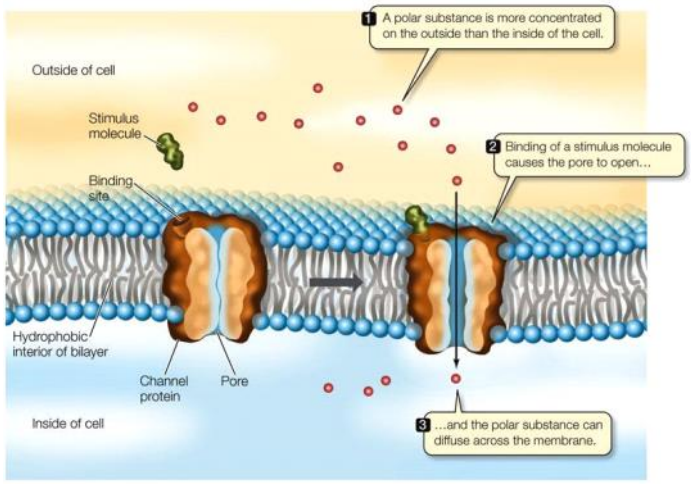
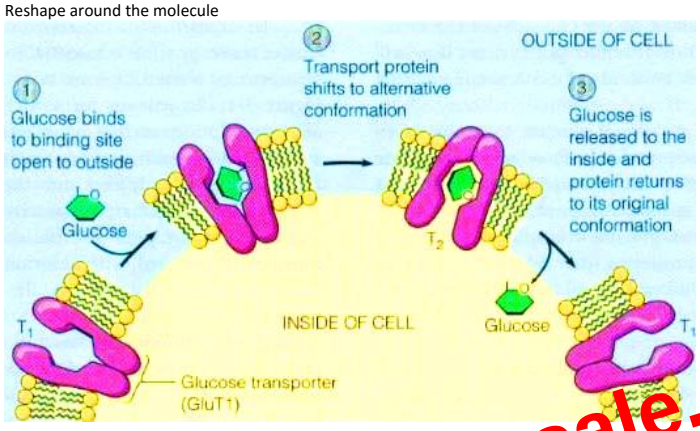
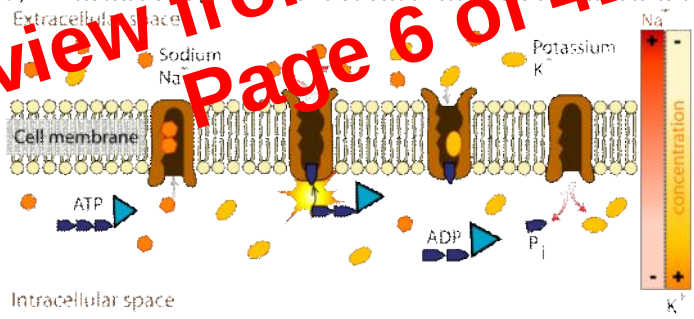
- 

  LIFE 8e, Figure 5.10

  - Carrier cells
    - Highly selective
    - Reshape around the molecule



- Active Transport
  - Cells often need to move solutes against a concentration gradient
  - This require energy
    - Provided by ATPases and ATP hydrolysis
  - The Na^+, K^+ ATPase uses the energy from ATP to move the sodium out of the cells against the concentration gradient



  - Importance
    - Environment within cell is different to outside
    - Can be used to:
      - Store energy
      - Acquire low abundance solutes
      - Creates signalling gradients
      - Expel waste

Cell Signalling

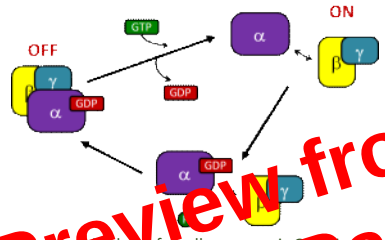
03 November 2014 11:31

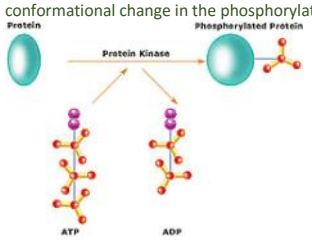
How do cells know where they are, what to become, and when to change?

