<table>
<thead>
<tr>
<th><strong>Hypothesis</strong>- a proposed answer to a scientific question (&quot;educated guess&quot;)</th>
<th><strong>Quantitative</strong>- involves numbers, counting, measuring objects.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Qualitative</strong>- involves characteristics that cannot easily measured or counted such as color or texture.</td>
<td><strong>Theory</strong>- a well-tested hypothesis.</td>
</tr>
<tr>
<td><strong>Levels of Organization</strong></td>
<td><strong>Theory</strong>- a well-tested hypothesis.</td>
</tr>
<tr>
<td>cells→tissues→organs→organ systems→organism</td>
<td>May be revised or replaced if new information becomes available.</td>
</tr>
<tr>
<td><strong>Homeostasis</strong>- ability to maintain constant or stable conditions inside despite changes outside. (like thermostat in your house)</td>
<td><strong>Controlled experiment</strong>- all variables are kept constant except one being tested.</td>
</tr>
<tr>
<td><strong>pH scale</strong>- used to indicate concentration of the H+ ions. 1. Scale ranges from 0 to 14 (decreases with acidity) 2. Pure water has pH of 7 3. Acids below 7 and bases above 7</td>
<td><strong>Characteristics of living things</strong></td>
</tr>
</tbody>
</table>
| • Made up of one or more cells  
• Need source of energy  
• Respond to environment  
  • Can reproduce  
• Have genetic material (DNA) |
Ribosomes

Animal cells vs. Plant cells

Cell membrane

Eukaryotic vs. Prokaryotic

Organic compounds

Enzymes

Golgi apparatus

Endoplasmic reticulum
**Ribosome** - organelle in the cytoplasm that makes proteins using coded instructions from the nucleus
- Made of rRNA
- Site of translation

**Organic compounds** - contain carbon (includes: carbohydrates, proteins, lipids, nucleic acids)
Large molecules (polymers) built with individual building blocks (monomers)
- Amino acid → protein
- Monosaccharide → starch, cellulose
- Nucleotide → nucleic acid

**Enzymes** - specialized proteins that act as biological catalysts.
**Catalysts** - a substance that speeds up the rate of a chemical reaction by lowering a reaction's activation energy.
- Enzymes are very specific
- Enzymes are not used up in a chemical reaction.

**Plant cell** - more rigid in shape (cell wall)

**Animal cell** - do not have chloroplasts, cell wall or large central vacuole

**Cell Membrane** - thin, flexible barrier around the cell composed of lipid bilayer. Channels in membrane made of proteins.
**Semi-permeable** - allows some things through but not others

**Golgi Apparatus** (Bodies) - “post office” of the cell
- Carbohydrates and lipids attached to proteins are “packaged”
- Then sent to final destination

**Endoplasmic Reticulum** - cells internal transport system. Components of the cell membrane assembled and some proteins modified
- **Rough E.R.** - (has ribosomes attached) Smooth E.R. (no ribosomes)

<table>
<thead>
<tr>
<th>Structure</th>
<th>Prokaryotic Cells</th>
<th>Eukaryotic Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Membrane</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cell Wall</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Nucleus</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Endoplasmic Reticulum</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Golgi Apparatus</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Lysosomes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Vacuoles</td>
<td>No</td>
<td>Small or none</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cytoskeleton</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
| **Diffusion** | **Mitosis** - Division of cells nucleus  
Divided into 4 phases (PMAT)  
- 2n cells → 2n cells  
- Diploid cells → Diploid cells  
- Produces 2 genetically identical cells  
- Occurs in all body cells  
  
**Cytokinesis** - division of cytoplasm following mitosis. |
| --- | --- |
| Movement of materials from areas of high concentration to areas of low concentration  
- Form of passive transport (no energy required.  
- When concentration equal on both sides of membrane → equilibrium | |
| **Osmosis** - Diffusion of water molecules through selectively permeable membrane  
- If cell has lower concentration of water → water flows into cell, causing it to burst.  
- If cell has higher concentration of water → cell loses water and shrinks in size. | **Meiosis**  
- making of sex cells (gametes)  
- 2n → n  
- Diploid cells → haploid cells  
- Produces 4 genetically different cells  
- Occurs only in sex organs  
- **Fertilization** (egg + sperm)  
  n + n → 2n |
| **Cell transport** - movement of materials into and our of cell.  
  
- **Active transport** - requires energy by cell  
- **Passive transport** - no energy required (diffusion and osmosis) | **Lysosomes** - “clean-up crew” of the cell  
- break down lipids, carbohydrates, proteins from food particles (“little digestive sacs”)  
- Break down “old” cell parts, |
| **ATP (adenosine tri-phosphate)** - chemical fuels that power all activities of the cell  
- Adenosine triphosphate (ATP) - stores energy in phosphate bonds  
- Gives up energy when remove a phosphate group | **Nucleus**  
- Controls most of cells processes and contains hereditary information (DNA).  
  
