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Transport Worksheet

Part A. Inquiry and Research

Go to the *Learn Genetics* website at http://learn.genetics.utah.edu/content/basics/proteintypes/, click on "transport proteins." Then answer the following questions.

1. What is the function of a transport protein?

2. List three transport proteins and what they do:

Go to the *Boundless Biology* online textbook at https://courses.lumenlearning.com/boundless-biology/chapter/components-of-the-blood/ (or search for "boundless biology textbook red blood cells") and answer the following questions.

3. Why do most mammals *not* have organelles in their erythrocytes (red blood cells)?

4. How many molecules of hemoglobin are in a red blood cell?

5. How many oxygen molecules does a molecule of hemoglobin hold?

6. Scroll down to the *Red Blood Cells* section and look at three drawings of different variations of oxygen-carrying proteins—hemerythrin, hemocyanin and hemoglobin. List two differences and one similarity between these proteins.

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Part B. Engineering Challenge

A couple has given birth to a child that has hypoxemia, which is when hemoglobin does not bring the correct amount of oxygen to cells. As a team of biological engineers, your challenge is to “cure” this child by creating an oxygen transport protein for the child.

Step 1: Brainstorm

A. What “things” do you use or see daily that carry and transport other “things”?

B. What characteristics are necessary for something to carry and transport a substance?

Step 2: Design. Your *challenge* is to use the amino acids (materials) listed below to design a model oxygen transport protein to move as much oxygen as possible. The design *requirements and constraints*: The protein you design must be able to catch, transport (be carried) and then release oxygen (represented by mini marshmallows). Make your design have many oxygen transport proteins. The limitation is that each protein can only hold four oxygen, so if your protein catches more than four oxygen, the rest will be removed (not counted). On another piece of paper, clearly sketch and label the planning diagram for your design so that someone else could recreate it.

Mini marshmallows represent oxygen. You are not building with them, but need to use them to make sure they fit your oxygen transport protein. Available materials include:

- 1 roll masking tape
- twine/string
- paper and paper bag
- saran wrap
- Popsicle sticks and toothpicks
- scissors

Step 3: Before you start building, have the teacher approve your design. **teacher initials _____**

Number of oxygen you hypothesize that your protein will hold: _______________

Step 4: Build. Next, use the amino acids (materials) to build a protein model. *Remember*: The function of this transport protein is to bring more oxygen to the child.

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Step 5: Test and evaluate. *Did your design hold as many marshmallows (oxygen) as you thought it would?* Circle: yes or no *How many did it hold?* ________________

Explain why it did/did not meet your expectations. *How effective was your protein model? What are the design strengths and weaknesses?*

Data collection: Fill in the data table with the number of oxygen each group's protein held.

Group #	Trial 1	Trial 2

Group #	Trial 1	Trial 2

Step 6: Redesign. *How will you change your design?* On another piece of paper, write/draw your adjustments.

Have the teacher approve your revised design. **teacher initials:** _______

Number of oxygen you hypothesize your revised protein will hold: ___________

Step 7: Test and re-evaluate. *Did your design hold as many marshmallows (oxygen) as you thought it would?* Circle: yes or no *How many did it hold?* ________________

Explain why it did/did not meet your expectations. *How effective is your protein? What are the strengths and weaknesses of your design?*

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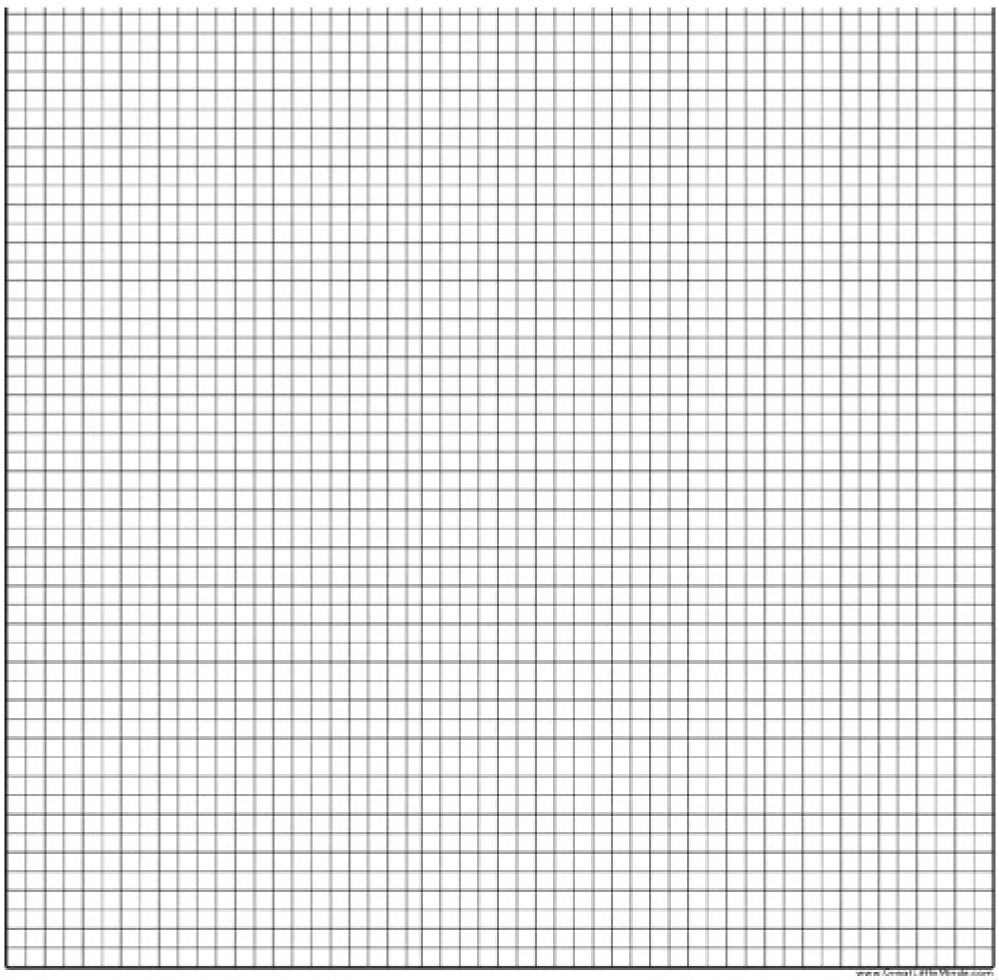
Step 8: Compare. Examine the data for all teams. Graph the data. *What does the data tell you?*

How did your oxygen-carrying protein perform compared to the other proteins that were built? What is an idea from a different protein that you could have incorporated into your design, and why would you use it? What is something another group did that you would not have incorporated, and why?

Step 9: Conclusion. When DNA has errors in it (mutations that cause disease), it produces faulty proteins or no proteins. *If your structure was a real hemoglobin protein that carries oxygen, would it be able to function well enough to keep you healthy? Or would you die because it is a mutated protein?* Explain.

Comparison of Number of Oxygen Each Protein Held

Number of Oxygen



Group Number