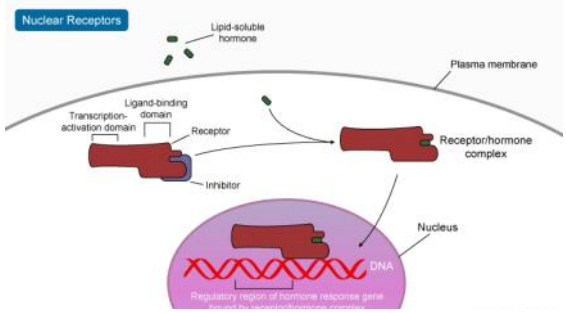
Coordination

- The immune system, for example has 7 types of cell, and 21 different chemical signals
- Each cell has to select one of a number of possible responses at the right time and in the right place

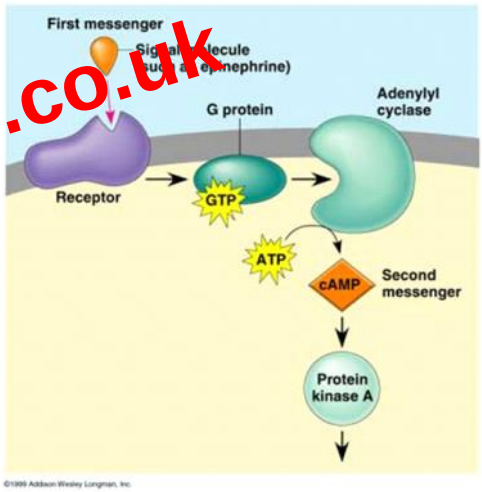
Signal problems

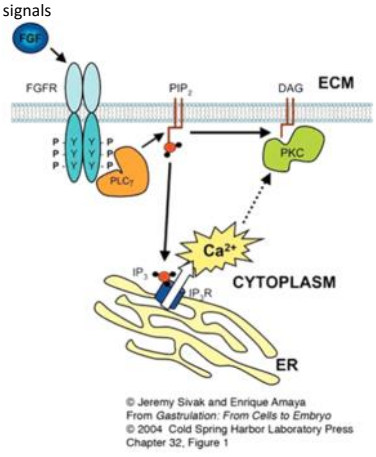
- Hormones such as steroids are lipophilic and easy to synthesise
- Lack diversity
- Peptide hormones are much more diverse
  - 34 human interleukins
    But are expensive to make and cannot cross the plasma membrane
- Peptide signals are at low concentrations and cannot enter the cell
- **Receptors**
  - Receptors are proteins which bind and respond to signals
  - Many sit on the cell surface
  - Respond to low concentration, hydrophilic, peptide signals
  - Characteristics:
    - Transfer information from outside to inside
    - Specific
      - Distinguish between closely related signals
    - Sensitive
      - Detect at low concentration
    - Interactions are reversible
      - End stimuli
    - Can be controlled (on/off)
    - Coupled to a response
  - Types:
    - Ligand-gated
      - Ionotropic
      - e.g. nicotinic, ACh
    - G-Protein-coupled
      - Metabotropic
      - Secondary messengers
      - e.g. muscarinic
      - Another type of on/off switch which depends on the binding of GDP or GTP
      - G proteins are heterotrimeric signal receptors
      - 

      - They are also lots of small monomeric GTP binding proteins that act as on/off switches or regulate decisions between two states
    - Kinase-linked receptor
      - Often long-term changes
      - Cytokine receptors
      - Protein kinases transfer a phosphate from ATP to an amino acid. Typically triggers a conformational change in the phosphorylated protein.
      - 

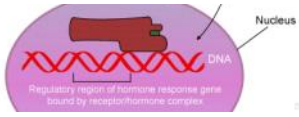
    - Nuclear receptors
      - Affect gene transcription
      - e.g. Oestrogen receptors
      - Used for steroid hormones
        - Can cross plasma membrane
      - Testosterone passes through p. membrane, and bind to androgen receptor (held out of nucleus by heat-shock proteins). This causes a conformational change, unbinding hsp's, and allowing the androgen to pass into the nucleus and bind to DNA, triggering change in expression.
      - 

Secondary Messengers

- A secondary messenger as a signal generated within a cell in response to an extracellular signal
- 

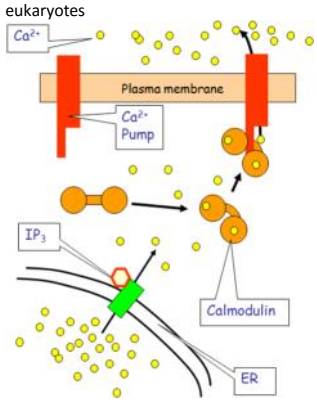
- Another type of secondary messenger system yes membrane phospholipids as a source of 2 internal signals
- 

