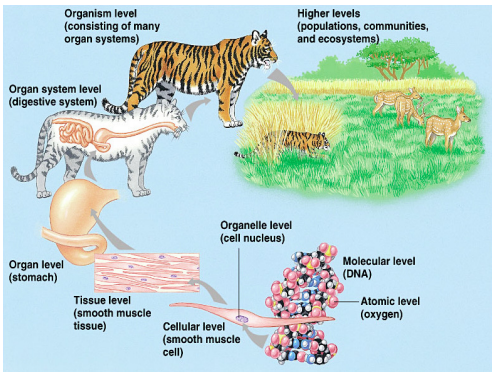
HAND OUT

BASIC BIOLOGY 1

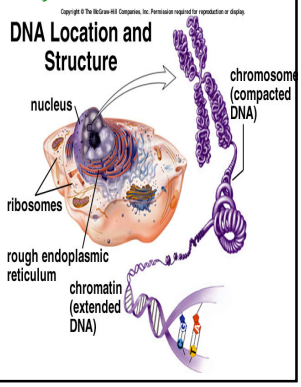
By Asri Widowati,
M.Pd.
2010

LEVELS OF COMPLEXITY

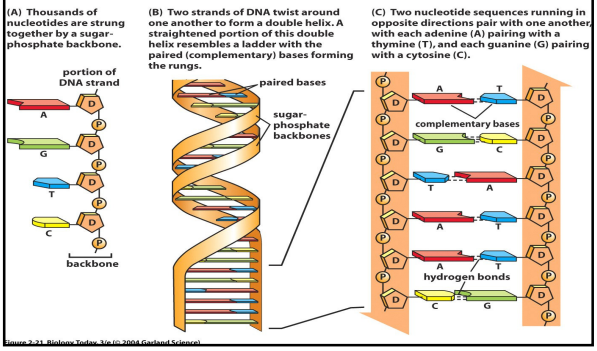


THE STRUCTURE OF DNA

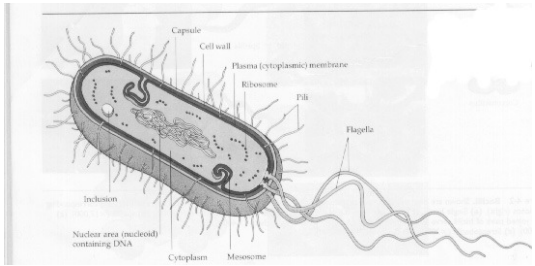
- Composed of 4 OR MANY nucleotide bases, 5 carbon sugar and phosphate.
- Base pair = rungs of a ladder.
- Edges = sugar-phosphate backbone.
- Double Helix
- Anti-Parallel



