. WHITES
STOMACH	LUNG	LUNG
LUNG	COLORECTAL	PROSTATE
LIVER	LIVER	COLORECTAL
ESOPHAGUS	NASOPHARYNX	BLADDER
COLORECTAL	PROSTATE	PANCREAS

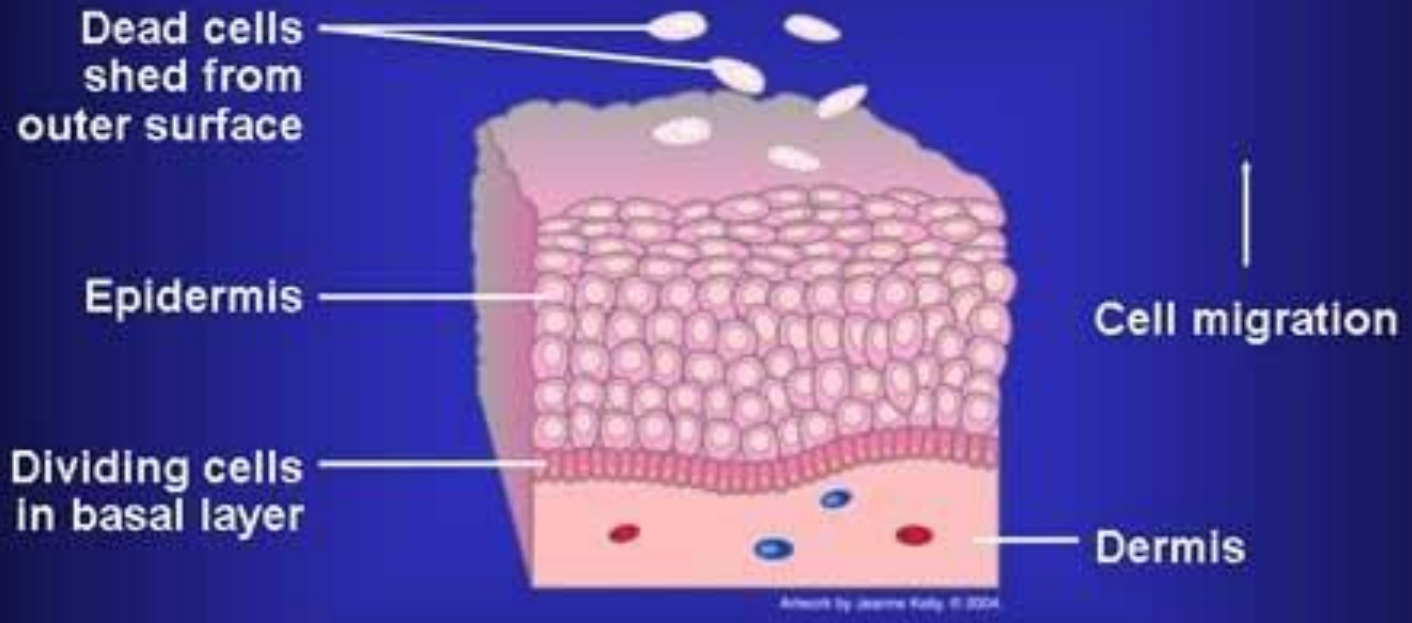
THE DAWN OF MOLECULAR EPIDEMIOLOGY OF HUMAN CANCER

"NO ONE SUPPOSES THAT ALL THE INDIVIDUALS OF THE SAME SPECIES ARE CAST IN THE VERY SAME MOLD"

