Ch3 Science

I) Matter
  A) Def'n – "Anything that takes up space and has mass"
    1) Just about everything we deal with is matter
      (a) Except: energy
  B) Chemistry – the study of substances, and how they change and react to each other
    1) Atoms – The building blocks of matter
      (a) History
        - Originally stuff was made of "humours" (earth, air, spirit, water)
        - *Atomos* is Greek for "uncuttable"
          ⇒ Consider gold…there is some smallest piece of gold that can't be cut
        - Eventually experiments would show atoms are real. Theory than said they were the smallest pieces of matter.
        - Around 1900 several **experiments** would discover:
          ⇒ Nucleus (with protons and electrons, Rutherford)
          ⇒ Electrons (in 'orbitals' around the nucleus, Bohr)
      (b) Classifying atoms
        - Elements – only one kind of atom (defined by the number of protons)
        - Bonding – more than one atom attaches together by "sharing" electrons.
          ⇒ Ionic – total transfer of an electron
            Δ There for ionic bonds have a negative (got the electron) and a positive (gave the electron)
          ⇒ Covalent bonds – truly share
            Δ An even split has no charge
            Δ A polar bond has a partial charge
  C) Molecules – When there is more than one atom
    1) Compound is more than one type of atom
    2) Types
      (a) Organic molecules – mostly Carbon and Hydrogen
        - We are 'carbon-based' life forms
        - Hydrogen is the most abundant element in the universe
        - They feature other elements (O, N, P, etc)
        - Carbon is useful because it makes 4 bonds
      (b) Hydrocarbons – only Carbon and Hydrogen
        - Oil, natural gas, and other petroleum product
      (c) Solutions – when anything is dissolved in anything else. (Dissolved means you can't see it)

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  D) Macromolecules – ("macro-" means large scale, big)
    (There are many, but we're looking at 4)

1) Proteins
   (a) Basically they are the machine components of life
   (b) If something is 'getting done' a protein is doing it.
      - sight
   (c) Built as chains of amino acids
2) Nucleic Acids
   (a) DNA or RNA
   (b) They are the code for life (mostly the meaningful code is for proteins)
   (c) Like a ladder with 4 types of rung (4 different building blocks)

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      - Guanine, cytosine, adenine, thymine (uracil in RNA)
   (d) Almost Everything keeps the code in DNA
      - There are bacteria and viruses that use RNA
   (e) RNA is a copy of the DNA used to make proteins
   (f) In both the 'uprights of the ladder' are sugar phosphates
3) Carbohydrates
   (a) Sugars (C, H, O)
   (b) On Nutrition Labels carbohydrates are listed separate from sugars. That is only because they are complex carbohydrates (chains of sugars)
   (c) Mostly used for energy
      - Literally burned by you body
   (d) Glucose (most common sugar) it makes glycogen which is your body's carb storage.
      - It is chemically almost identical to cellulose (used in plant walls and CANNOT be used by animals for energy)
        $\Rightarrow$ Cows chew cud. We chew salad
4) Lipids
   (a) Carbohydrates used for energy but also:
   (b) Make up cell membranes (phospholipids)
   (c) Half of the hormones (proteins are the other half)
      - Hormones: chemical signals in the body
   (d) Lipids are nonpolar (balanced covalent bonds)
      - immiscible with water (don't mix/dissolve)
      - (use organic solvents when water doesn't work)

E) Water
1) They say it's what makes life possible.
2) <picture>
3) Polar (has a partially negative side, and a partially positive side)
   (a) It's also "bent"
4) Because of these it has important properties:
   (a) Cohesion-it sticks to itself. That means you can 'pull' on one side of a chain, and draw water (and anything dissolved in it) along.

(b) Heat Capacity – Resistance to a change in temperature (because polar bonds absorb energy)
(c) Ice Floats (b/c shape and polarity)
- <picture>

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(d) "universal solvent" in biological systems (living things)
- Blood is water, based, the 'intracellular space' is water-based, etc…
- all the hormones, vitamins, etc needed by living things are transported in water.

F) Acids and bases
1) basically these are water
2) They either have extra protons (H^+) or less protons
3) Basically acids have H_3O^+
4) Bases have OH^-
5) The ratio of water to H_3O^+ is given in the pH scale
(a) Every step is a factor of 10x the concentration of H_3O^+
(b) 1 is most acidic, 7 is neutral (water) and 14 is most basic
6) Acids and bases neutralize when they mix
(a) They make water and other (potentially deadly) products