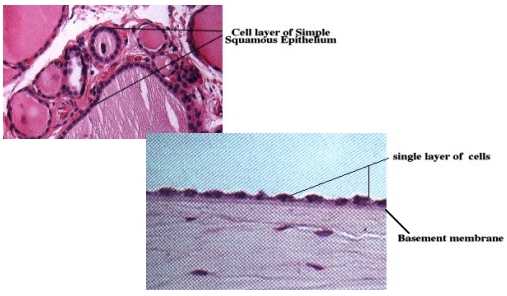
THE STRUCTURE OF DNA



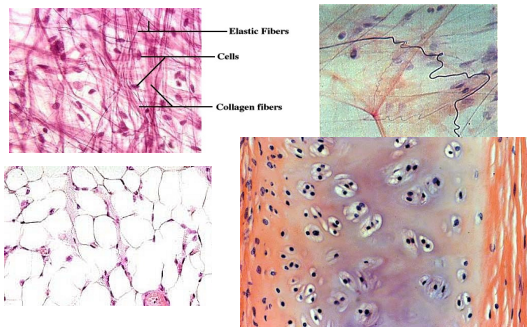
Structure of Prokaryotic Cells



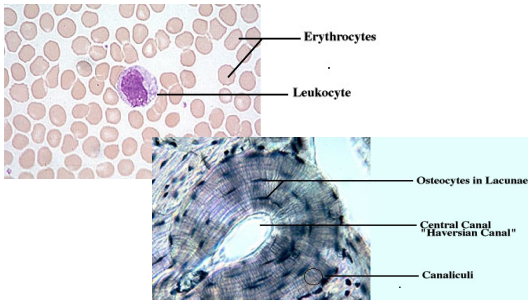
EPITHELIAL TISSUE



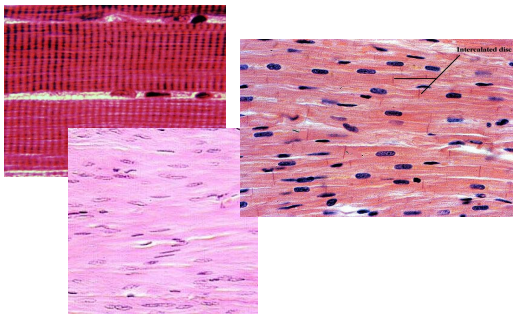
CONNECTIVE TISSUE



CONNECTIVE TISSUE CONTINUES

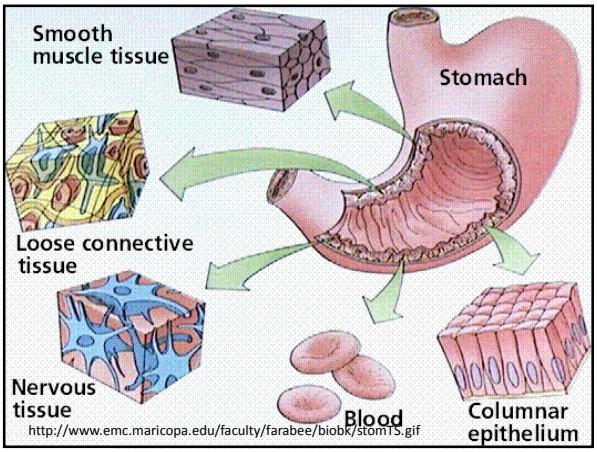


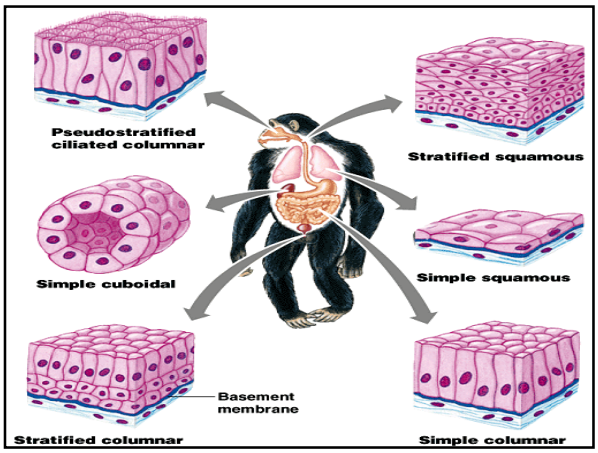
MUSCLE TISSUE

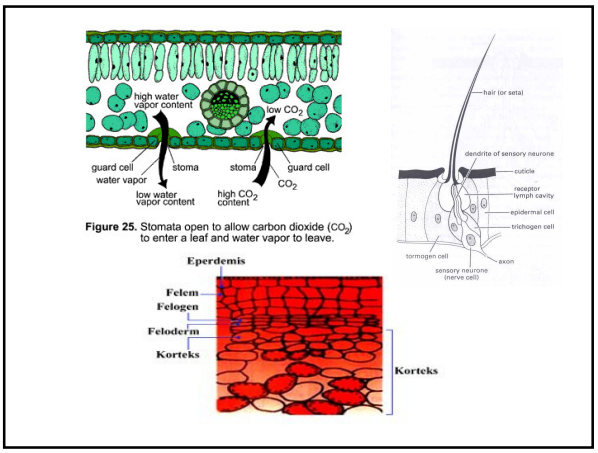


NERVOUS TISSUE

- Tissues make up organs, organs → organ systems → organisms.
- Tissues - groups of cells with common structure and function.
- 4 types of tissues: epithelial, connective, muscle, nervous.



