Scientific practice

solutions

electrolytic solutions

Ionic dissociation occurs when the addition of a solvent or energy in the form of heat causes molecules if crystals of a substance to break down into ions.

Osmotic effects.

spontaneous net movement of solvent molecules through a semipermeable membrane

tonicity

hypotonic

lower ions concentration, high solvent concentration lower osmotic pressure

hypertonic

higher ion concentration, higher solute concentration, lower solvent concentration, higher osmotic pressure

isotonic

equal osmotic pressure. and solute/solvent concentrations.

Ideal Solutions

an ideal solution is a solution which has a enthalpy of solution equal to zero NOTE: bonds forming releases heat energy. FR: the concentration of water in a typical cell is 55molar.

concentration measurements

molar/molarity/molar concentration

concentration of solute in a solution in terms of moles of solute per volume of solution

molality

concentration of solute in a solution in terms of moles of solute per mass of solvent.

Other measures.

%w/w weight of solute per weight of (solvent?)

%w/v weight per volume.

%v/v volume per volume.

osmolarity

concentration of solute as total number of solute particles per litre (?)

osmolality

Concentration of solute as total number of solute particles per kilogram.

####osmol number of solute particles which contribute towards the osmolarity of the substance.

##Life Molecules

Basic list

- Carbohydrates (2%)
- Lipids (2.5%)
- Proteins (15%)
- Nucleic Acids (RNA 20% E. Coli < 10% mammalian DNA is functional)
- Inorganic ions (3% Salts, 1% small metabolites)
- water (70%)

Water

general properties

covalent bonds. dipole moment.

hydrogen bonds.

many hydrogen bonds are formed which together gain considerable strength.

Hydrogen bonds are typically up to $ angstroms in length, which a strength of 2-10kcal/mol.

NOTE: the advantage of hydrogen bonds is that they do not take too much energy to break down so the body can readily re-purpose/recycle organic compounds.

polarity

high polarity means water has a large ability to stabilise other charges

auto ionisation. water can auto ionise into hydroxide ions and hydronium ions, the concetrations of which in solution can be measured by pOH and pH respectively.

Solvation of ionic and polar solutes

$Coulomb's\ law : F = k\frac{q_1 q_2}{Dr^2}$

Where D is a measure of solvent polarity.The higher the polarity, the greater the ability to stabilise charges. water forms solvations shells around each ion.

Solvation of apolar groups and molecules (the hydrophobic effect)

free amphipathic molecules will associate in water to form hydrophobic internal environments. molecules (amphipathic molecules contain both polar and a polar groups)

Examples

Integral proteins within the cell membrane are amphipathic, and allow for non polar channels through the membrane.

fatty acids form micelles (globules) and bilayers in water.

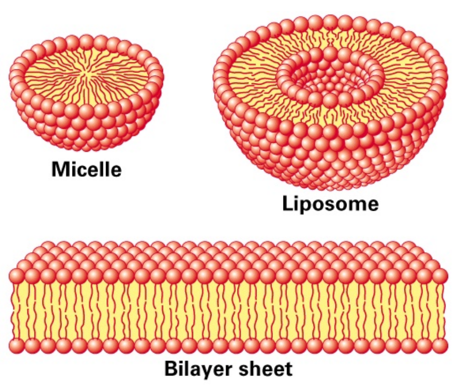

Figure 1: hydrophobicEffect

Septicaemia

Certain bacteria, respond to antibiotics by releasing proteins which punch holes in the cell surface membrane creating freely permeable pore through which cell contense can leak out, and killing the cells.

water and protein structure

water proteins can be buried in the interior of protein structures where they may furfill vital functions

examples

proteases only work if the have a water molecule imbedded within their internal structure, without this one molecule the entire enzyme becomes inactive.

other examples are reverse transcriptase and HIV protease and GST (detoxifying enzyme) which all rely on water molecules to function.