- Where does calcium come from?
  - Cells expend energy keeping cytosolic calcium concentration low
  - Ca^{2+} enters the cytosol:
    - IP_3 from PIP_2
    - Opens Ca^{2+} channels in ER
    - Diffusion gradient floods Ca^{2+} through
  - Ca^{2+} binding proteins
    - Ca^{2+} works by binding to Ca^{2+} binding



- Function:
  - Receptors bind ligands
  - Receptors are constantly flicking between active and inactive
  - Majority are active at a given time
  - Signal traps the receptors in the less stable active state - tips equilibrium
  - Explains the ability to switch off

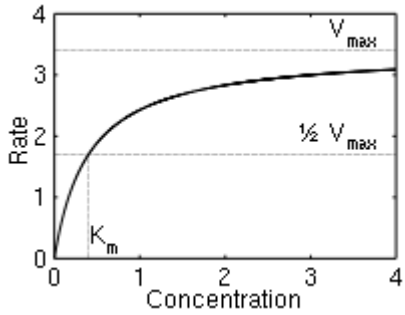
  - Opens Ca^{2+} channels in ER
  - Diffusion gradient floods Ca^{2+} through
- Ca^{2+} binding proteins
  - Ca^{2+} works by binding to Ca^{2+} binding proteins
  - Many hundreds of types
    - Calmodulin is found in all eukaryotes
    -

