This material is based on work supported by the National Science Foundation under Grant No. DUE 9987332.

TxCETP Course Component:

Introduction of Valence and Covalent Bonds
"Simple Bonds for Biology"

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I. Introduction

Overview of Course Component:

The Introduction of Valence and Covalent Bonds Course Component is designed to facilitate an understanding of the relationship between valence electrons of the elements most common in biology and their use in bonding. The activities included in the Course Component require students to: 1) develop an understanding of valence electrons, 2) apply this understanding to the bonding and molecules and 3) develop an understanding of linkage between reactive groups and biological monomers.

Objectives of Course Component:

The student is expected to develop an appreciation of the arrangement of subatomic particles in atoms, the ability to react with other atoms to form molecules, and these molecules to react with other molecules. During the activities associated with the Course Component, students will: clarify their understanding of atoms and molecules, predict the probable reactivity of these elements, and how molecules can be linked to form macromolecules.

Overall Time Frame for the Course Component:

Approximately two, thirty-minute time periods

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II. Activities

Inquiry A: *The Atoms*

Objective: Students creates an organizational scheme based on own criteria.

Time Frame for Activity: 15 minutes

Materials:

Assorted Legos®

Quantity of each color	Size
4	1X1
2	1X2
1	1X3
1	1X4

Procedure:

1. Get the students into groups.
2. Hand each group a bag of Legos® listed above.
3. Allow the students to play with the Legos® without instruction for a few minutes.
4. After a few minutes, ask the students to separate the Legos® into individual pieces.
5. Instruct the students to organize the Legos® for the next procedure.
6. Have the students to make a note on how they organized their Legos®.
7. Ask the students how they organized the Legos® and draw their organizational chart(s) on the board. (If the first organizational chart is not based on size and color, lead the students towards this type of organizational system.)
8. Introduce atomic structure, bond orbitals, and valence concepts.
9. Let students compare the Lego® block structure to the ability of the elements to bind to other elements. Receptacles and prongs correspond to valence. Different elements are represented by different colors. Different elements may have the same or different numbers of valence electrons as others. (See the charts below.)

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Lego® Organizational Chart

	1X1 (+)	1X2 (+)	1X3 (+)	1X4	1X3 (–)	1X2(–)	1X1(–)
Red							
Blue							
Yellow							
White							

Modified Periodic Table

	1A	2A	3A	4A	5A	6A	7A
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K	Ca	Ga	Ge	As	Se	Br
Period 5	Rb	Sr	In	Sn	Sb	Te	I

10. Let students construct CO_2, CH_4, and H_2O as typical biological molecules.

Formative Assessment:

1. How many valence electrons does carbon have?

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Inquiry B: *Molecules*

Objective: Students will combine elements to form molecules

Time Frame for Activity: 15-20 minutes

Materials:

Assorted Legos® (See Inquiry A Materials)

Procedure:

1. Instruct the student to make 3 models using the Legos® with the restriction that the models have only two levels using the 1X4 and with no uncoupled receptacles or prongs (no overhang). Example: two blue 1X2 on top of a white 1X4, two red 1X1 and a blue 1X2 on top of a yellow 1X4, or a blue 1X4 on top of 2 red 1X1 and 2 blue 1X1.

2. Observe students progress and assist groups that are having difficulties.

3. Allow the student enough time to complete the three models.

4. Have the students compare and discuss their models with another group.

5. Draw a few of the student's models on the board and ask the other groups if they have any similar models.

6. Compare the models of a 1X4 to the molecules formed with C.

Formative Assessment:

1. How many hydrogen atoms can combine with one carbon?

2. If a carbon double bonds with one oxygen, how many valance electrons are left on carbon to bond to other elements.

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Inquiry C: *The Linkage*

Objective: Students demonstrate the linkage of biological monomers.

Time Frame for Activity: 10-15 minute

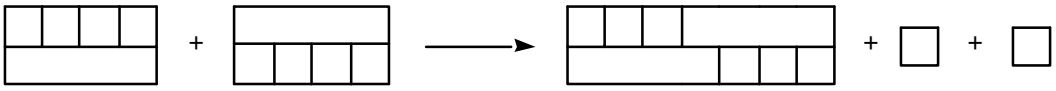
Materials:

Assorted Legos® (See Inquiry A Materials)

Procedure:

1. Instruct the students to make two models using one of the 1X4, one model with the 1X4 on the top and one model with the 1X4 on the bottom.

2. Once the students have made their models, instruct them to combine the two models so that the combined models contain two layers. If students say that it cannot be done, inform them that they may remove a 1X1 or 1X2 from each of the models to accomplish the combining of the original models.



3. Observe students progress and assist the groups that are having difficulties.

4. Ask the students how they combined their models and draw a few examples on the board.

5. Give the students some example molecules and ask them to combine these models in a similar fashion.

6. Relate these models to similar reactive groups (amino, carboxyl, hydoxyl,…).

7. Introduce the concept of linkage of reactive groups and relate back to linkage of 1X4 Legos®.

8. Give the students four models using the 1X4 and ask the students to combine these models into one, two level structure.

9. Introduce the concept of polymerization to form macromolecules such as carbohydrates and proteins.

Formative Assessment:

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1. Can you combine molecules with out removing elements?

2. In the following reaction, does the disaccharide have exactly twice the number of atoms that you find in each monosaccharide?

3. What single molecule is used to form the following macromolecule?

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III. Assessment and Evaluation

A. Pre-Test for the Course Component

Inquiry A Evaluation

1. Some elements can combine with other elements to form molecules; some elements do not have that property or ability.

    A) Some elements are stickier than others are.
    B) Some elements are natural attracted to one another.
    C) Elements have distinct binding abilities due to the organization of their electrons.

2. Oxygen atoms are found in combination with other elements in chemical bonds. Can they form chemical bonds with other oxygen atoms?

    A) Yes
    B) No

3. Carbon atoms combine with many different elements. What is the largest number of atoms that a carbon can bind to?

    A) 1
    B) 2
    C) 3
    D) 4
    E) 5

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B. Post-Test

Inquiry A Evaluation

1. Sulfur has 6 electrons in its valance shell. Which of the following combinations is chemically correct?

   A) H_2S
   B) H_3S
   C) SH_4

2. Which of the following combination of atoms is not correct?

   A) H_2
   B) O_2
   C) N_2
   D) C_2
   E) H_2O

3. How many hydrogen atoms can combine with a carbon atom?

   A) 1
   B) 2
   C) 3
   D) 4
   E) 5

4. When carbon has formed a double bond with oxygen, how many valence electrons are left to combine with other elements?

   A) 1
   B) 2
   C) 3
   D) 4
   E) 5

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IV. Appendix of Resources

A. Quizzes

Quiz

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