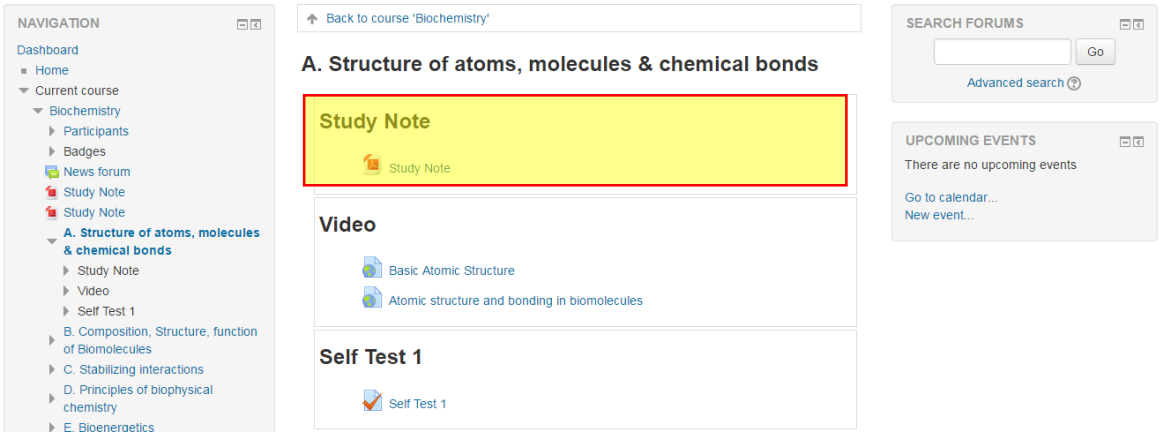
Study Notes

SAMPLE CONTENT



[A] Topics: Structure of atoms, molecules & chemical bonds

Importance of the topic and exam strategy

Biomolecules may be characterized by their biological origin and they may appear more complex and bulkier than basic chemical entities often seen in chemistry textbooks, yet their fundamental constituents are atoms and their integrity as well as chemical properties are governed by basic rules of chemistry. In order to understand the mechanism of biochemical reactions, the stability of biomolecules and their interactions it is essential to revisit the atomic structure and basic atomic/molecular interactions that are essential for the very existence of every chemical entity in this universe. Here in this chapter we will also take account of biological relevance of atomic structure and their interactions. **Although previous trends of exam do not show many direct questions on this topic but basic understanding of Biomolecular interactions especially hydrogen bonding and van der waals interactions have been asked in CSIR-NET successively.** The purpose of this study note will be to provide students a guide to prepare this topic, suitable references and brief introduction about atomic structure and various type of chemical bonds.

Structure of atom

A thought about atomic structure gives us a close analogy with solar system, where planets revolve around sun and in atom electrons spin around nucleus, but recent models are very different and they consider atom in the form of interfering waves of electrons such as ripples arising in a pond after

throwing a stone. The present structure of atom is a result of sternous work of many famous scientists. It all started with the discovery of electron by J.J. Thomson, then discovery of neutron by Chadwick and proton by Goldstein. Then the quest for determining arrangement of these sub-atomic particles begun. The first model was given by JJ Thomson called plum pudding model which stated that electrons are like dry fruits in a cake (sea of protons). Then next model was given by Rutherford, which described that most of the space in atom is empty and positively charged particles are accumulated in a very small space at the centre, but as this model could not explain the stability of spinning electrons and hence a better model was proposed by Neils Bohr, which defined the energy states of atom and thefore the stability. It was based on absorption spectra of hydrogen atom. Finally the latest model of the atom is quantum mechanical model that is based on the wave nature of electron and Schrodinger's equations on wave nature of electron. The concept of quantum numbers and subshells (and orbitals) is an outcome of quantum mechanical model which ultimately forms basis of atomic combination, formation of covalent bonds and hybridization.

