Why is Standard Deviation SOOOOOOO Easy?

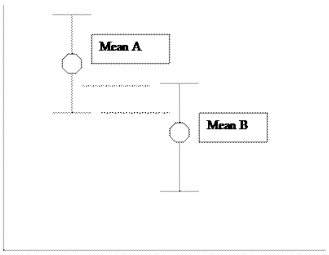
07 April 2014
21:17

- A Standard Deviation of a set of data is calculated by **calculating the deviation of each measurement from the mean**
- **Formula:**

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

It is much more convenient to use a GDC's table settings to calculate via one variable statistics

- A standard deviation is a measure of the variability of a set of data
  - 68% of all values usually lie within the range of the mean ± 1 S.D
  - 95% of all values usually lie within the range of the mean ± 2 S.D
- Standard Deviations are graphically represented as **Error Bars**
- If error bars between different means on the same graph overlap, we cannot conclude that the values are **truly different**



  - There is still a chance of correlation between the two values
- **If a standard deviation is calculated for a set of data, a minimum of 5 repeats per value is required**
- **If the standard deviation of values do not overlap (the error bars) then they are significantly different**

Syllabus Statements:

1. State that error bars are a graphical representation of the variability of data
2. Calculate the mean and standard deviation of a set of values
3. State that the term standard deviation is used to summarize the spread of values around the mean - that 68% of values fall within one standard deviation of the mean and 95%... Etc.
4. Explain how standard deviation is used for comparing the means and the spread of data between two or more samples
5. Deduce the significance of the difference between two sets of data using calculated values for 't' and the appropriate tables
6. Explain that the significance of a correlation does not establish that there is a casual relationship between two variables

T Tests (student t test) accounts for the means as well as the amount of overlap between two sets of data

- A **big value of T** is an indication of significant difference
- A **small value of T** suggests that the two sets of data cannot be shown to be significantly different
- **YOU ARE NOT EXPECTED TO REMEMBER THE FORMULA FOR THE T TEST**
- To judge whether the value of t is big or small, you must refer to **'a table of critical values'** which will give you the **'degrees of freedom'**
- **Degrees of Freedom = (number of classes - 1) per sample**
  - Example: 21 objects per sample, two samples -- Degrees of Freedom = (21-1) + (21-1) = 40
- Biology uses a **one-tailed T test**, if the **t value** is larger than the **value given by the significance level**, then we deduce that the two sets of data are significantly different etc. etc.
- **Significant Levels are often 1% and 5%** corresponding to **99% and 95% confidence intervals**

WE CANNOT ASSUME THAT JUST BECAUSE THERE IS A CORRELATION BETWEEN TWO SAMPLES THAT X CAUSES Y OR VICE VERSA.

3.6 Enzymes

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00:26

3.6.1 Define Enzyme and Active Site

- An enzyme is a biological catalyst - speeds up biological reactions
- Active site is the position on the enzyme occupied by the substrate

3.6.2 Explain Enzyme-Substrate Specificity

- Enzyme specificity is due to the complementary shape of the active site and the substrate - basically specific substances have specific enzymes

3.6.3 Explain the effects of temperature, PH and substrate concentration on enzyme activity

- **PH -** PH affects the rate of reaction of an enzyme catalysed reaction. Each enzyme has its optimal PH. Should the PH be too far from the optimum, the enzyme will denature and 0 reactions will occur - **bonds are formed or changed because of electromagnetic forces**
- **Concentration -** As substrate concentration increases so will the rate of reaction - there are more collisions between the substrate and the enzyme. However, there are a limited amount of enzymes. Sooner or later, this increase in rate of reaction will level off as all enzymes will then be occupied and an increased substrate concentration will be of no use.
- **Temperature** - Increase in temperature means an increase in the kinetic energy of the enzyme molecules - vibrations of enzyme molecules lead to more collisions between the substrate and active site hence an increased rate of reaction. **However, once kinetic energy is too great, the enzyme stability decreases and the enzyme atoms vibrate too much, resulting in the hydrogen bonds breaking and causing the active site to change shape - this results in 0 reactions**

3.6.4 Define Denaturation:

- Denaturation is a structural change in a protein that results in the loss of its biological properties - this loss is usually permanent