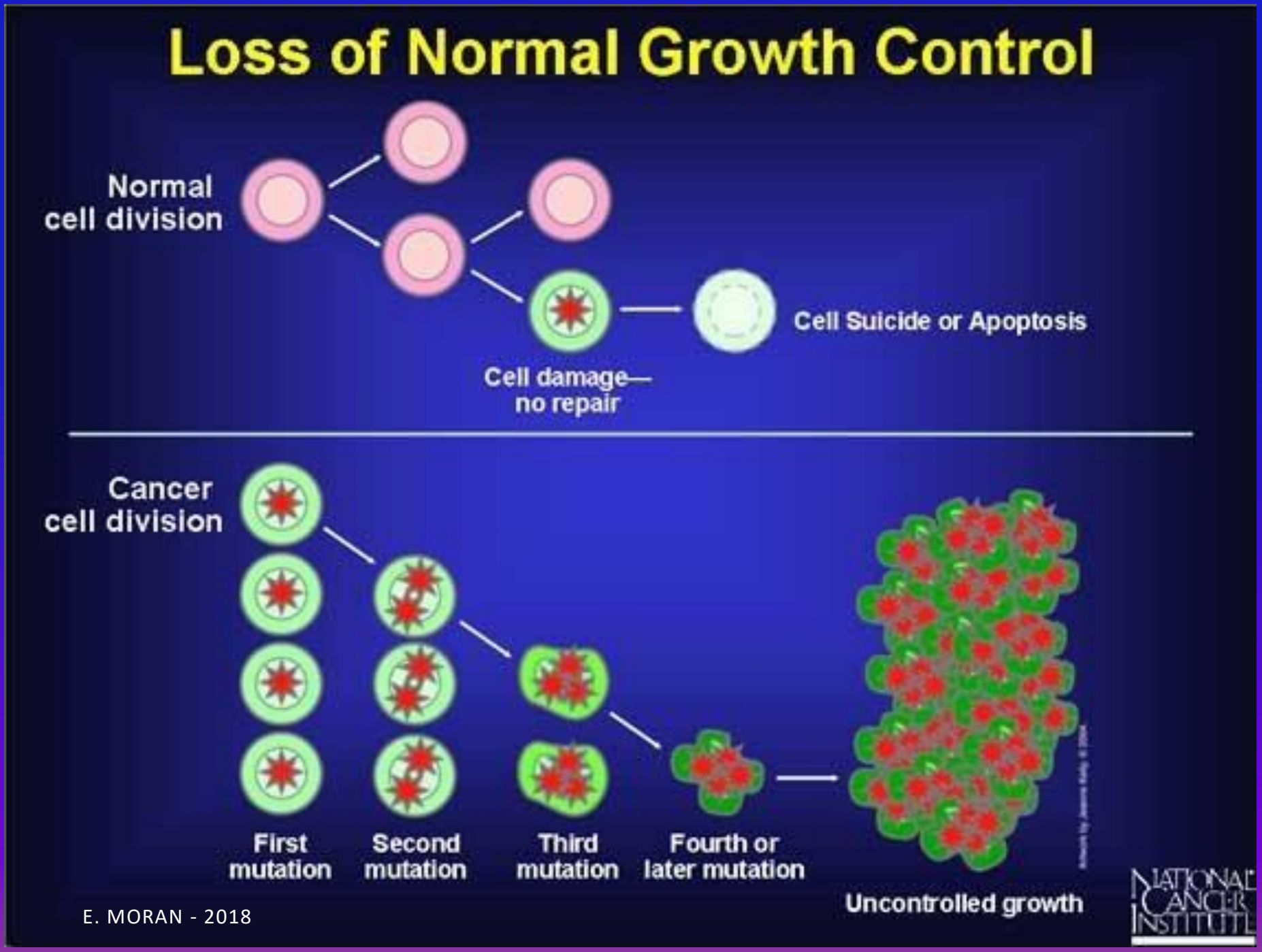
C. Darwin, 1859

CARCINOGENESIS

Example of Normal Growth