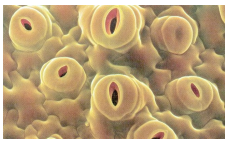


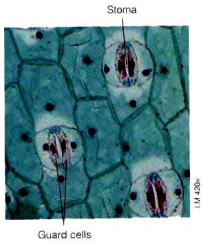


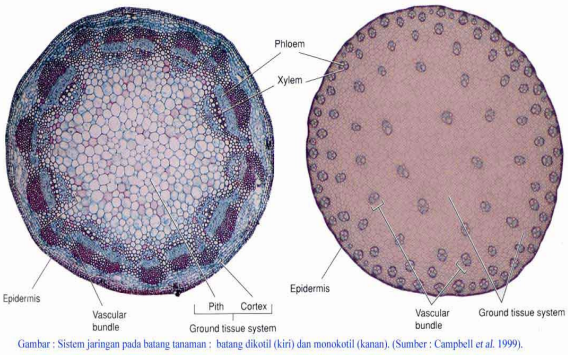
Stomata

Stomata berdasarkan letaknya ada 2 :

- Faneropor (menonjol)
- Kriptopor (tenggelam)







Gambar : Sistem jaringan pada batang tanaman : batang dikotil (kiri) dan monokotil (kanan). (Sumber : Campbell *et al.* 1999).

METABOLISM

- Overview: The Energy of Life
- The living cell
  - Is a miniature factory where thousands of reactions occur
  - Converts energy in many ways

- Some organisms
  - Convert energy to light, as in bioluminescence

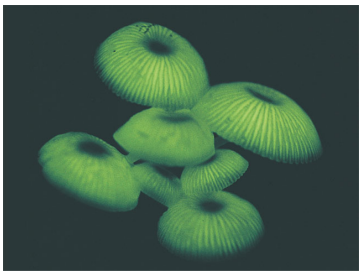


Figure 8.1

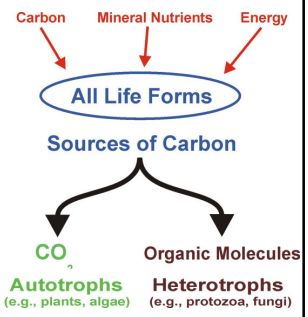
- Concept : An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics

All organisms have three fundamental requirements

Carbon

Energy

Mineral nutrients



20

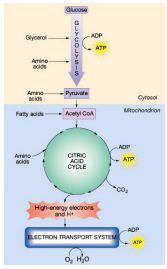
- Metabolism
  - Is the totality of an organism's chemical reactions
  - Arises from interactions between molecules

Metabolism

- Total of all chemical changes that occur in body. Includes:
  - **Anabolism**: energy-requiring process where small molecules joined to form larger molecules
    - E.g. Glucose + Glucose
  - **Catabolism**: energy-releasing process where large molecules broken down to smaller
- Energy in carbohydrates, lipids, proteins is used to produce ATP through oxidation-reduction reactions

Metabolic Pathways

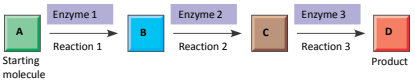
- The enzymatic reactions of metabolism form a network of interconnected chemical reactions, or pathways.
- The molecules of the pathway are called intermediates because the products of one reaction become the substrates of the next.
- Enzymes control the flow of energy through a pathway.



Intermediary Metabolism

Organization of the Chemistry of Life into Metabolic Pathways

- A metabolic pathway has many steps
  - That begin with a specific molecule and end with a product
  - That are each catalyzed by a specific enzyme



- Catabolic pathways
  - Break down complex molecules into simpler compounds
  - Release energy
- Anabolic pathways
  - Build complicated molecules from simpler ones
  - Consume energy

Forms of Energy

- Energy
  - Is the capacity to cause change
  - Exists in various forms, of which some can perform work

- Kinetic energy
  - Is the energy associated with motion
- Potential energy
  - Is stored in the location of matter
  - Includes chemical energy stored in molecular structure

