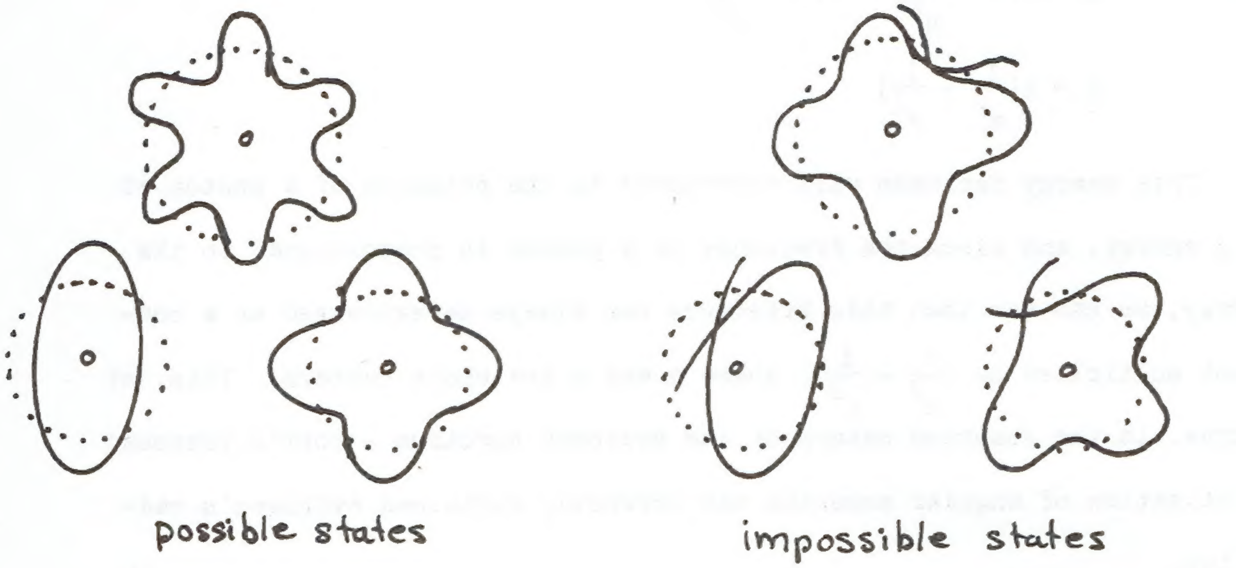


Diagram 5-6 Standing Waves - simbolizing electron orbitals

We cannot explain the mathematics used in studying the arrangements of the probabilistic waves which correspond to electrons. We can only state that the theory explains the quantization of orbital angular momentum, and is capable of making a useful description of all electron arrangements.

The theory makes use of four quantized properties of an electron, which specify its state in the atom. The first of these is Bohr's angular momentum; the other properties will be discussed shortly. While their existence was postulated before the knowledge of the wave-particle duality, it was not until this relationship was known that the theory took on rigid form.

The wave theory employs these four quantized properties in an extremely complex equation, first proposed by Schrodinger in the 1920's. This equation describes the probability distribution formed by the standing

Looking at the periodic chart of the elements, we now have an explanation of an amazing regularity - atoms of similar chemical properties, (located in the vertical rows of the chart), also have the same arrangement of electrons in their unfilled energy levels. These outer-most electrons are termed "valence electrons", and are the indicators of chemical reactivity. The following table is a detailed description of row one of the chart:

H	1	$1s^1$
Li	3	$1s^2 2s^1$
Na	11	$1s^2 2s^2 2p^6 3s^1$
K	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
Rb	37	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$
Cs	55	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 6s^1$

All of these elements are very reactive and form stable components by giving up their outer-most electron. Note that for each of these atoms, there is a highest s energy level which contains only one electron. A similar regularity is seen throughout most of the rows of the table. (In the center of the table the agreement is less precise because the actual arrangement of the energy levels changes somewhat as electron number increases.)

Thus we can see that our quantum description of electron arrangement can explain the empirical observations which lead to the formation of the periodic table. The similar chemistry of the vertical rows corresponds to similar outer-electron arrangements, while the horizontal rows correspond to the elements between stable configurations.