3.6.5 Explain the use of lactase in the production of lactose-free milk

- Lactose -- (Lactase) --> Glucose + Galactose
    - First, the lactase is immobilized in alginate beads
    - The beads are placed in a container over which the milk is passed
    - Milk is re-circulated to convert any remaining lactose to glucose and galactose
    - Circulation is maintained until all lactose is converted into glucose and galactose

5.1 Communities and Ecosystems

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22:03

5.1.1 Define species, habitat, population, community, ecosystem and ecology

- **Species** - A group of organisms that can interbreed and produce fertile, viable offspring
- **Habitat** - The environment in which a species normally lives or the location of a living organism
- **Population** - A group of organisms of the same species who live in the same area at the same time
- **Community** - A group of populations living and interacting with each other in an area
- **Ecosystem** - A community and its abiotic environment
- **Ecology** - A study of relationships between living organisms and between organisms and their environment

5.1.2 Distinguish between autotroph and heterotroph

- **Autotroph** - An organism that synthesizes its organic molecules from simple inorganic substances - they are **producers**
- **Heterotroph** - An organism that obtains organic molecules from other organisms - they are **consumers**

5.1.3 Distinguish between consumers, detritivores and saprotrophs

- **Consumer** - An organism that ingests other organic matter that is living or recently killed
- **Detritivore -** An organism that ingests non-living organic matter
- **Saprotroph -** An organism that lives on or in non-living organic matter, secreting digestive enzymes into it and absorbing the products of digestion

5.1.4 Describe what is meant by a food chain, giving three examples, each with at least 3 linkages (4 organisms)

- A food chain shows the linear feeding relationships between species in a community
- The arrows represent the transfer of energy and matter as one organism is eaten by another
- The first organism is the producer, followed by the consumers
- **Examples:**
  - Buffalo Grass --> Two striped grasshopper --> Greater stick nest rat --> Black rat snake
  - Green Algae --> Tiger mosquito --> Flame skimmer dragonfly --> Long-legged horn frog
  - Phytoplankton --> Zooplankton --> Sardine Fish --> Tuna Fish

5.1.5 Describe what is meant by a food web

- A food web is a diagram that shows how food chains are linked into more complex feeding relationships within a community
- There can be more than one produce in a food web and consumers can occupy multiple trophic levels

5.1.6 Define Trophic Level

- An organism's trophic level refers to the position it occupies in a food chain
  - Producers always occupy the first trophic level, while saprotrophs would generally occupy the ultimate trophic level of a given food chain or food web
- Trophic levels in a community are:

Trophic Level 1	Producer
Trophic Level 2	Primary Consumer
Trophic Level 3	Secondary Consumer
Trophic Level 4	Tertiary Consumer