Loss of Normal Growth Control



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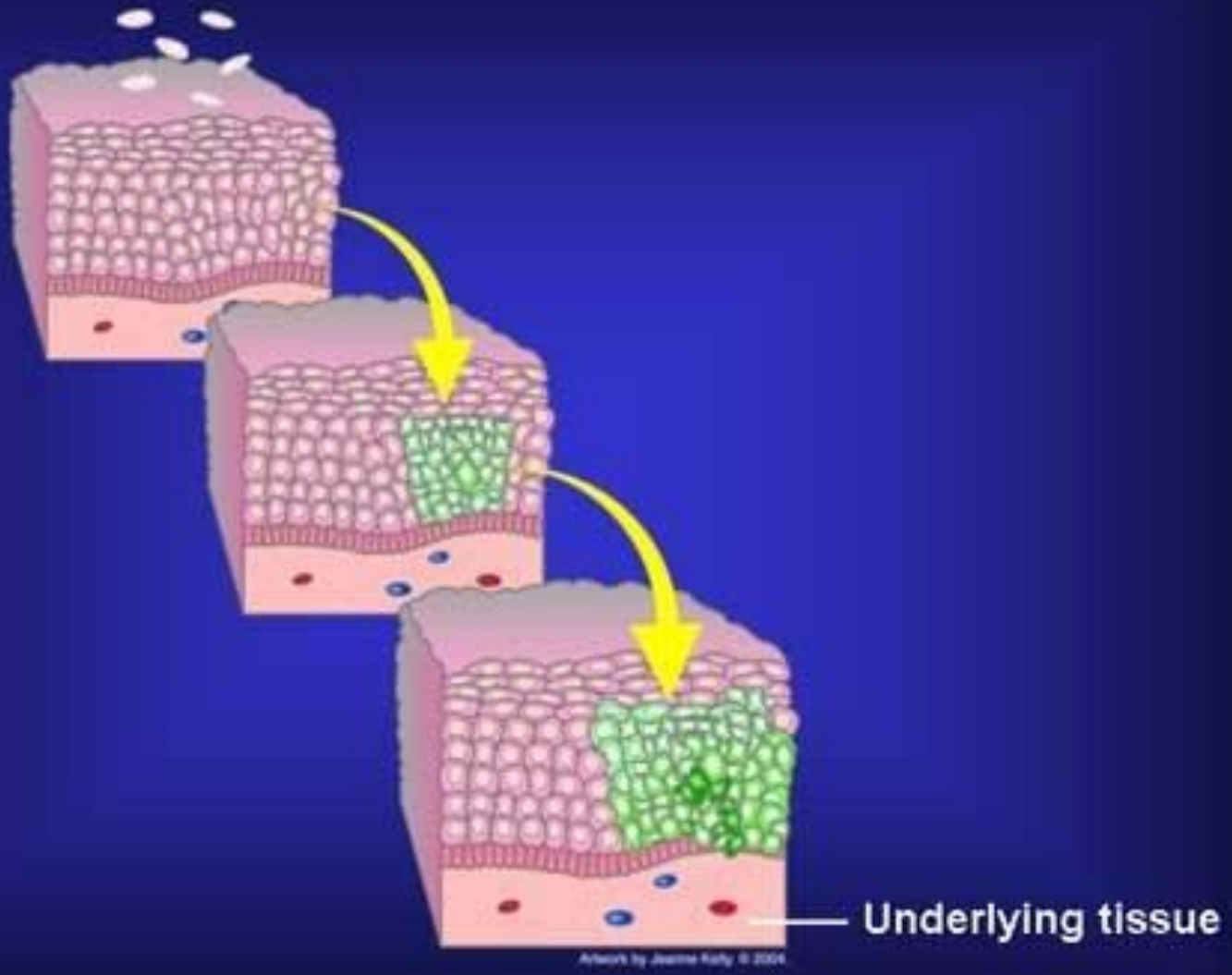