The energy is carried by ATP (adenosine triphosphate), which looks like this:

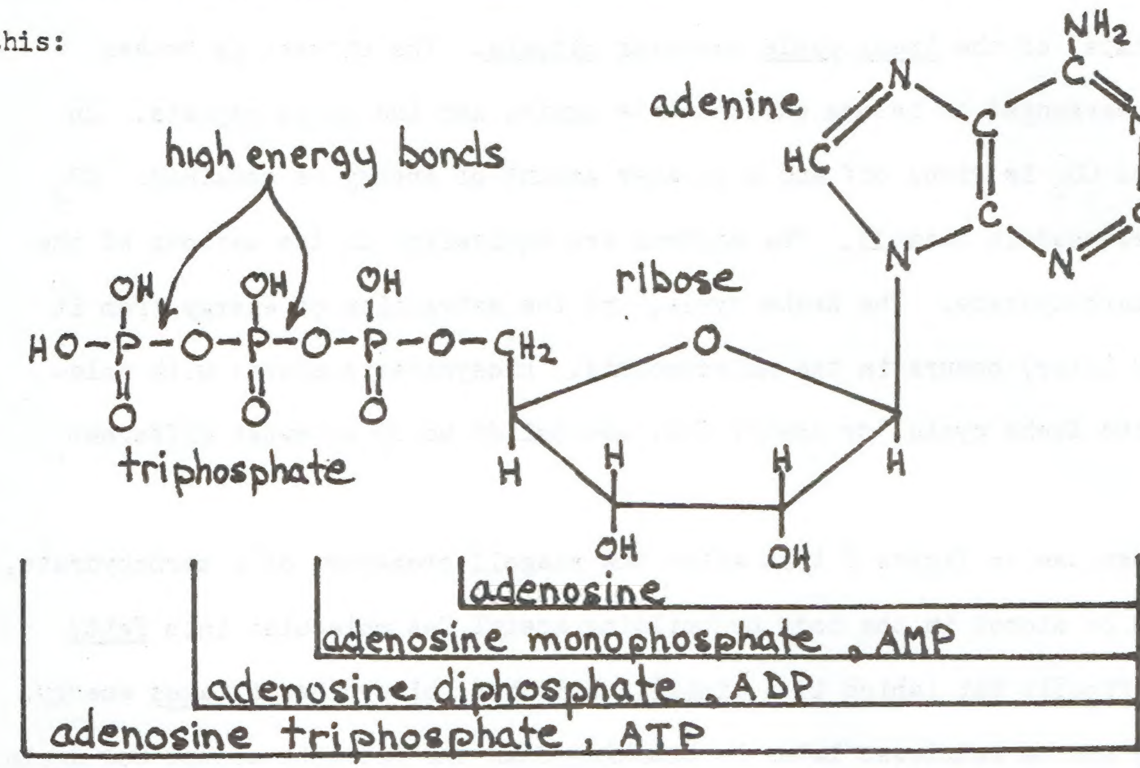


figure 9

Here the phosphate bonds are called high energy bonds because there is a relatively large negative ΔG associated with the removal of a phosphate thus:

ATP $\longrightarrow$ ADP + P + energy   equation 2)

Reactions which release energy have it trapped in the simultaneous back reaction of:

energy + ADP + P $\longrightarrow$ ATP   equation 3)

This effectively stores the free energy as a phosphate bond. Reactions that require energy (ie: have a positive ΔG), as do the biosynthesis reactions and a few of the catabolic ones, are coupled with the forward reaction of:

ATP $\longrightarrow$ ADP + P + energy   equation 2)

(like two half reactions; see essay #3) so that their ΔG's add. The result

E_1, E_2, and E_3 are genes that code for the enzymes. The promotor site, P, is the place where RNA polymerase starts the syntheis of mRNA.

The repressor gene, R, produces a protein that bonds to the operator, O. This blocks the RNA polymerase from proceeding, so that genes E_1, E_2, and E_3 cannot be transcribed.

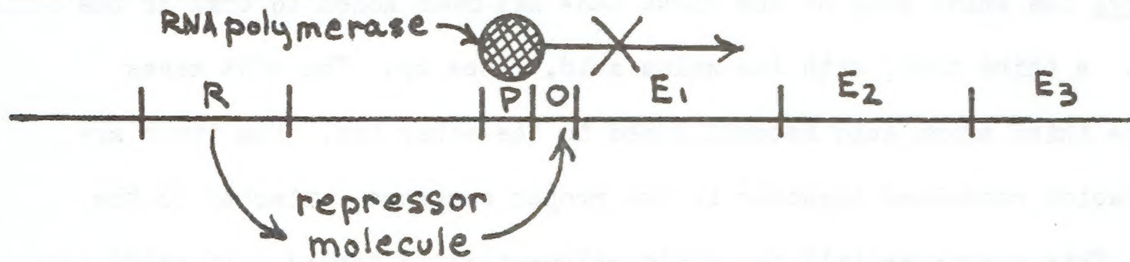


figure 17 a)

The only other molecule that the repressor protein can bond with is lactose. When a lactose molecule is present, it bonds with the represser molecule and their combination is inactive; the promoter site is no longer blocked, and the three enzymes are created to catabolize lactose.