5.1.7 Deduce the trophic levels of organisms in a food web and food chain

- Trophic Level = no. of arrows in sequence before organism + 1

5.1.8 Construct a food web containing up to 10 organisms

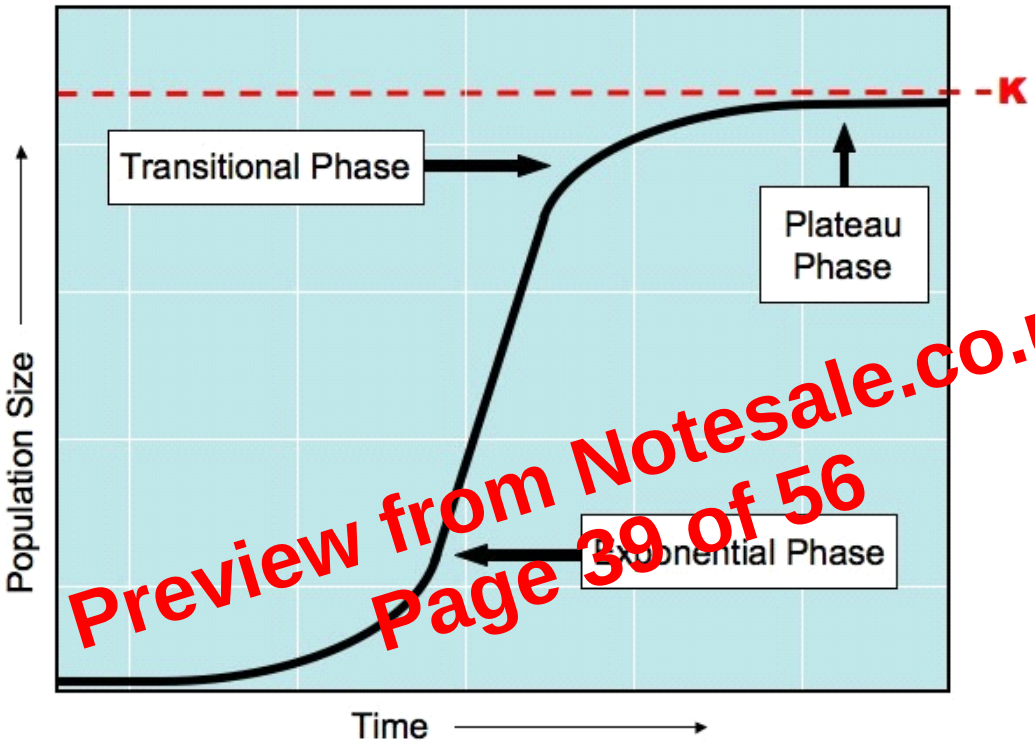
5.3 Populations

23 April 2014
22:31

5.3.1 Outline how population size is affected by natality, immigration, mortality and emigration

- **Natality -** Increases population size through reproduction
- **Immigration -** Increases population size from external populations
- **Mortality -** Decrease population size as a result of death
- **Emigration -** Decreases population size as a result of loss to external populations

5.3.2 Draw and label a graph showing the sigmoid population growth curve



5.3.3 Explain reasons for the exponential growth phase, the plateau phase and the transitional phase between these two phases

- **Exponential Growth Phase:**
  - There is a rapid increase because there are abundant resources and limited environmental resistance
- **Transitional Phase**
  - Competition increases for resources as population grows
  - Natality rates fall and mortality rates rise
- **Plateau Phase**
  - Eventually Mortality Rate = Natality Rate
  - Population has reached the carrying capacity of the environment **(K)**
  - Limited resources, predation and disease keep the population fairly constant
    - There will be fluctuations but they will always converge towards **(K)**

5.3.4 List three factors that sets limits to population Increase

Factors affected by Population Density	Factors unrelated to Population Density
Predation and parasites	Natural Disasters
Availability of resources	Climate

5.4 Evolution

23 April 2014
22:44

5.4.1 Define Evolution

- Evolution is the cumulative change in the heritable characteristics of a population

5.4.2 Outline the evidence for evolution provided by fossil record, selective breeding of domesticated animals and homologous structures

- **Fossil Record:**
  - **Direct:** Bones, teeth, shells, leaves etc.
  - **Indirect:** Footprints, tooth m arks, tracks, burrows etc.
  - Fossil record has revealed that over time, changes have occurred in features of organisms living on the planet
  - Different kinds of organisms are found in rocks of particular ages in consistent order
- **Selective Breeding:**
  - Products of selective breeding can show significant variation compared to their counterparts - this is a demonstration of evolutionary changes in a much shorter time frame than might have occurred naturally
  - Examples include breeding race horses (speed) or endurance horses (draft)
- **Homologous Structures:**
  - Groups of animals or plants show certain structural features which are similar
    - This implies a common ancestry
  - Homologous structures are those that are similar in shape in different types of organisms despite being used different ways
  - Example would be the human hand compared to the cats paw, whale fin, bat wing being quite similar
    - This illustrates adaptive radiation (divergent evolution)

5.4.3 State that populations tend to produce more offspring than the environment can support

- Populations tend to produce more offspring than the environment can support

5.4.4 Explain the consequence of the potential overproduction of offspring is a struggle for survival

- When resources are abundant, population growth is exponential
- When the population is too large, there is a lot of pressure on the environment to provide enough resources for them to survive
- This will lead to a competition for available resources and a struggle for survival

5.4.5 State that members of a species show variation

- Members of a species show variation

5.4.6 Explain how reproduction promotes variation within a species

- During Prophase , when homologous chromosomes pair up, crossing over occurs
- During Metaphase, the paired chromosomes can randomly arrange themselves in one of two orientations
- Because fertilization is random, offspring will receive different combinations of traits every time, resulting in near infinite genetic variability