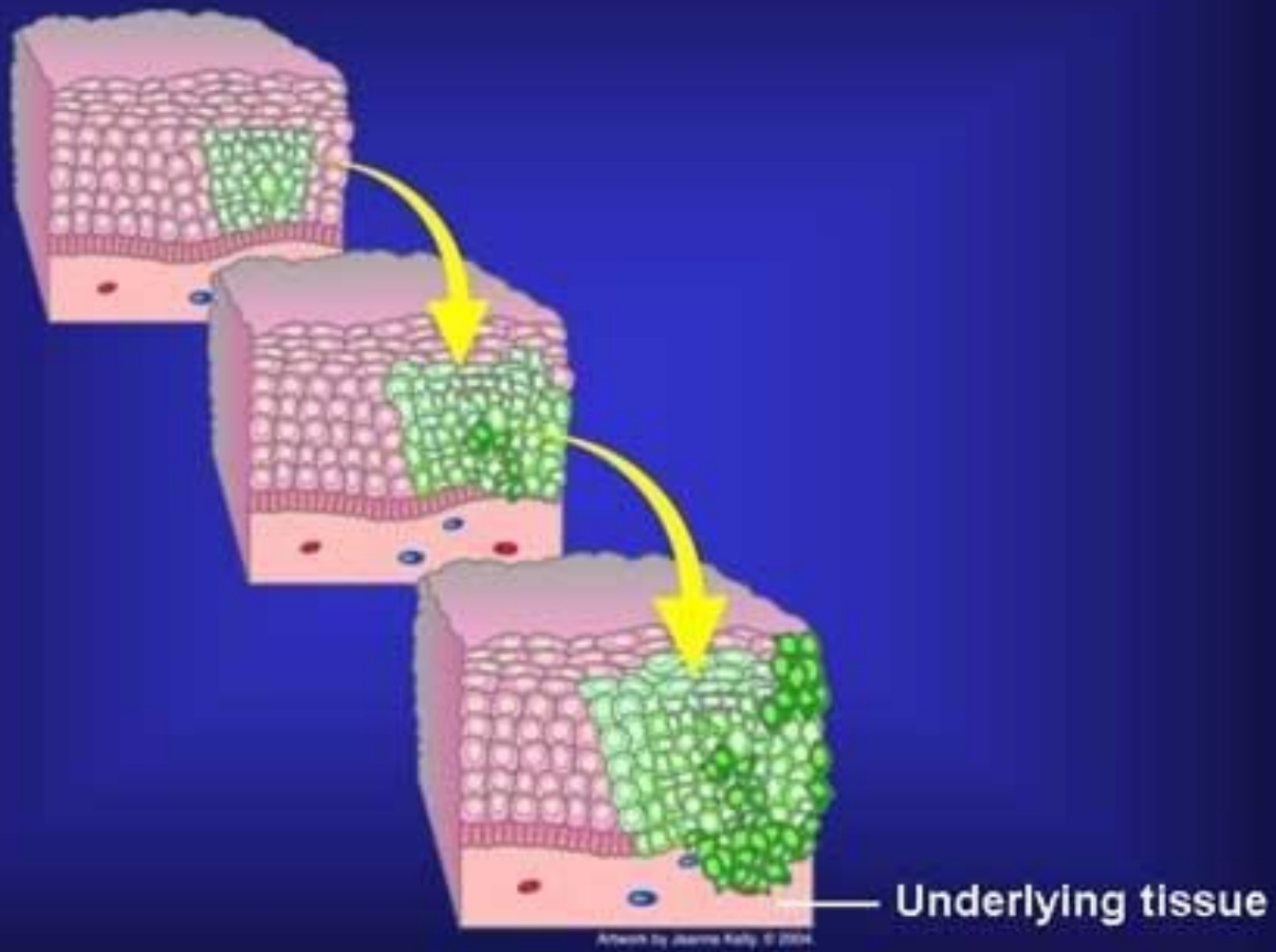
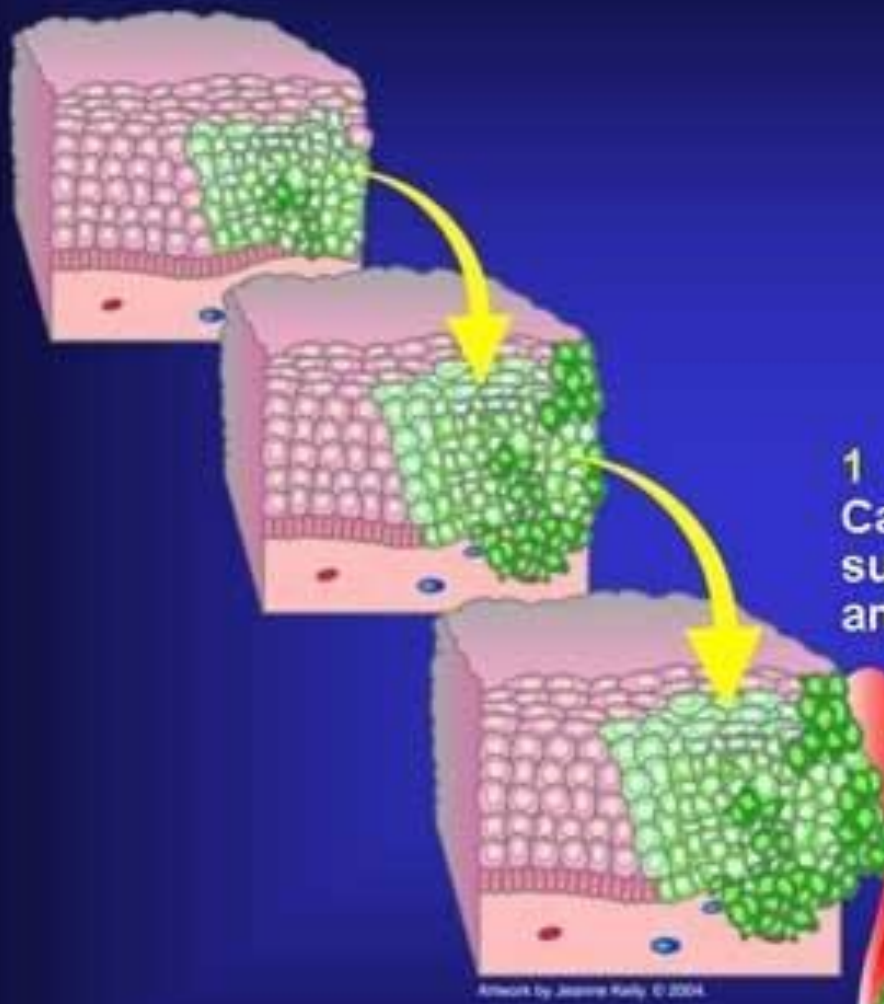
The Beginning of Cancerous Growth