(Controls activities of the cell by making proteins)  
- Found in eukaryotic cells |
<table>
<thead>
<tr>
<th>Fermentation</th>
<th>Photosynthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process that allows glycolysis to continue and produce small amount of energy. Takes place when oxygen not present (anaerobic). 2 kinds- Alcoholic and lactic acid.</td>
<td>Energy from sunlight converts water and carbon dioxide into oxygen and high-energy sugars. Takes place in chloroplast. Affected by temperature, light, and amount of water. First stage- light dependent (chlorophyll).</td>
</tr>
<tr>
<td></td>
<td><strong>6CO₂ + 6H₂O + LIGHT → 6O₂ + C₆H₁₂O₆</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DNA</th>
<th>Cellular Respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deoxyribonucleic acid</td>
<td>Process that releases energy by breaking down food molecules in the presence of oxygen. Occurs in three stages- glycolysis→krebbs cycle→electron transport. Occurs in mitochondria.</td>
</tr>
<tr>
<td>Contains genetic information in segments of DNA called genes. Made up of nucleotides. Letters (bases)- A-T C-G. Double helix shaped molecule.</td>
<td>6O₂ + C₆H₁₂O₆ → 6CO₂ + 6H₂O + ENERGY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RNA</th>
<th>Mitochondria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ribonucleic acid</td>
<td>Cells “Powerhouse”</td>
</tr>
<tr>
<td>3 types made from DNA (mRNA, tRNA, and rRNA). Made up of nucleotides. Letters (bases)- A-U C-G. Single stranded.</td>
<td>found in nearly all eukaryotic cells. use energy from food to power growth, development, and movement. Cells that require more energy have more mitochondria.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Replication</th>
<th>Chloroplast</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA making exact copy of itself before cell division. Occurs in nucleus. DNA “unzips” and complimentary bases pair up with each side of DNA to form two new identical strands.</td>
<td>found in plants and some other organisms (none found in animals and fungi). produce energy-rich food molecules (glucose) from sunlight by photosynthesis. Green pigment- chlorophyll found in photosynthetic membranes.</td>
</tr>
</tbody>
</table>
Principle of Independent Assortment
• Allele pairs separate independently of each other during meiosis (gamete formation)
• Different traits are inherited separately
• Use FOIL rules to determine gametes from two-factor cross (i.e. TtFf would produce TF, Tf, tF, tf gametes)

Principle of Segregation
• that two alleles for traits separate (segregated) from each other during meiosis (formation of sex cells (gametes))
• Like flipping a coin (50/50)

Mutation
• Any change in DNA of an organism.
• May or may not affect individual (phenotype)
• May be small change in sequence of DNA, or may involve extra or missing chromosomes.

Haploid & diploid cells
• Haploid (n) - half the number of chromosomes. Found in gametes (sex-cells) produced by meiosis
• Diploid cells (2n) - two sets of chromosomes (one from each parent). Found in all body cells (i.e. skin cells, bone cells, etc.)

Transcription
• DNA making RNA
• Occurs in nucleus of cell
• DNA “unzips” and one side codes for new single strand of RNA
• A→U T→A C→G G→C
• Makes 3 kinds of RNA (mRNA, tRNA, and rRNA)
• 3-letter “word” called codon

Translation
• RNA making proteins
• Occurs in cytoplasm
• Uses all 3 kinds of RNA
• Code carried on mRNA
• Occurs at ribosomes which are made of rRNA in the cytoplasm
• tRNA transports amino acids to ribosomes
• 3-letter “word” called anticodon

Genes
• Segment of DNA molecule
• Found on chromosomes
• Carries instructions to make one protein
• Proteins control traits
• 20,000 - 25,000 genes in humans

Principle of dominance
• Some alleles are dominant and some are recessive
• Use capital letter for dominant trait (i.e. T=tall and t=short)
• TT and Tt would be tall, tt = short
• Only way to have recessive trait is to have 2 recessive alleles (tt)
Polygenic traits

Crossing over

Heterozygous & Homozygous

Genotype & Phenotype

Amino acids & Proteins

Sex-linked traits

Multiple allele traits

Incomplete dominance
### Amino acids and Proteins
- Amino acids are monomers that build proteins
- 20 kinds of amino acids
- 64 codons on mRNA for amino acids (more than one codon codes for each amino acid)
- Thousands of proteins using different types and number of amino acids

### Polygenic traits
- Traits which are controlled by more than one gene
- Examples are eye color and skin color

### Sex-linked traits
- Traits on the X-chromosome
- Occur more often in males because males only have a single X-chromosome
- Males - XY  
  Females - XX
- Include colorblindness, hemophilia
- Females can be carrier, males cannot. Example- \( X^H X^h \) and \( X^h Y \)

### Crossing over
- Exchange of portions of chromatids takes place while chromosomes exist as tetrads during meiosis
- Increased variety in gametes (mixes up the genes more)

### Multiple allele traits
- More than 2 choices (tall/short), such as in Blood type. 3 alleles- \( I^A, I^B, i \)
- Can exhibit dominant/recessive, as well as co-dominance. E.g. \( I^A \) and \( I^B \) are codominant, and are both dominant over \( i \).
- Can lead to 4 phenotypes (A, B, AB, 0)

### Heterozygous & homozygous
- Heterozygous- different alleles (Tt)
- Homozygous- same alleles (TT or tt)

### Incomplete dominance
- Blending of traits
- Purebred Red flower crossed with purebred white gives pink flowers
- Heterozygous is blending of 2 traits
- \( RR \times WW = RW \) (pink flower)

### Genotype & Phenotype
- Genotype- the letters (TT, Tt, tt)
- Phenotype- The physical traits (tall or short, red or white flowers, etc.)