5.4.7 Explain how natural selection leads to evolution

- **Survival of the fittest**
  - There is genetic variation within a population
  - There is competition for survival

6.1 Digestion

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22:03

6.1.1 Explain why digestion of large food molecules is essential

- Most food is solid and in the form of large complex molecules which are insoluble or chemically unusable
- Food is synthesized by other organisms and thus some of these molecules are not suitable for human tissue
    - These need to be separated and removed
    - These small useful molecules can be reassembled into new products (amino acids)

6.1.2 Explain the need for enzymes in digestion

- Enzymes are biological catalysts which speed up the rate of reactions by lowering the activation energy
- Enzymes allow digestive processes to occur at body temperature and at sufficient speed to meet the organism's survival requirements
- Enzymes are specific for a given substrate so can allow digestion of certain molecules to occur independently of others

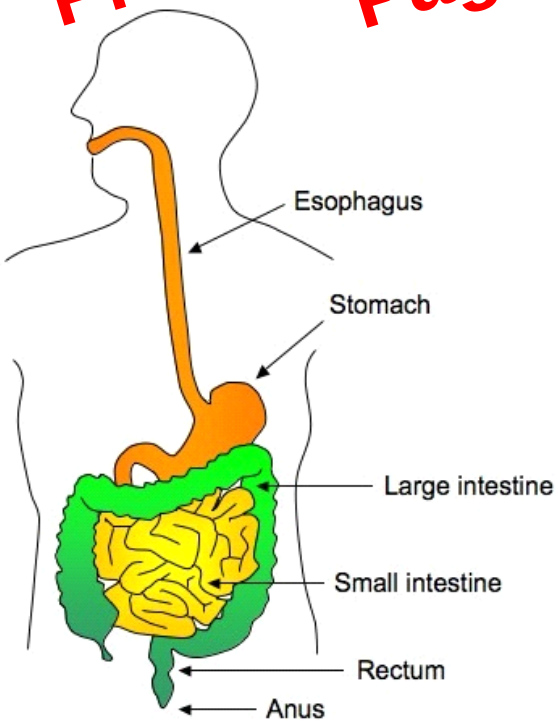
6.1.3 State the source, substrate, product and optimal pH conditions for one amylase, one protease and one lipase

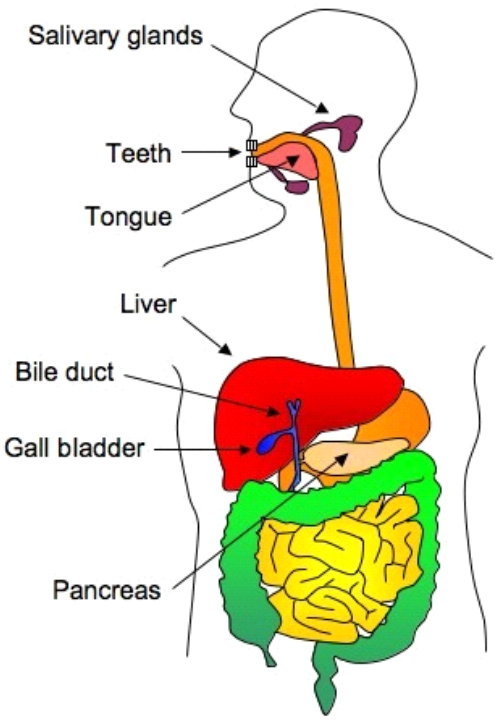
Enzyme Type	Example	Source	Substrate	Product	Optimum pH
Amylase	Salivary Amylase	Salivary Glands	Starch	Maltose	pH - 7 (neutral)
Protease	Pepsin	Gastric Juice	Protein	Short Polypeptides	pH - 2 (highly acidic)
Lipase	Pancreatic Lipase	Pancreas	Lipids (triglycerides)	Glycerol, fatty acids	pH - 8 (slightly alkaline)

6.1.4 Draw and label a diagram of the human digestive system

Alimentary Canal:

Accessory Organs:





6.1.5 Outline the function of the stomach, small intestine and large intestine

    - The pressure of the air in the lungs is decreased below atmospheric pressure
    - Air flows into the lungs to equalize the pressure
- Exhalation:
    - Diaphragm muscles relax and diaphragm curves upwards
    - External intercostal muscles relax allowing the ribs to fall
    - This decreases the lung volume
    - Pressure of the air in lungs is increased above atmospheric pressure
    - Air flows out of the lungs to equalize the pressure

Inhalation

Exhalation

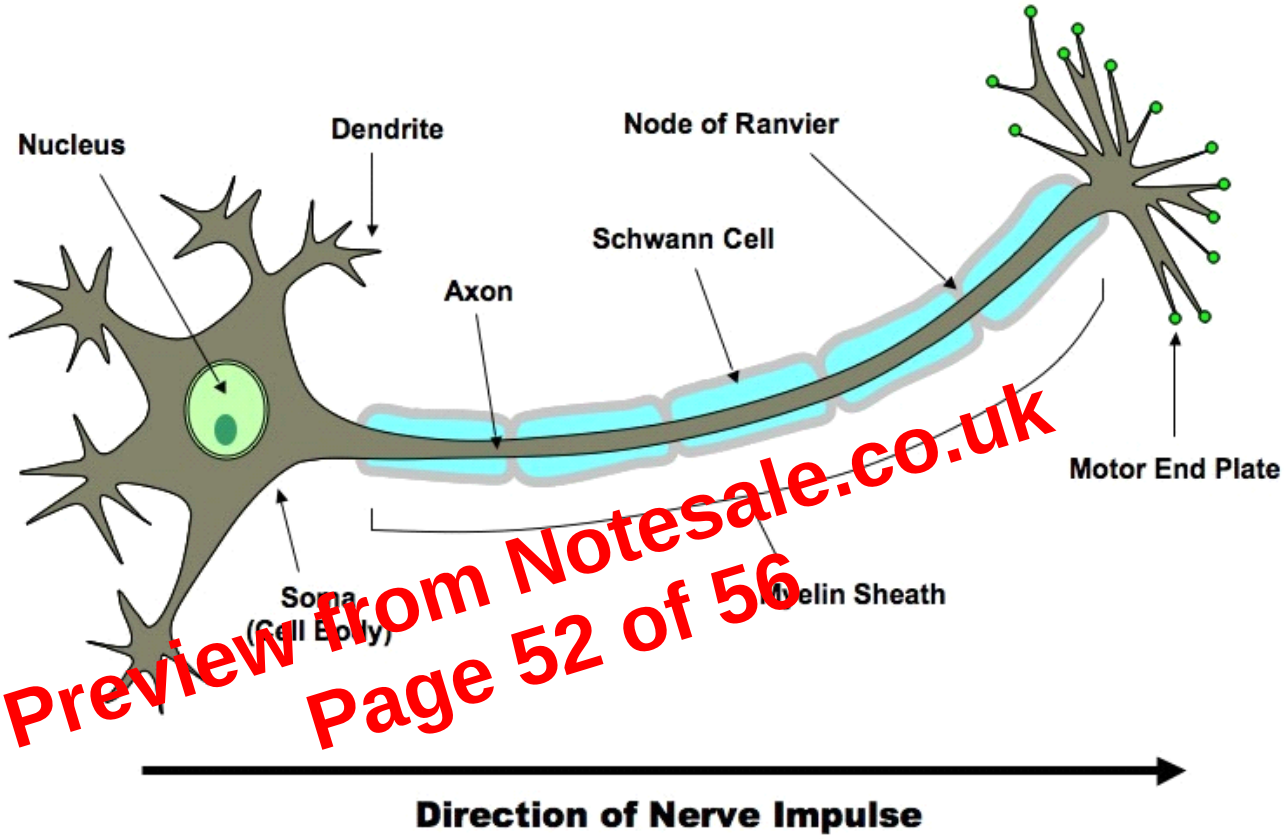
6.5 Nerves, Hormones and Homeostasis

26 April 2014
20:47

6.5.1 State that the nervous system consists of the central nervous system and peripheral nerves, and is composed of cells called neurons that carry rapid electrical impulses