Tumors (Neoplasms)



Invasion and Metastasis



1
Cancer cells invade surrounding tissues and blood vessels

2
Cancer cells are transported by the circulatory system to distant sites

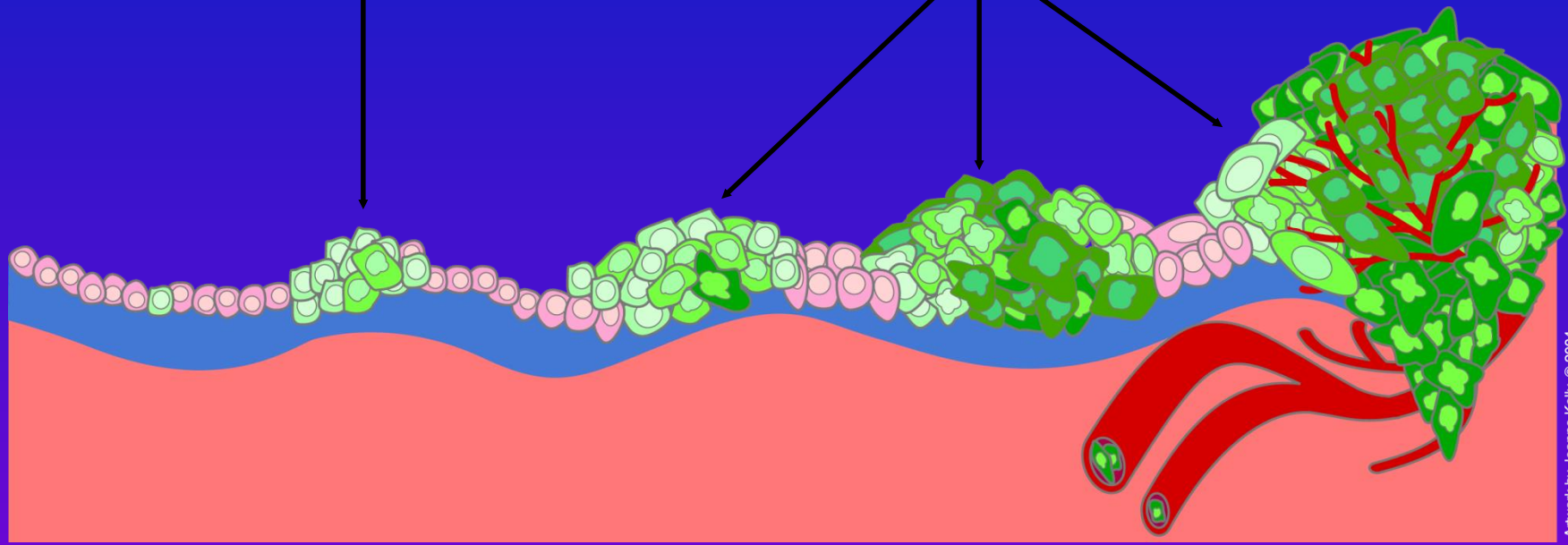
3
Cancer cells reinvade and grow at new location

NATIONAL CANCER INSTITUTE

Malignant versus Benign Tumors

Benign (not cancer) tumor cells grow only locally and cannot spread by invasion or metastasis

Malignant (cancer) cells invade neighboring tissues, enter blood vessels, and metastasize to different sites



Time

Maturation of Cancer Cells

Cancer may be formed by cells in various degrees of maturation ("differentiation"):