- Energy can be converted
  - From one form to another

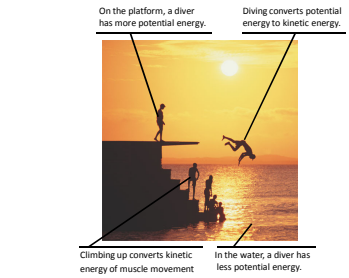


Figure 8.2

The Laws of Energy Transformation

- Thermodynamics
  - Is the study of energy transformations
- According to the first law of thermodynamics
  - Energy can be transferred and transformed
  - Energy cannot be created or destroyed
- According to the second law of thermodynamics
  - Spontaneous changes that do not require outside energy increase the entropy, or disorder, of the universe

Free-Energy Change, ΔG

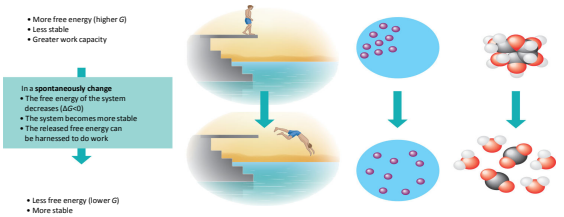
- A living system's free energy
  - Is energy that can do work under cellular conditions
- The change in free energy, Δ*G* during a biological process
  - Is related directly to the enthalpy change (Δ*H*) and the change in entropy

$$\Delta G = \Delta H - T\Delta S$$

Free Energy, Stability, and Equilibrium

- Organisms live at the expense of free energy
- During a spontaneous change
  - Free energy decreases and the stability of a system increases

- At maximum stability
  - The system is at equilibrium



(a) **Gravitational motion.** Objects move spontaneously from a higher altitude to a lower one.

(b) **Diffusion.** Molecules in a drop of dye diffuse until they are randomly dispersed.

(c) **Chemical reaction.** In a cell, a sugar molecule is broken down into simpler molecules.

Figure 8.5

Exergonic and Endergonic Reactions in Metabolism

- An exergonic reaction
  - Proceeds with a net release of free energy and is spontaneous

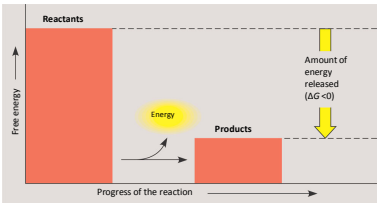


Figure 8.6 (a) Exergonic reaction: energy released

- An endergonic reaction
  - Is one that absorbs free energy from its surroundings and is nonspontaneous

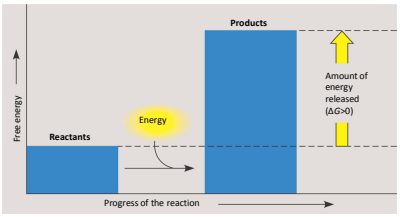
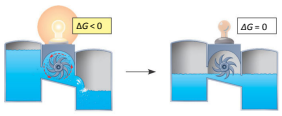


Figure 8.6 (b) Endergonic reaction: energy required

Equilibrium and Metabolism

- Reactions in a closed system
  - Eventually reach equilibrium



(a) A closed hydroelectric system. Water flowing downhill turns a turbine that drives a generator providing electricity to a light bulb, but only until the system reaches equilibrium.

Figure 8.7 A

- Cells in our body
  - Experience a constant flow of materials in and out, preventing metabolic pathways from reaching equilibrium

(b) An open hydroelectric system. Flowing water keeps driving the generator because intake and outflow of water keep the system from reaching equilibrium.

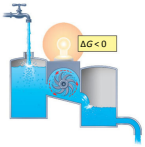


Figure 8.7

- An analogy for cellular respiration

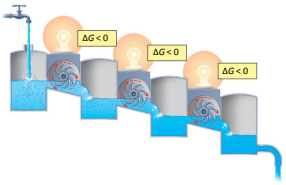


Figure 8.7 **(c) A multistep open hydroelectric system.** Cellular respiration is analogous to this system: Glucoce is brocken down in a series of exergonic reactions that power the work of the cell. The product of each reaction becomes the reactant for the next, so no reaction reaches equilibrium.

