Leonardo da Vinci’s Vitruvian Man shows how the proportions of the human body fit perfectly into a circle or a square. With these proportions, your arm span (distance from fingertip to fingertip) should be equal to your height (distance from head to heels). In this laboratory exercise, you will see if this is true! In this activity you will explore the legitimacy of Vitruvius' theory by developing a hypothesis regarding the Vitruvian Man.

Background Information

Leonardo da Vinci, a famous Italian renaissance inventor and painter, was greatly influenced by a man named Vitruvius. Vitruvius was a Roman engineer and architect during the first century B.C. Vitruvius discovered a formula to model what he thought were ideal proportions for a man. Da Vinci used this ideal model when drawing the Vitruvian Man in about the year 1490. The drawing shows a man standing in a square, which is inside a circle. The man has two pair of outstretched arms and two pair of outstretched legs.

These are some of the proportions given for the Vitruvian Man:
• The span of the man’s arms is equal to his height.
• The width of his shoulders is one-fourth of his height.
• The distance from the top of his head to the middle of his chest is one-fourth of his height.
• The distance from the middle of his chest to the top of his leg is one-fourth of his height.
• The distance from the top of his leg to the bottom of his knee is one-fourth of his height.
• The distance from the bottom of his knee to the bottom of his foot is one-fourth of his height.

Laboratory Exercise Objective

You will learn and practice the scientific method by measuring human dimensions.
A hypothesis is a possible explanation for a set of observations or an answer to a scientific question. A hypothesis is useful only if it can be tested. Testable hypotheses are generally written in a formalized format using an if/then statement.

- **IF** my car does not start because the battery is dead, **THEN** when I replace the old battery with a new one, it will start.
- **IF** increasing physical activity causes a person to burn calories and lose weight, **THEN** I should lose weight if I run 2 miles a day and do not increase my calorie intake.

Formalized hypothesis contain both a dependent and an independent variable. The independent variable is the one that YOU change and the dependent variable is the one you observe and measure to collect data. Using the if-then format, **IF** I change temperature, **THEN** what will happen to movement.

Temperature is the independent variable because I change it and movement is the dependent variable because it is the one that is observed to look for change. Using the if-then format forces the scientist to think about what results are expected.

The subject of the exercise is Leonardo da Vinci’s drawing Vitruvian Man. You will focus on the primary proportion of the drawing, “The span of the man’s arms is equal to his height.” You will test a hypothesis regarding Vitruvius' theory on human proportions.

**The scientific method consists of the following steps:**
1. From observations, state a question.
2. Write a hypothesis.
3. Design an experiment to test the hypothesis.
4. Gather data by doing the experiment.
5. Analyze the data.
6. Write and explain your conclusion.

**Laboratory Resources**
Your classmate  Meter stick  Masking tape  Graph paper

**Laboratory Procedure**  Remember to use metric units (centimeters).
1. Write an if-then hypothesis based on Vitruvius' theory relating arm span and height. Record your hypothesis on the student answer page.
   Your hypothesis: If the Vitruvian man ratio is__________ then, the arm span and height will be________________.
2. If the Vitruvian Man ratio/theory is correct/incorrect (pick one), then the arm span and height will be same/ different (pick one).
3. Working with a partner, measure your arm span by standing against a flat surface and spreading your arms out as far as possible. Have your partner measure the distance from the longest finger on one hand to the tip of the longest finger on the other hand. Record the measurements in Data Table 1.
4. Repeat step two on your partner.
5. Remove your shoes and have your partner measure your height as you stand against a flat surface. Measure the distance from the top of your head to the floor. Record your measurements in data Table 1.
6. Repeat step 4 on your partner.
7. Calculate the difference between your arm span and your height (arm span minus height).
8. If the difference is within +/-2 cm -- we will say that it is close enough.
9. Go back and make a conclusion on your original hypothesis -- Was it right or wrong??
VITRUVIAN MAN STUDENT DATA SHEET

Section I.
Write your if-then hypothesis:
If the Vitruvian man ratio is________ then, the arm span and height will be __________.