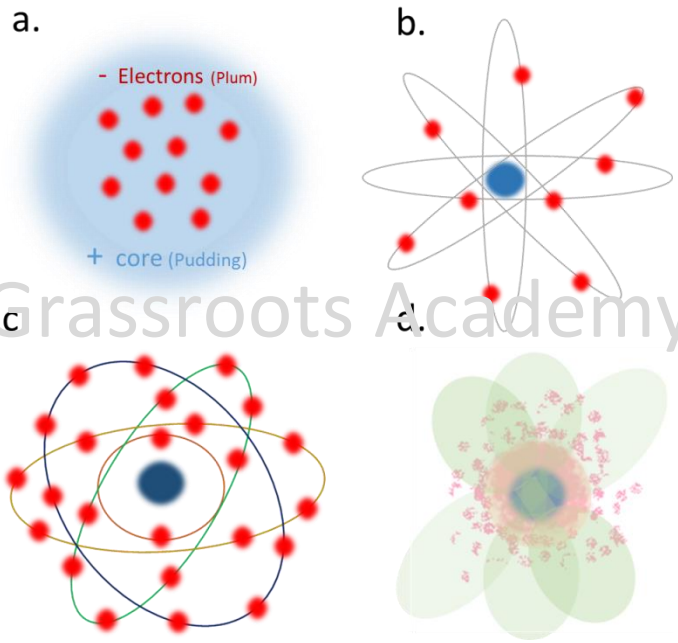
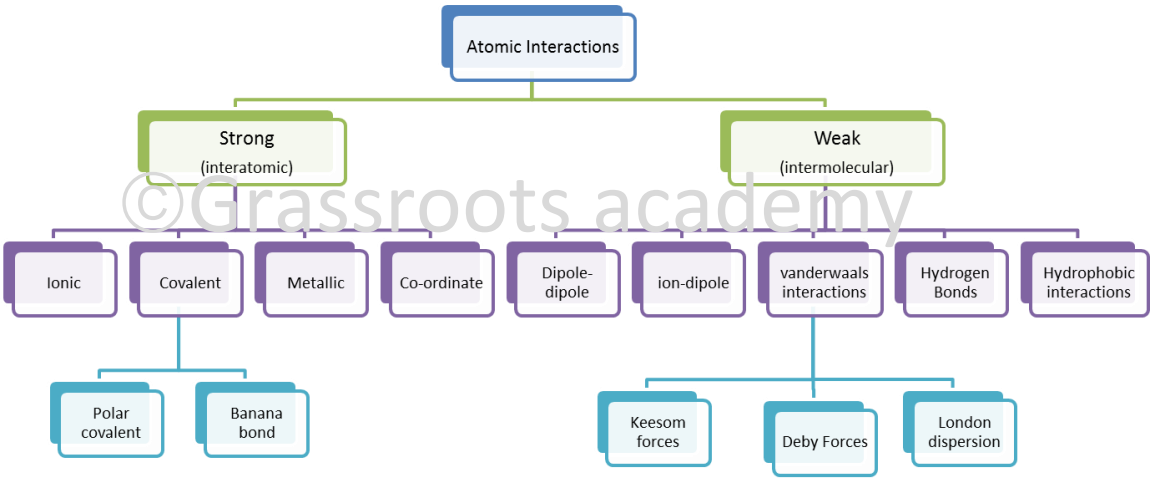


Figure : Chronological advent in the structure of atom a. plum pudding model of JJ Thomson – No defined position of electrons and protons, **b.** Rutherford's atomic Model – centrally located nucleus, spinning electrons but not defined orbits **c.** Neil Bohr's atomics structure – defined orbits and energy levels. d. Quantum mechanical model – position of electrons/probability is calculated from Schrodinger equation, and electron density varies at different places surrounding nucleus.

Chemical bonds and interactions

Chemical bonds are both strong and weak, although for the formation of molecules (atomic interactions) is dependent on strong bonds. Such as formation the very existence of amino acids, carbohydrates, and lipids is primarily due to covalent bonds. But the weak interactions make

biomolecules different from chemical entities, because their number is quite large and therefore the integrated strength is more. So weak interactions are primarily responsible for stability of biomolecules. Following chart summarizes the major types of interactions.



Which book should I read to prepare this topic?

This topic should be read from standard NCERT books and an animated initiative by NCERT

http://www.ncert.nic.in/ncerts/l/kech102.pdf

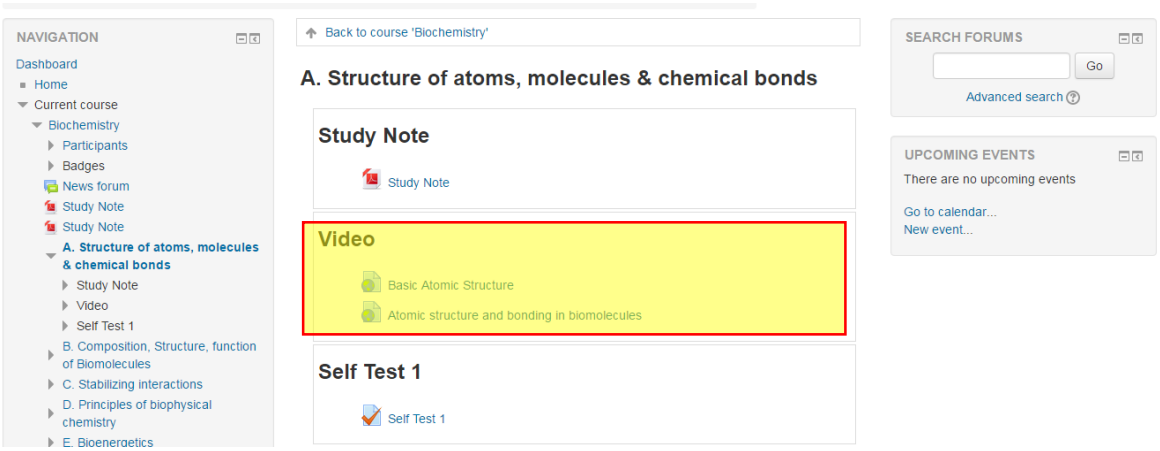
http://www.ncert.nic.in/online_sub_books/chemistry/chem_chap_2.html