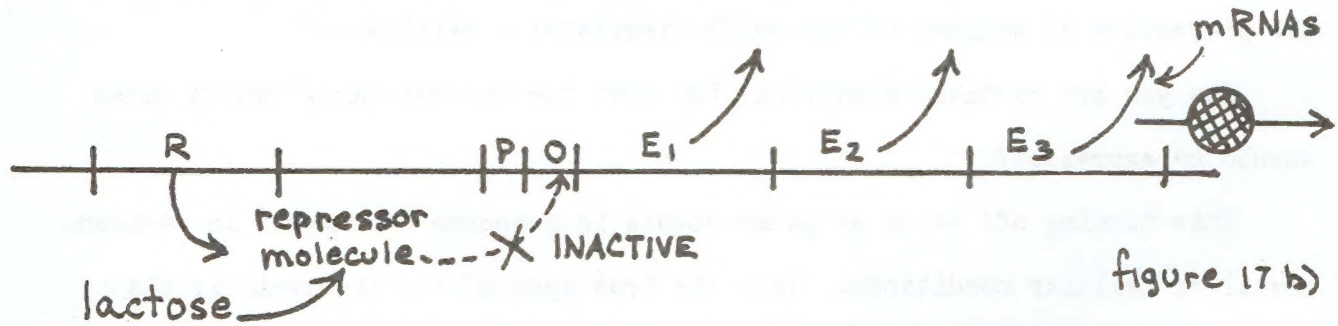


figure 17 b)

This is an example of induction, where an active repressor molecule binds with an inducer (in this case lactose) to deactivate it and let transcription proceed.

Another method of gene "selection" exists, where the repressor is inactive till it meets a substance that bonds with it to make it active, whereby it then blocks transcription. This is basically the opposite of the first mechanism, and is called inhibition.

The processes examined so far in this essay account for how the cell's structure or function changes in response to its environment. Membranes (men-

7) A representative life-cycle is illustrated in figure 36. The Tracheophyta are not as successful as the next phylum, Bryophyta. Because of the lack of a vascular system they cannot grow large, and swimming sperm is disadvantageous.

Metaphyta — Tracheophyta or vascular plants

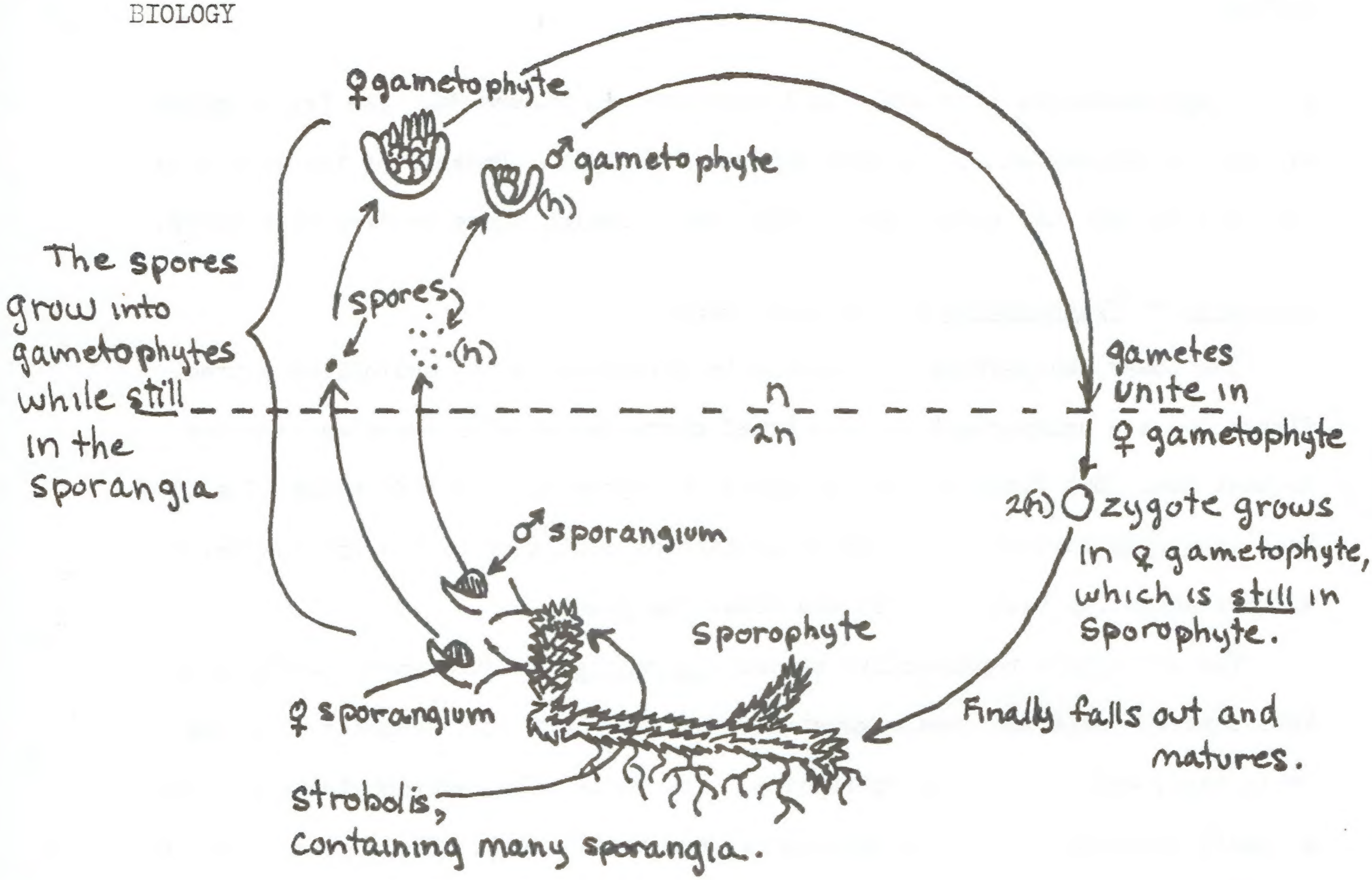
The lower sub-phylums (you should be referring to the evolutionary tree, figure 30) are unimportant in this brief overview; we will describe only the highest one. But first we have included in figure 37, the life cycle of a typical Lycopsida to show the trend of increasing dominance of the sporophyte, which reaches its peak later in the flowering plants.