Dom/Rec cross
- Phenotypic ratio- 3:1
- Genotypic ratio- 1:2:1

\[
\begin{array}{ccc}
\text{T} & \text{t} \\
\text{TT} & \text{Tt} & \text{tt}
\end{array}
\]
If Tall (T) is **dominant** over short (t)
Cross two heterozygous parents

Phenotypic ratio - 3:1
Genotypic ratio - 1:2:1

<table>
<thead>
<tr>
<th>T</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT</td>
<td>Tt</td>
</tr>
<tr>
<td>Tt</td>
<td>tt</td>
</tr>
</tbody>
</table>

If Tall (T) is **incompletely** dominant over short (t)
Cross two heterozygous parents

Phenotypic ratio - 1:2:1
Genotypic ratio - 1:2:1

<table>
<thead>
<tr>
<th>T</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT</td>
<td>Tt</td>
</tr>
<tr>
<td>Tt</td>
<td>tt</td>
</tr>
</tbody>
</table>

Multiple allele- $I^A$ & $I^B$ are codominant and both are dominant over i.

Phenotypic ratio - 2:1:1
Genotypic ratio - 1:1:1:1

<table>
<thead>
<tr>
<th>$I^A$</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^A$</td>
<td>$I^A$</td>
</tr>
<tr>
<td>$I^B$</td>
<td>$I^B$</td>
</tr>
</tbody>
</table>

**Chlorophyll** - pigment found in chloroplast that captures energy from sunlight
- Reflects green light (look green)
- Found in plants (chloroplasts)

**Punnett Squares** - a tool to show the probable outcome of genetic cross

- Dominant / Recessive
- Incomplete Dominant
- Multiple alleles
- Sex-linked

**Codons Found in Messenger RNA**

<table>
<thead>
<tr>
<th>U</th>
<th>C</th>
<th>A</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phe</td>
<td>Ser</td>
<td>Tyr</td>
<td>Cys</td>
</tr>
<tr>
<td>Phe</td>
<td>Ser</td>
<td>Tyr</td>
<td>Cys</td>
</tr>
<tr>
<td>Leu</td>
<td>Ser</td>
<td>Stop</td>
<td>Stop</td>
</tr>
<tr>
<td>Leu</td>
<td>Ser</td>
<td>Stop</td>
<td>Stop</td>
</tr>
<tr>
<td>Leu</td>
<td>Pro</td>
<td>His</td>
<td>Arg</td>
</tr>
<tr>
<td>Leu</td>
<td>Pro</td>
<td>His</td>
<td>Arg</td>
</tr>
<tr>
<td>Leu</td>
<td>Pro</td>
<td>Gln</td>
<td>Arg</td>
</tr>
<tr>
<td>Leu</td>
<td>Pro</td>
<td>Gln</td>
<td>Arg</td>
</tr>
<tr>
<td>Ile</td>
<td>Thr</td>
<td>Asn</td>
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</tr>
<tr>
<td>Ile</td>
<td>Thr</td>
<td>Asn</td>
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</tr>
<tr>
<td>Met</td>
<td>Thr</td>
<td>Lys</td>
<td>Arg</td>
</tr>
<tr>
<td>Met</td>
<td>Thr</td>
<td>Lys</td>
<td>Arg</td>
</tr>
<tr>
<td>Val</td>
<td>Ala</td>
<td>Asp</td>
<td>Gly</td>
</tr>
<tr>
<td>Val</td>
<td>Ala</td>
<td>Asp</td>
<td>Gly</td>
</tr>
<tr>
<td>Val</td>
<td>Ala</td>
<td>Glu</td>
<td>Gly</td>
</tr>
<tr>
<td>Val</td>
<td>Ala</td>
<td>Glu</td>
<td>Gly</td>
</tr>
</tbody>
</table>

**Chloroplast**

- The stroma is the space outside the thylakoid membranes.
- A granum is a stack of thylakoids.
- Photosystems, clusters of pigment and protein that absorb light energy, are found in this photosynthetic membranes called thylakoids.

**KEY**

- Affected Male
- Affected Female
- Wild Type Male
- Wild Type Female

23 pairs - 46 chromosomes

22 pair (autosomes)
1 pair (sex-chromosomes)

One of each pair from mother and father (50/50)

Each chromosome contains many genes.