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II) Systems – a group of things that interact
A) Systems can be any size. It just depends where you put the boundaries.
1) The pieces interact in many ways (often complex)
B) Earth has a ton of systems
1) From tiny to humongous there are almost infinite systems
C) Inputs are things that change the system. Outputs are things the system changes.
1) Consider your house: as weather changes (input) you use different resources and make different waste (output)
2) In this way systems can affect other systems
3) When an output is an input of the same system, that's a feedback loop.
(a) Negative feedback loop – It pushes 'up or down' to keep balanced (very common in nature)
- Engine setting its own idle
- Predator – prey relationship
- body temperature

(b) Positive feedback loop – (rare) pushes to extremes (output encourages the system)
- erosion
- prolactin
- oxytocin

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III) The Spheres

A) Earth is logically broken up into a few major systems (spheres)
   1) Sometimes they crossover, and in all cases they affect each other

B) The Geosphere – all the rock
   1) Broken into a bunch of layers
      (a) The only ones we really care about are the core, (solid), mantle (plastic: liquid-like), Crust (where we are)
      (b) How do we know? – Evidence
         - Volcanoes show us that the inner earth is at least partially liquid (plastic means 'liquid-like-solid')
         - Earthquakes can be measured all over the globe. If we compare notes we see what appears to be a solid core. That is, sound moves faster through a solid, and we see sound move faster through the center of the earth.
   2) <u>Tectonics</u> – The theory that explains the 3D shape of the surface (mountains, oceans, trenches…)
      (a) <u>Convection</u>
         - If 2 things are made of the same substance, the warmer one is less dense .
         - The less dense thing wants to be on top
         - If the system is closed and there is one heat source than a current will occur
         - (Heat up → rise; cool-down → fall)
      (b) The crust is solid because it cooled down
      (c) The magma underneath in convection cycles that push the solids on top (Tectonic Plates) around
      (d) Know your boundaries (p78)
      (e) <u>Subduction</u> – when one plate gets pushed under another
         - Continental plates make sweet mountains (Himalayas)
         - Oceanic plates make volcano chains (Japan)
            ⇒ When the soaked plate hits the magma the water boils to the surface- volcanoes

C) Biosphere – All living or formerly living material on earth

D) Atmosphere – The gases above earth
   1) Thicker than the crust, but not nearly as thick as earth
   2) Troposphere – First layer, where we are ('tropo-' means 'grow')
   3) Ozone layer – O_3 made by solar radiation.
      (a) Plays an important role in blocking radiation
      (b) located in the Stratosphere
   4) The magnetosphere is the name given to our planetary magnetic field. It blocks solar wind (particles) and funnels to the north and south poles (Aurora Borealis and Aurora Australis, respectively)

- Check them out

E) The Hydrosphere is all the water.
   1) It includes the biosphere, atmosphere and some of the geosphere

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IV) Earth Re-cycles
   A) Law of Conservation of Matter – Matter is neither created nor destroyed
      1) Einstein 'modified' the law because nuclear energy comes from matter. (Still not created or destroyed.)
   B) Everything is re-used.
      1) When you die, every single atom in you will be used again.
   C) Nutrient Cycling
      1) A <u>nutrient</u> is anything required for life
         (a) (can be considered just the elements, OR any molecules)
      2) We consider amino acids (proteins), vitamins (compounds) and individual elements to be nutrients
         (a) Macronutrient – you need a lot
            - (carbon, O_2, water, Nitrogen (amino acids), Phoophorus (DNA))
         (b) Micronutrient – need a little
            - (iron, gold, copper, etc)
         (c) Biogeochemical cycle – (life)(earth)(substance) cycle (A <u>cycle</u> is a system that repeats)
   D) Water Cycle
      1) All water is in the cycle.
      2) Evaporation → Sky; Precipitation → earth
         (a) There are a lot of storage places (oceans, lakes, rivers, people, plants, aquifers, rocks)

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   E) All of the cycles have a few things in common
      1) Stores – places where the nutrient accumulates
         (a) Also called 'sinks'
         (b) In water: aquifers, lakes, ocean, rivers, atmosphere, the biosphere
      2) Transformations – how the nutrient changes
         (a) In water, it's always H2O, (s→l→g)
         (b) Sometimes the chemicals change ($N_2(g)$ → ammonia (NH_3) → ammonium (NH_4^+) and also urea (NH_2OH)
   F) Human Affects on the Cycles
      1) Almost everything we do affects multiple nutrient cycles
         (a) You already know systems interact. So this is old news
      2) When do we have ***<u>too much</u>*** effect?
      3) The Greenhouse effect

(a) Many gases act like the windows of a green house. They let in light, but they don't let out heat.
(b) The greenhouse effect on Earth has helped keep the temperature moderate (not an ice age) on earth for a long time.
(c) Is it possible for humans to release enough of the CO_2 stored in organic materials (sugar, oil, gas, coal, trees, animals etc) to significantly impact the temperature on earth?
(d) Is it possible to change our affects intentionally?