- Concept 8.3: ATP powers cellular work by coupling exergonic reactions to endergonic reactions
- A cell does three main kinds of work
  - Mechanical
  - Transport
  - Chemical

- Energy coupling
  - Is a key feature in the way cells manage their energy resources to do this work

The Structure and Hydrolysis of ATP

- ATP (adenosine triphosphate)
  - Is the cell's energy shuttle
  - Provides energy for cellular functions

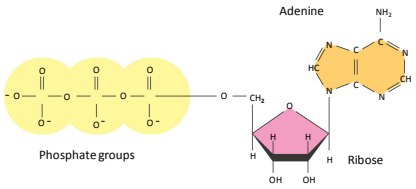


Figure 8.8

- Energy is released from ATP
  - When the terminal phosphate bond is broken

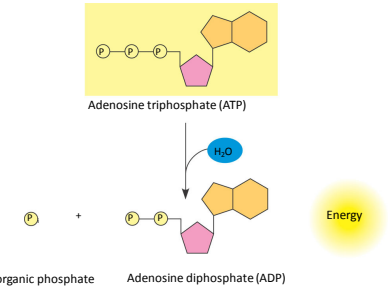


Figure 8.9

- ATP hydrolysis
  - Can be coupled to other reactions

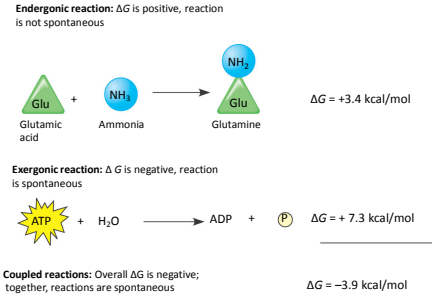


Figure 8.10

How ATP Performs Work

- ATP drives endergonic reactions
  - By phosphorylation, transferring a phosphate to other molecules

- The three types of cellular work
  - Are powered by the hydrolysis of ATP

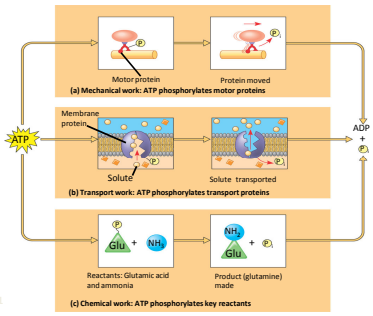


Figure 8.11

The Regeneration of ATP

- Catabolic pathways
  - Drive the regeneration of ATP from ADP and phosphate

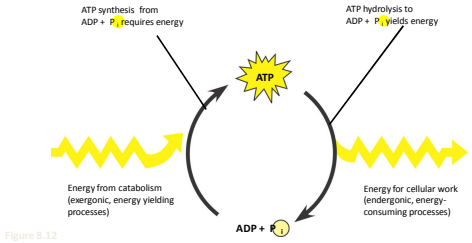
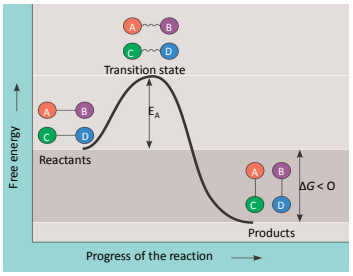


Figure 8.12

- The activation energy, E_A
  - Is the initial amount of energy needed to start a chemical reaction
  - Is often supplied in the form of heat from the surroundings in a system

- The energy profile for an exergonic reaction



How Enzymes Lower the E_A Barrier

- An enzyme catalyzes reactions
  - By lowering the E_A barrier

- The effect of enzymes on reaction rate

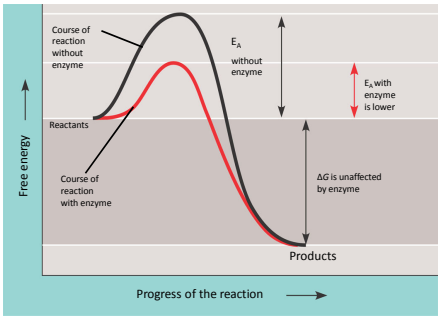


Figure 8.15

Substrate Specificity of Enzymes

- The substrate
  - Is the reactant an enzyme acts on
- The enzyme
  - Binds to its substrate, forming an enzyme-substrate complex