- The nervous system consists of the CNS and PNS - they are composed cells called neurons and carry rapid electrical impulses

6.5.2 Draw and label a diagram of the structure of the motor neuron



6.5.3 State that nerve impulses are conducted from receptors to the CNS by sensory neurons, within the CNS by relay neurons, and from the CNS to effectors by motor neurons

- Sensory neurons conduct nerve impulses to the CNS from the receptor
- Relay neurons conduct nerve impulses within the CNS
- Motor neurons conduct nerve impulses from the CNS to the effector

6.5.4 Define resting potential and action potential

- **Resting Potential:** The charge difference across the membrane when a neuron is not firing (-70 mV)
- **Action Potential:** The charge difference across the membrane when a neuron is firing (30 mV)
- **Depolarization:** The change from a negative resting potential to a positive action potential (opening sodium channels and letting sodium in)
- **Repolarization:** The change from a positive action potential back to a negative resting potential (opening potassium channels and letting potassium out)
    - **POLARIZED = NEGATIVE**

6.5.5 Explain how a nerve impulse passes along a non-myelinated neuron

- **Generating a Resting Potential:**
    - The sodium-potassium pump maintains an electrochemical gradient of the resting potential (-70 mV)

- It is a trans-membrane protein that uses active transport to exchange Na^+ and K^+ ions across the membrane
- It expels 3 Na^+ ions for every 2 K^+ ions admitted
- This makes the inside of the membrane relatively negative when compared to the outside

- **Transmission of an Action Potential**
  - Sodium and Potassium channels in nerve cells are voltage-gated **(they open and close depending on the voltage across the membrane)**
  - Influx of Na^+ ions in causes the membrane potential to become positive **(depolarized)**
  - If sufficient change in membrane potential is achieved, adjacent voltage-gated sodium channels open, generating **a wave of depolarization that spreads down the axon**
  - The change in membrane potential also activates voltage-gated potassium channels, causing potassium to exit the neuron passively
  - The removal of K^+ ions cause the membrane potential to become negative again
  - Before the neuron can fire again, the original distribution of ions must be re-established
  - The inability to propagate another action potential during this time ensures nerve impulses only travel in one direction

6.5.6 Explain the principles of synaptic transfer

- The junction between two neurons is called a synapse
- An action potential cannot cross a synaptic gap - this is where neurotransmitters come in to continue the signal
- **Chemical Transfer Across Synapses:**
  - When an action potential reaches the axon terminal, it triggers the opening of voltage-gated calcium channels
  - Ca^{2+} ions diffuse into the cell and promote the fusion of vesicles containing neurotransmitters with the membrane
  - Neurotransmitters are released from the axon terminal via exocytosis
  - Neurotransmitters bind to appropriate neuro-receptors opening ligand-gated channels
  - The chemical messengers received by dendrites determines whether the threshold is reached for an action potential in the post-synaptic neuron
  - Neurotransmitters are then recycled or degraded

6.5.7 State that endocrine system consists of glands that release hormones that are transported in the blood

- The endocrine system consists of glands that release hormones that are transported in the blood

6.5.8 State that homeostasis involves maintaining the internal environment between limits, including blood, pH, carbon dioxide concentration, blood glucose concentration, body temperature and water balance

- Homeostasis involves maintaining the internal environment between limits; this includes:
  - Blood
  - pH
  - CO_2 concentration
  - Blood Glucose concentration
  - Water balance

6.5.9 Explain that homeostasis involves monitoring levels of variables and correcting changes in levels by negative feedback mechanisms

- Most homeostatic control mechanisms operate through a negative feedback loop
- When specialized receptors detect a change in an internal condition, the response generated will be the opposite of the change that occurred
  - When the level has returned to equilibrium then the effector ceases to generate a response
- If levels go too far in the opposite direction, antagonistic pathways are activated to restore it to normal

6.5.10 Explain the control of body temperature, including the transfer of heat in blood, and the roles of the hypothalamus, sweat glands, skin arterioles and shivering

- Temperature receptors in the skin relay this information to the **hypothalamus** which coordinates corrective measures
- **Skin arterioles** dilate or constrict depending on whether they want the body to cool down or retain its heat (in respective order)