However the detailed description of these topics in biological context is difficult to find in standard chemistry book and thefore it will be difficult to obtain information requiring to solve CSIR-NET questions. Keeping this is view Grassroots academy has taken initiative and with the help of subject experts a text book on biochemistry is available you may mail to grassroots academy to obtain the information grassrootsacademy@gmail.com . We highly recommend you this book for further preparation. All the questions asked in previous exam have also been solved at the end of this chapter.

Grassroots ACADEMY

Classroom Video Lecture

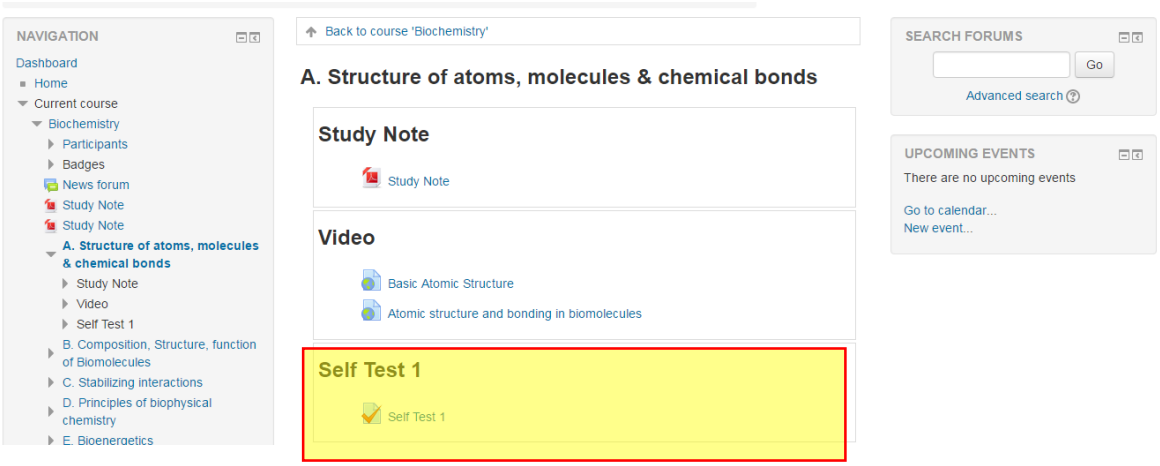
Click on the link Below: You must be connected to internet



https://www.youtube.com/watch?v=Fm6MrA22eig

Self test

3- 4 short questions with solutions



Q1. Which of the following non-covalent interaction between two non-bonded atoms A and B is most sensitive to the distance between them? **[CSIR June 2012]**

a. A and B are permanent dipoles and are involved in salt bridges

b. A and B are fully ionized and are involved in salt bridges

c. A and B are uncharged and repel each other

d. A and B are uncharged and attracted each other

Solution: Van der Waals interactions at a distance below 5 Angstrom become highly repulsive and the magnitude of these repulsive van-der-waals interactions id related inversely to 12^{th} power of distance between two charges (or nuclii of atoms) therefore c is correct answer.

Q2. On the molar scale which of the following interactions in a nonpolar environment provides highest contribution to the bio-molecule? **[CSIR NET Dec 2011]**

a. **van der Waals interaction**
b. Hydrogen bonding
c. Salt bridge
d. Hydrophobic interaction

Solution: Hydrogen Bonds are associated with water (in hydrophillic environment), Salt bridges are also electrostatic in nature and therefore depend upon the hydrophillic environment. Hydrophobic interaction are also a result of repulsion from hydrophillic groups. Van der waals interactions are the only interactions that provide highest contribution to biomolecule.

Q4. In proteins, hydrogen bonds form as follows: Donor (D)-H---Acceptor (A). Hydrogen bond is more favorable if the angle between D-H and A is [CSIR-NET 2014]

a. <90° b. 180° c. >180° d. 120°

Ans:- 2 The angle between the D-H bond and the H---A hydrogen bond should be close to 180° for a strong hydrogen bond.

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