The sporophyte reproductive organs, sporangia, produce spores which grow into separate male and female gametophytes. They are only composed of a few cells each, and stay on the sporophyte. The whole male gametophyte falls onto a female gametophyte. Their gametes can now easily meet. The zygote grows in the female gametophyte, which is still in the sporophyte but eventually falls out. Thus the gametophyte has become inconspicuous.

The highest sub-phylum is Pteropsida. Here we find all the familiar plants: evergreen trees, deciduous trees, shrubs, vines, ferns, and flowers. These are all sporophytes. The development of vascular tissue, thick carbohydrate (cellulose) cell walls, and tree roots, has provided these plants with the ability to assume practically any shape or size.

Plants with cones (typically the evergreens) are called gymnosperms, and plants with flowers are called angiosperms.

Cones are basically enclosures for sporangia (as in lycopsida figure 37) There are male and female cones. As in figure 37, the cones produce spores which grow into male and female gametophytes. The female gametophyte is only



Life-cycle of typical Lycopsida fig. 37.

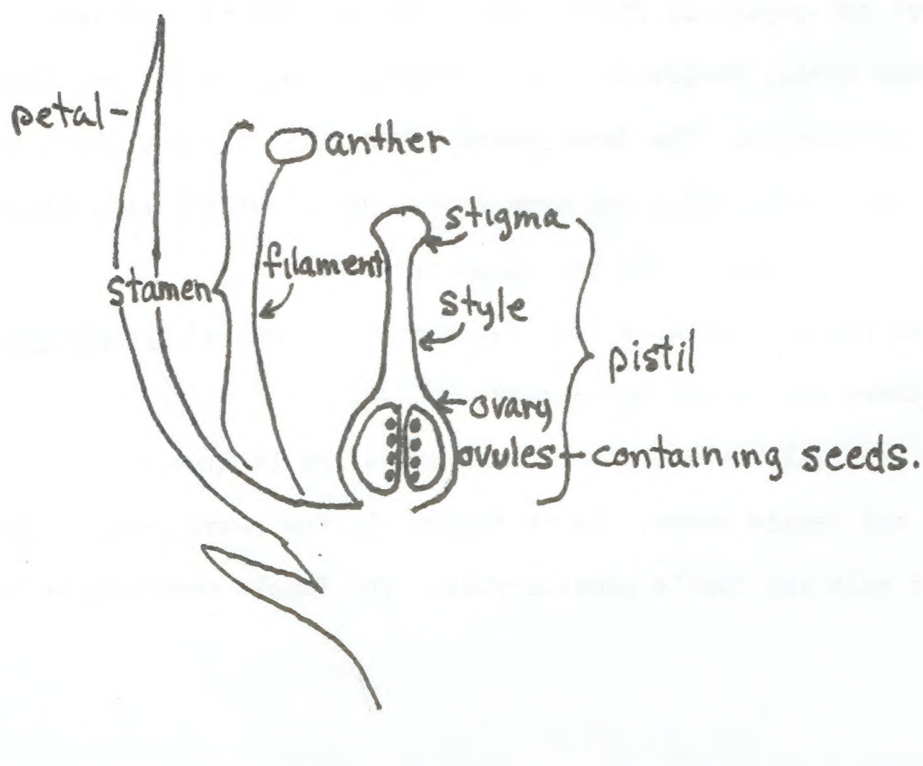


fig 38.