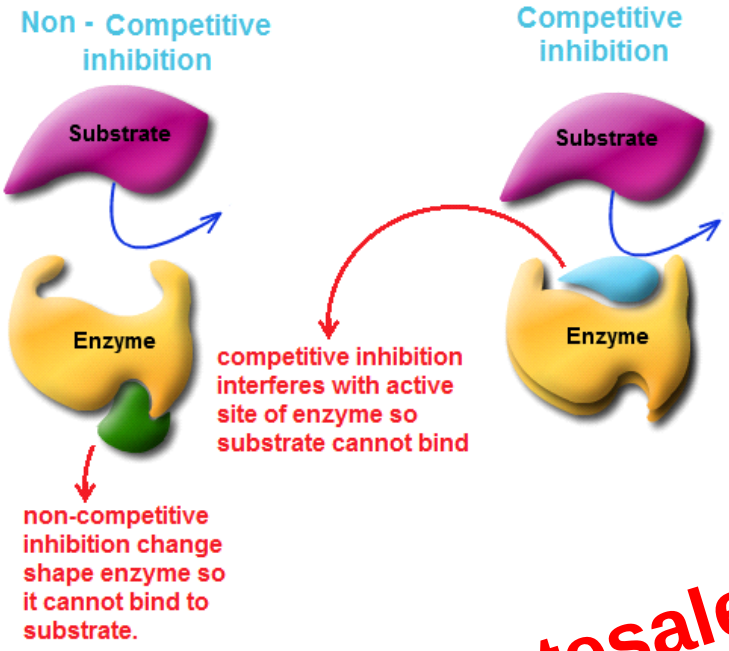


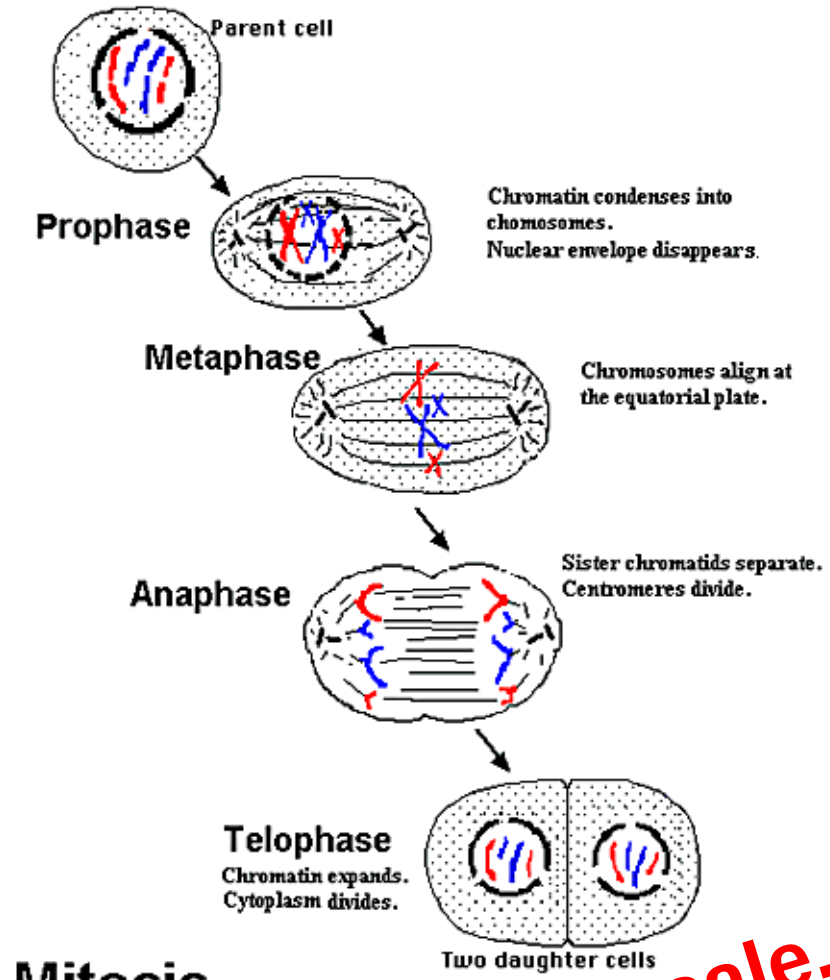
Enzymes

26 November 2014 13:45

- Macromolecular biological catalysts
- Many key reaction impossible without enzymes
- Most are proteins
    - Ribozymes
        - Make all other enzymes
- Function depends on sequence and 3D structure
- Structure
    - Sequence
        - Key catalytic amino acids
    - 3D structure
        - 3D cleft brings reactants together
        - Enzymes are selective
        - Other regulatory sites
            - e.g. activation sites
    - Co-factors, co-enzymes, prosthetic groups
        - Crucial to function
        - Co-factors
            - Inorganic ions
        - Co-enzymes
            - Organic molecules
        - Prosthetic groups
            - Tightly bound co-factor/enzyme
        - Haem
            - Permanently bound prosthetic
            - Inorganic ion in organic framework
- Role
    - Many reactions are slow/don't happen
    - Enzymes increase rate by 10^{8} to 10^{14} times
    - Bring reactants together
        - Substrates enter site and are held there
            - Interaction more likely than when free floating
        - Interaction stabilised
            - H, ionic, covalent bonding
        - Product is formed and released
    - Take intermediate routes
    - Makes even unfavourable reactions possible
- Activation energy
    - Lowered
- <u>Michaelis-Menten kinetics</u>
    - Relationship between [S] and rate in enzyme catalysed reactions
    - V_{max} = maximum turnover
    - K_m = [S] at $1/2V_{max}$
        - Measure of [S] at which enzyme is active
    - Gives a clue to the [S] at which saturation occurs

- 

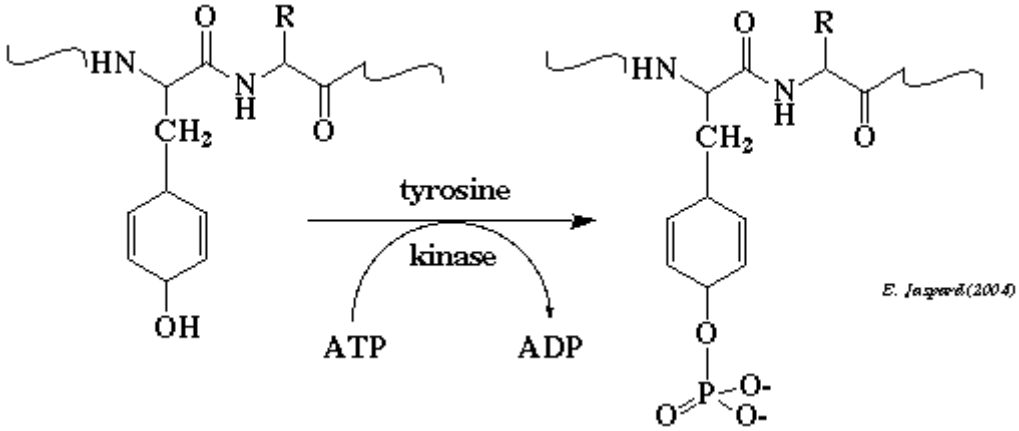
- Inhibition
  - 



- **Mitosis**

- Cytokinesis in animals
  - Cleavage furrow
  - Contractile ring of actin microfilaments
  - Interaction with myosin tightens contractile ring

Phosphorylation

- Addition of phosphate to an amino acid
- Can cause a protein to undergo conformation change
  - 

- Cyclin dependent kinases
  - CDKs
  - Control cell cycle
  - CDKs bind cyclins and become active
  - Cyclin b and CDK 1 form mitosis promoting factor
    - Cyclin b concentration rises, forms complex
    - Mitosis happens