Acids and Bases

Bronsted and lowery

acids are proton donors bases are proton acceptors. difference between acid/base and its conjugate is a proton.

lewis

acids are electron pair acceptors bases are electron pair donors.

lewis bases

- alchohol
- organophosphates.

buffering

relies on weak acids or bases which do nto fully dissociate.

Scientific Reasoning

Basic structures of an argument

Premises

A Premise is a statment. This statement may be true or false.

In science the orginial premise is known as the hypothesis. this hypothesis will be tested, usually impirically.

Conclusions

A conclusion should be well supported by all premises. The conclusion leads one to decide if the hypothesis is true fo false.

A good argument

A good argument can be deductively, or nondecuctive but abductively, or inductively strong.

NOTE: Arguments can be invalid even if all of the premises and the conclusion are true. If they do not actually imply eachother then it is simply a collection of facts and not an argument.

Deductive arguments

$A \in B \wedge B \in C \rightarrow C \in B$

Conditional

$\exists P \rightarrow \exists Q$

Contrapositive

$\nexists P \rightarrow \nexists Q$

Converse

$\exists Q \rightarrow \exists P$

deductive validity

1. Are the premices true (this is difficult if not impossible to establish in mathematics.)
2. Do the premices guarentee the truth on the conclusion.
3. does the argument beg the question (Not really one of the criteria)

Non deductive arguments

most of science is actually non deductive reasoning. science will often venture conclusions beyond the scope of observation (induction).

Inductive Reasoning

In Inductive reasoning premises are veiw as strong support of the truth of the conclusion. however they do not garuntee the truth of the conclusion. Induction allows for conclusions to be made about issues outside the scope of ovservation.

Inductive strength

two factor influence the inductive strength of an argument, sample size and bias.

Deductive arguments

Abduction

abductive arguments seek to explain what is observed, otherwise known as inference to best explination.

Abductive arguments

abductive hypothesies should be able to predict easily testable results, such that if the predicted result is achieved during experimentation then the validity of the hypothesis is supported, and if it is not the hypothesis can be rejected.

(Abductive arguments usually rely on a number of assumptions which can be supported by the predictive power of the argument)

NOTE: if testing two alternative theories H1 and H0 then a good test experiment will be set up such that the the observation of event P supports H0 and negates H1 and visa versa.

Evaluating Abductive Inferences.

Surprise principles

If an observation supports a hypothesis, then it must strongly favour that hypothesis over others with which it competes

In order to satisfy this principle: 1. the hypothesis should make no fasle predictions 2. Within the set of true predictions which the hypothesis makes, there should be predictions which are expected NOT to come true if the hypothesis is false (Is this not mixed up somewhere?)

Abductive fallacy

A widely used and accepted expination is not necessary at all plausible, (even if no competing explination exists)

Making observations

obervations can be made by human senses as well as by sophisticated scientific equipment.

examples

Medelian genetics.

mendal made conclusions very far beyond his premises, abducting from color change to the existance and role of gentic elements.

A bad argument

Circular arguments.

$A \in B \rightarrow A \in B$

Definitions

Premise

A Premise is a statment. This statement may be true or false.

Conclusion

Bias

factors which may skew the results of a test in some form.

Steriochemistry

Rotamers

Isomers which can be interconverted by rotation (of a given part of the molecule) about a particular bond

Different isomers are known as Isoforms.

NOTE: bonds within molecules can lengthed, shorted,bend and rotate, depending on what stresses are excerted upon them.

Newman Projections

A visualisation of a moleculeviewed from the front.

the front atom is reprisented as a dot the back atom is reprisented as a circle.

Conformations

Staggered

Surrounding atoms/hydrogens are all equally spaced.

this conformation is more stable for two reasons

Steric Hinderance

in the eclipsed conformation outside atoms are forced to close to eachother, raising the energy level of the conformation

Hyperconjugation

stabilising interactions of the electrons in a σ-bond (usually C-H or C-C) with an adjacent empty or partially filled p-orbital or a *pi*-orbital to give an extended molecular orbital that increases the stability of the system)

Eclipsed

Outside atoms line up with each other.