DATA TABLE 1:

<table>
<thead>
<tr>
<th>Name</th>
<th>Arm span (cm)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Difference: NAME 1 = ______ cm NAME 2 = ______ cm

Conclusion: Based on the data; my hypothesis was ________________ (correct/incorrect).

Section II.

Some people have observed that the length of their foot is the same as the length of their forearm. Others disagree saying there is no relationship between the two. We will now examine whether the other Vitruvian measurements are accurate. Circle if you agree or disagree BEFORE the measurement.

- The width of his shoulders is one-fourth of his height.
  - AGREE
  - DISAGREE
- The distance from the top of his head to the middle of his chest is one-fourth of his height.
  - AGREE
  - DISAGREE
- The distance from the middle of his chest to the top of his leg is one-fourth of his height.
  - AGREE
  - DISAGREE
- The distance from the top of his leg to the bottom of his knee is one-fourth of his height.
  - AGREE
  - DISAGREE
- The distance from the bottom of his knee to the bottom of his foot is one-fourth of his height.
  - AGREE
  - DISAGREE

Hypothesis 2: If the theory is right and I am a proportional person then the measurements will be ___________________ - (within +/- 2 cm) of the predicted measurement.

Data:
Fill in for your measurements only:
Your height in cm = __________ cm  ¼ height = __________ cm
Width of shoulders = ______ cm Difference in cm from ¼ height = ______ cm
Top of head to middle of chest = ______ cm Difference in cm from ¼ height = ______ cm
Top of leg to bottom of knee = ______ cm Difference in cm from ¼ height = ______ cm
Bottom of knee to bottom of foot = ______ cm Difference in cm from ¼ height = ______ cm

Conclusion: My hypothesis was ______________________

Hypothesis 3: If the theory continues as the first two hypotheses, then the remainder measurements __________________ (will, will not) support the Vitruvian theory.
- From the elbow to the top of the hand will be 1/5 of height.
- From the elbow to the angle of the armpit will be 1/8 of the height.
- The whole hand will be 1/10 of the height.
- The foot to the longest toe will be 1/7 of your height.
- The foot is equal to the length from the wrist to the elbow
- The distance from the bottom of the chin to the nose and from the roots of the hair to the eyebrows is, in each case the same, and like the ear of third of the face.

**DATA TABLE 2:**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Your measurement</th>
<th>Fraction of your Height</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow to the top of the hand</td>
<td></td>
<td>1/5=</td>
<td></td>
</tr>
<tr>
<td>Elbow to the angle of the armpit</td>
<td></td>
<td>1/8=</td>
<td></td>
</tr>
<tr>
<td>The whole hand</td>
<td></td>
<td>1/10=</td>
<td></td>
</tr>
<tr>
<td>The foot to the longest toe</td>
<td></td>
<td>1/7=</td>
<td></td>
</tr>
<tr>
<td>The foot is equal to the length from the wrist to the elbow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The distance from the bottom of the chin to the nose</td>
<td></td>
<td>1/3 total face =</td>
<td></td>
</tr>
<tr>
<td>and from the roots of the hair to the eyebrows is,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in each case the same, and like the ear of third of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the face</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Final Conclusion: Go back and look at all of your hypotheses and come up with a 2-sentence conclusion based on your data. Write it here.

**Questions:**
Do you think gender would make a difference, why or why not?

Why are we using the measurement units of cm or meters in this lab?

Why is using the scientific method important in science?

Based on the following problems, state a hypothesis for each.
a. Plant growth and fertilizer: If fertilizer increases plant growth, then

b. If my car does not start and the lights do not come on, then

c. Sugar and bees: If bees are attracted to sugar, then

**Final Question:** What is a hypothesis?