GENETICS

GREGOR MENDEL OBSERVED PHENOTYPES AND FORMED HYPOTHESES

- How do offspring come to resemble their parents physically?
- Genetics begins with the unifying assumption that biological inheritance is carried by structures called ***Genes***.
- The same basic patterns of inheritance apply to most organisms.
- The inheritance of ***some*** human traits can be explained from work on plants
- Sex-linked traits in humans is more complicated

- **GREGOR MENDEL**
  - Was the first person to analyze patterns of inheritance
  - Deduced the fundamental principles of ge

TERMS:

- ***Phenotype***
  - An organism's physical traits
- ***Genotype***
  - An organism's genetic makeup

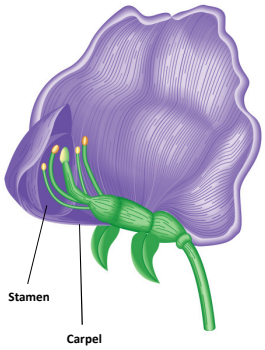
ALLELE

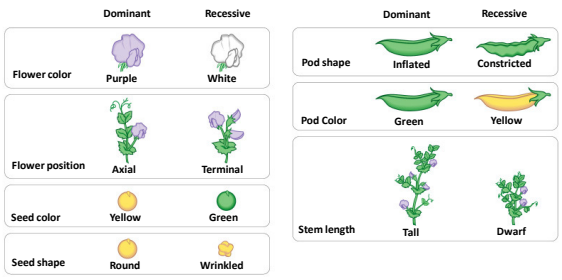
- ***Allele***: Alternate form of a gene at same position on pair of chromosomes that affect the same trait.
- **Dominant Allele**: Capital Letter--O
- **Recessive Allele**: lowercase letter--o
- **Homozygous Dominant**--OO
- **Homozygous Recessive**--oo
- **Heterozygous**--Oo

Mendel's Peas

- These plant are easily manipulated
- These plants can self-fertilize

Garden pea

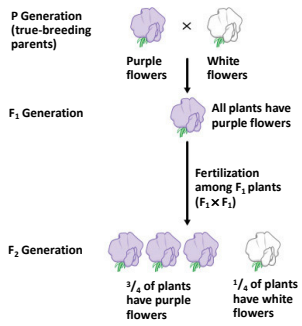




Monohybrid Inheritance

- Mendel selected several varieties of garden peas that has different characteristics. E.g :
  - Short and tall plants
  - Red or white flower plants
  - Seeds that were either yellow or green, or round and wrinkled
- Inheritance involving only one pair of contrasting characters is called monohybrid inheritance

MONOHYBRID CROSSES



F2 = 3:1 ratio

Some terms…

Hybrid

A hybrid is the offspring from two different varieties or species

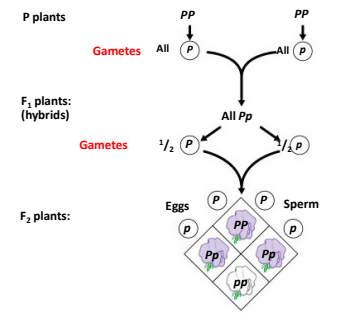
F_1 generation

Also known as first filial generation

F_2 generation

Also known as second filial generation

- **Using a <u>Punnett</u> square to explain the results of a monohybrid cross**



<u>Phenotypic</u> ratio
3 purple : 1 white

<u>Genotypic</u> ratio
1 *PP* : 2 *Pp* : 1 *pp*

Figure 9.8b

Table 22.1 Mendel's monohybrid crosses

	Traits in Parental Plants	F_1 Generation (character appearing is dominant)	F_2 Generation	F_2 Ratio of Dominants to Recessives
1	round x wrinkled seeds	all round	5 474 round seeds 1 850 wrinkled seeds 7 324 Total	2.96 : 1
2	yellow x green seeds	all yellow	6 022 yellow seeds 2 001 green seeds 8 023 Total	3.01 : 1
3	purple x white flowers	all purple	705 purple flowers 224 white flowers 929 Total	3.15 : 1
4	inflated x constricted pods	all inflated	882 inflated pods 299 constricted pods 1 181 Total	2.95 : 1
5	green x yellow pods	all green pods	428 green pods 152 yellow pods 580 Total	2.82 : 1
6	axial x terminal flowers	all axial flowers	651 axial flowers 207 terminal flowers 858 Total	3.14 : 1
7	long x short stems	all long	787 long stems 277 short stems 1 064 Total	2.84 : 1