Dihedral Angle

There is a whole range of conformations depending on the exact angle of rotation. 1. anti (180 orinetation) 2. gauche (60 orientation)

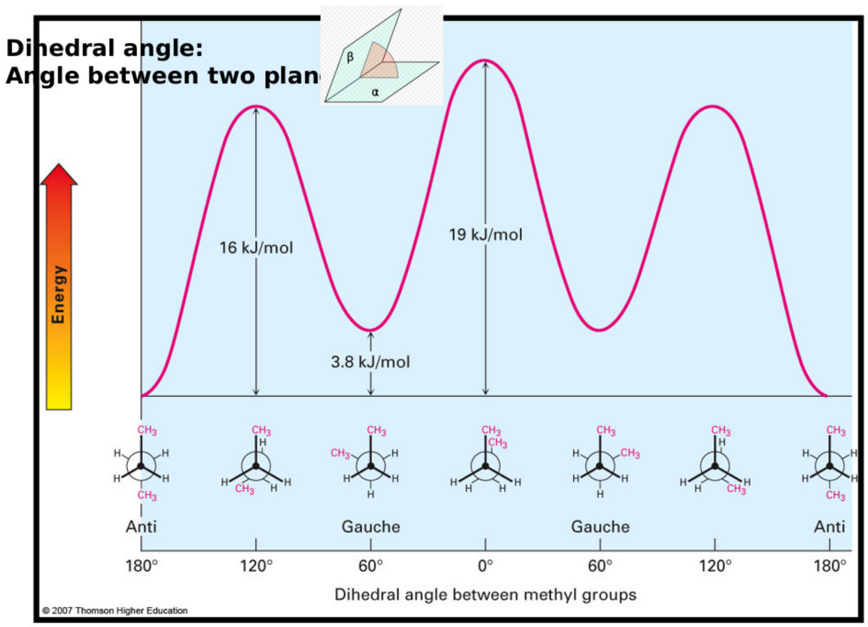

Figure 2: Rotamer Energy Diagram

Protiens

protiens also exibit a dihedral structure with peptide bods forming planes whith a given angle between them

this angle can be calculated which is very useful as most protein analysing techniques are very low res (for example obsorbance spectra to distinguish protein (max absorbance 280nm) from DNA/RNA (max absorbance 260nm))

Solving protein structure

1. complex maths in necessary (furner(?) transfer analysis)
2. complex measuring equipment is needed.

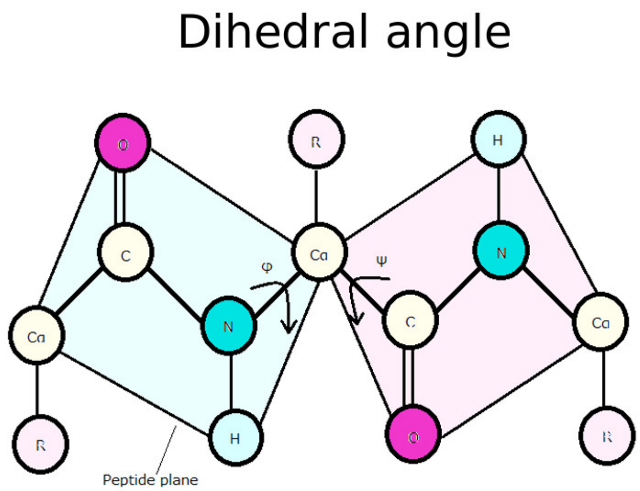

Figure 3: Proteins Dihedral Angle

Inantomers.

Enantiomers

opposite conformation at all chiral centers.

Chiral compounds

a chiral compound consists of four separate atoms bonded to one central (tetrahedral,carbon) molecule.

NOTE: this central carbon atom will always be sp^3 hybridized.

Optical activity

certain molecules rotate plane polerised light to the right (dextrorotatory +) or to the left (levorotatory -)

the exact degree of rotation depends on the length of substance which the light is shon through, the composition of the substance, and the optical properties of the substance.