- Undifferentiated – One cannot identify the tissue origin
- Moderately well differentiated – Some features
- suggest a tissue origin
- Well differentiated – One can identify a tissue origin and
- specific function (mucus secreting, keratin formation)

The degrees of cell differentiation correlate with the

- progression (undifferentiated are progressing fast)

- response to chemoradiation (undifferentiated have a better response)

DEVELOPMENT OF A MALIGNANT TUMOR

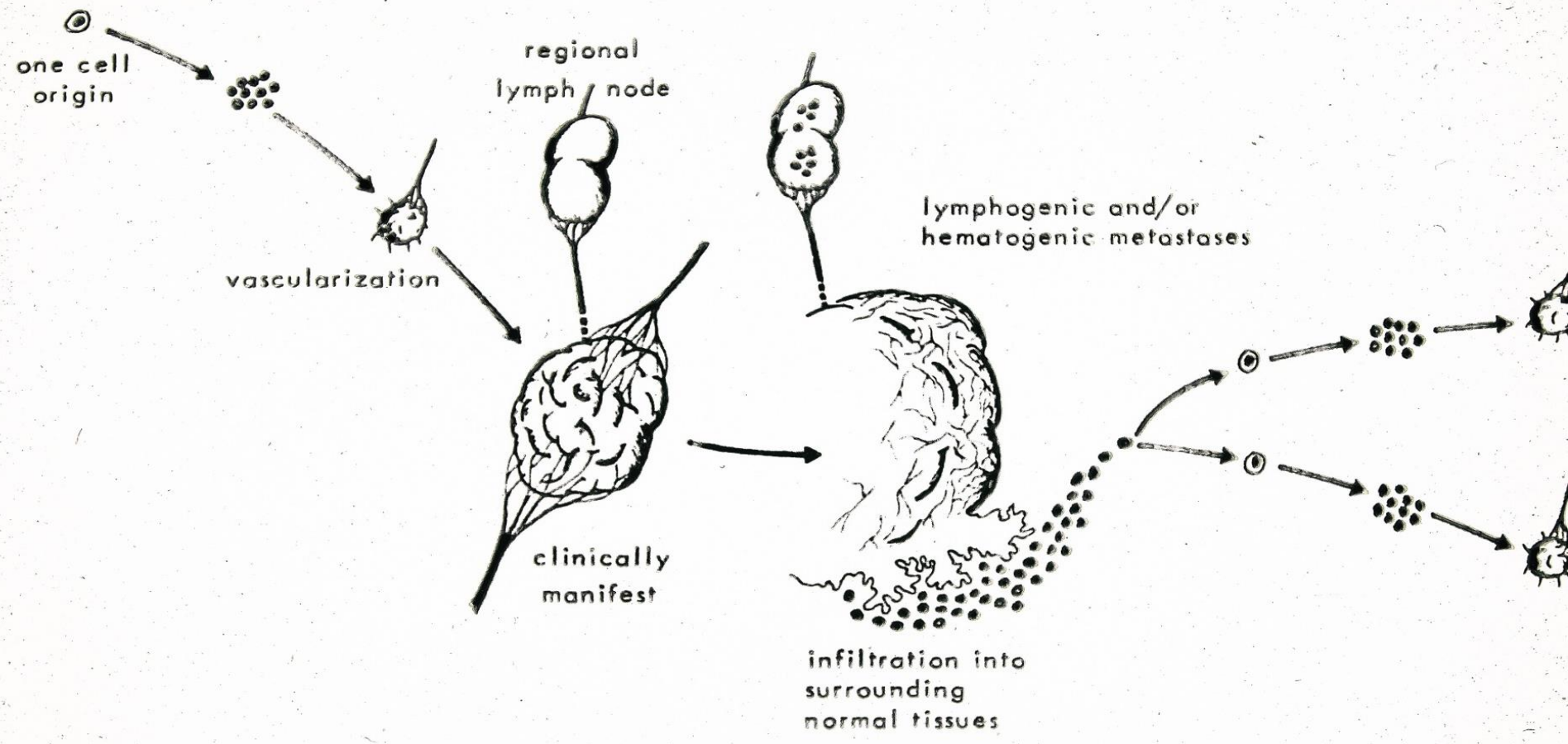


Figure 1. Development of a tumor.

END OF LECTURE #1