Question

- Why does the observed ratios differ from expected ratios, especially when there are small numbers of progeny?

Results of all experiments

- One trait or character remained unchanged in the F_1 hybrids while the other trait seemed to disappear
- This character then appear again in the F_2 generation but only in about one-quarter of the total number of offsprings
- Trait unchanged – dominant trait
- Trait disappeared and appear again – recessive trait

Mendel's suggestion

- Hereditary factors are responsible for the transmission of characteristics
- Each characteristic controlled by a pair of factors in the cells of an organism
- The two factors in each pair separate (segregate) during gamete formation and each gamete contain only one factor ➔ Mendel's Law of Segregation
- Fusion of gamete restores the diploid condition in the zygote
- Gamete unite at random so that a predictable ratio of characteristics occurs among offspring (Fig 22.3)

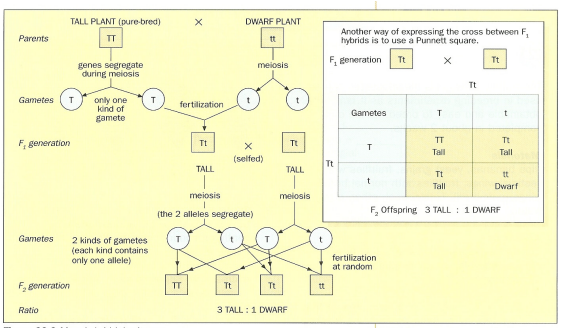


Figure 22.3 Monohybrid inheritance

- from the monohybrid crosses, Mendel derived 4 hypotheses….combined, we now refer to these as…

= Mendel's Principle of Segregation

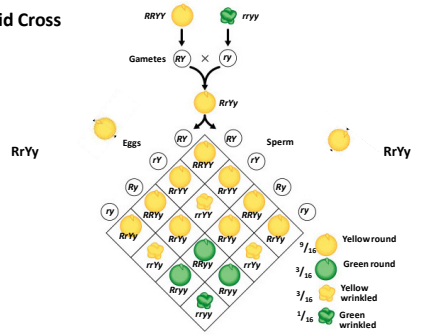
  - There are alternative forms of genes, now called alleles
  - For each characteristic, each organism has two genes
  - Gametes carry only one allele for each inherited characteristic
  - Alleles can be dominant or recessive

MENDEL'S PRINCIPLE OF INDEPENDENT ASSORTMENT

- **What happens when you follow the inheritance of more than a single trait at one time?**
- **How do two different traits get passed to offspring?**

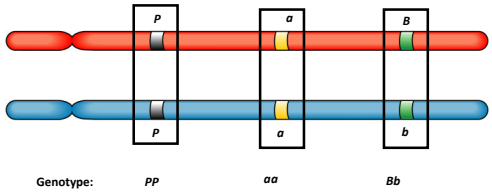
A Dihybrid Cross

Dihybrid Cross



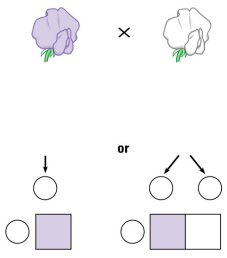
9:3:3:1

- Mendel's principle of independent assortment
  - Each pair of alleles segregates independently of the other pairs during gamete formation



USING A TESTCROSS TO DETERMINE AN UNKNOWN GENOTYPE

- A testcross is a mating between:
  - An individual of unknown genotype and
  - A homozygous recessive individual



```
ERROR: stackunderflow
OFFENDING COMMAND: ~

STACK:
```