Poleriser

only allows light of certain phases (that is light with a particular electric and magnetic component) through. the light alowed throguh is now plane polerised.

Analyser

observes/ analyses how light interacts with certain molecules.

Diastereomers

opposite conformation at some chiral centers.

Allo Diastereomers

Messo Diastereomers

Drawing structures

simple system

1. wedges indicate bonds coming out of the page
2. straight lines are in the line of the page.
3. dotted line are receding back out of the page.

Diastereomers are *allo* forms

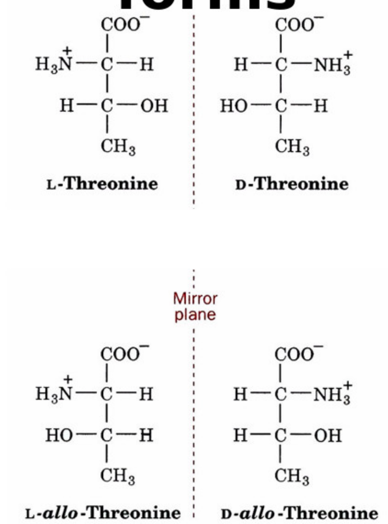

Figure 4: Allo Diastereomers

defn

Meso Compounds

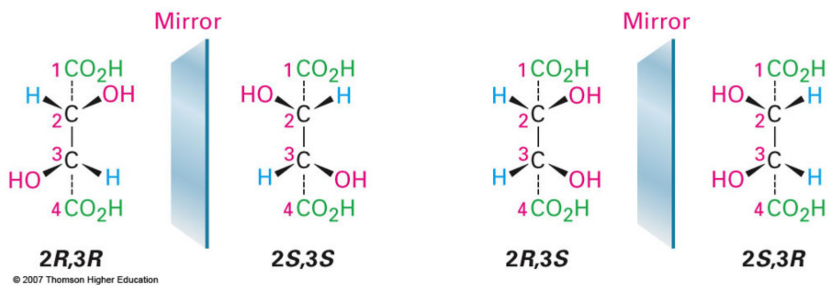

Figure 5: Messo Diastereomers

Fisher Convention.

2 dimentional reprisentation of a three dimentional molecule.

The stereocentre furthest from the anomeric centre. The rotation brings about two distinct configurations, α and β – anomers) 1. For sugars if the OH group is on the right it is a D sugar. 2. If it is on the left then it is an L sugar. 3. vertical lines reprisent atoms thatpoint away from the viewer. 4. horizontal lines reprisent atoms that point towards the viewer. 5. the point of intersection between thevertical and horizontal lines reprisents the centeral carbo atom.

NOTE: the anomernic carbon is the carbon single bonded to two oxygen molecules.

Amino Acids

NOTE: natural Amino Acids occur in the L form only.

NOTE: appart from glycine all amino acids are chiral.

D and L convention

L amino acids have the H_3N^+ group on the left side, D antomers have it on the right side.

CORN.

along the line between th COO and N group, if R is left of the central Carbon atom the antomer is L, if R is right the antomer is D.

Alternative if the molecule is orinetated with the H group dirrectly behind the centeral carbon. then if CoRN reads clockwise the antomer is a D amino acid, if it reads Anticlockwise it is an L amino acid.

R and S (find what R and S stand for)

more generally applicable

each atom around the central carbon is assigned a priority based on its atomic number (lower atomic number $\rightarrow$) lower priority. (if two atoms have equal atomic numbers then the atomic numbers of their side groups are checked and so on outwards until an order can be established)

Cahn-Ingold-Prelog Convention

Uses the R, S system but is still based on glyceraldehyde. 1. priorities are assigned 2. the molecule is orientated so that the lowest priority group is dirrectly behinf the central carbon atom. 3. if the remain molecules arrange clockwise in terms of priority (highest to lowers) the molecule is a R antomer, if they arrange counterclockwise the molecule is a S antomer

NOTE: D sugars have the R conformation and L sugars have the S conformation.