

How-To-Do-It

Insect Singularis

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Students often have difficulty with laboratory exercises because they do not read the exercise in advance of class, or if they do read the material, they do not follow directions. The following exercise was designed in an effort to help with this problem.

Listed in Table 1 are a group of terms and their definitions that students are to use in drawing a hypothetical insect. If the terms are understood and the directions followed closely, the insect produced should be an exact copy of the instructor's master drawing. A correct drawing will be evidence of a successful exercise, but checks will indicate where the student has "gone wrong." At the end of the laboratory period, all the students' drawings should be identical.

Materials

You will need the following items in order to successfully complete this exercise:

- Sharp 2H pencil
- Clean eraser
- *Straight edge or ruler with metric markings
- *Metric circle template
- *Protractor
- Clear eye and steady hand

*A Sterling Geometry Aid #534 may be used instead of these items, but the circles in this piece of equipment are in inches rather than millimeters. The measurements for circles will be given in both mm and inches so that the student may use either piece of equipment. The cost of the Geometry Aid is only about 29 cents as compared to about \$3 if one goes with the other pieces of equipment.

Instructions to Students

In constructing your drawing of *Insect singularis*, use only straight ruled lines and circles drawn with the metric template or geometry aid. Circle dimensions refer to the required diameter. Use the protractor to correctly determine angular measurements.

Locate a point midway between the

short sides of the paper and draw through this point a line 120mm long and perpendicular to the long side of the page. Allow for lateral margins of equal width at either end of this line. Draw a second line parallel to the first line and located 50mm from it. Position the paper so that the line closest to the edge of the paper is away from you. The anterior end of the insect will be directed toward the left hand margin of the paper and the dorsal surface will be represented by the line closest to the edge of the page. At the anterior end of the insect draw a line connecting the dorsal and ventral surfaces. At the posterior end draw a line perpendicular to the dorsal surface and extending toward the ventral surface. Make this line 36mm long. Also at the posterior end draw a second shorter line perpendicular to the ventral surface and extending toward the dorsal surface. Make this line 10mm long. The 4mm gap between the ends of the last two lines drawn represents the anal opening. Draw a perpendicular line from the dorsal to the ventral surface and exactly 31mm from the anterior end; this line marks the posterior border of the insect's cephalic segment. Construct a similar line 50mm from the posterior end of the insect; this line marks the anterior border of the abdomen and the posterior border of the thorax. You have constructed the major divisions of the body of your insect.

Draw lines perpendicular to the dorsal surface positioned so that the thorax is divided into three metameres of equal area. Sketch three appendages, each consisting of three segments perpendicular and ventral to the ventral surface of the thorax. Make the proximal segment of each appendage a square with sides 9mm long and centered on the ventral surface of a thoracic segment. Make the median segment 7mm wide and 10mm long and center it on the distal end of the proximal segment. The distal segment should be 5mm wide and 15mm long and be centered on the distal surface of the median segment. Represent terminal setae by drawing a single 3mm long pencil line perpendicular and

ventral to and from the center of the distal end of each appendage. Place wings on your insect by extending a 40mm line perpendicular and dorsal to the dorsal surface at the anterior border of the prothoracic segment. Now extend a 40mm line dorsally and posteriorly at a 45-degree angle from the posterior border of the prothorax segment. Connect the distal end of this line with the distal end of the other wing line.

Divide the abdomen into five metameres of equal area by drawing four lines perpendicular to the dorsal surface and extending to the ventral surface. Divide the abdominal segments into dorsal and ventral portions by a median longitudinal line. To represent spiracular opening, draw a circle 2mm ($\frac{1}{8}$ inch) in diameter in each abdominal segment. Locate the spiracle halfway along the length of the segment and with its dorsal border just touching the median longitudinal line.

You will now concentrate on providing structures for the insect's head. Draw a 2mm thick antenna with its base at the angle of the anterior and dorsal surfaces of the head. Extend the antenna 30mm at a 45-degree angle so that it projects anteriorly and dorsally to the head. Separate the antenna into five segments of equal length and extend the antenna by adding a circle 3mm ($\frac{1}{8}$ inch) in diameter to the distal segment so that the circumference of the circle touches the midpoint of the apex. Construct mouth parts by drawing two labial

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and one lingual structures. One labial structure 3mm wide and 10mm long should extend perpendicularly from the anterior surface of the head with its ventral border 5mm from the ventral border of the head. A second labial structure, of the same dimensions, should extend perpendicularly from the ventral surface of the head with its anterior border 5mm from the anterior border of the head. Connect the ends of the lines, which represent the upper and lower borders of each lip, with short perpendiculars. The lingual structure is to be 2mm thick and 8mm long and extend at a 45-degree angle from the head with its base situated equally between the two labial structures. Connect the ends of the lines which represent the upper and lower borders of the tongue with a short perpendicular line. Place an eye on the head segment by drawing an 8mm (1/2 inch) diameter circle whose center is 15mm from both the dorsal and anterior surfaces of the head.

Although you and I know your drawing represents an insect and we

can recognize its various parts and structures, it might be good to label it so neophytes are able to recognize it for what it is. Label structures by extending 5mm lines which run parallel to the longitudinal axis of your insect; if possible, do not have any of the lines or labels cross body structures. Use lower case printed letters for your labels. Place labels on the following structures: antenna, anus, dorsal lip, leg, tongue, ventral lip and wing. Place a caption 25mm below the drawing. Use the following caption: Figure 1. Hypothetical insect produced by (your name) on the basis of provided terms and directions. The first letter of the caption should be in upper case and one and one-half inches from the left hand margin of the paper. The caption should not extend further than one and one-half inches from the right hand margin. If it is necessary to have a second line of print in the caption, start it at the same distance from the margin as the first line.

Please turn in your drawing to be evaluated for accuracy. A check mark

at a specific place will indicate an error there. Correct your error(s) and return the paper for evaluation.

Comments

An overhead transparency is useful as the "master" for correcting student drawings.

This exercise has proven quite successful in setting the tone for future drawings and other written materials to be turned in for laboratory work. The instructions have been used by both high school and freshman college students. Some of the students have found it to be somewhat demanding and require considerably more assistance to successfully complete the exercise. It is necessary to check students rather closely at the start of the exercise to make sure they do not get so far off base that they become discouraged.

Most of the students seem to enjoy the exercise and obtain a good deal of satisfaction out of successfully completing it. Since this exercise serves as a pattern for future laboratory work

Table 1.

Vocabulary	
Abdomen	The body division posterior to the thorax, behind the diaphragm in mammals.
Antenna	A sensory appendage, especially on arthropods, projecting from the head; it usually contains receptors for chemical reception.
Anterior	The forward-moving or head end of an animal.
Anus	Posterior opening of the digestive tract.
Apex	The end or point of a structure.
Appendage	A movable projecting part on an animal body having an active function.
Axis	A central or principal line bisecting a body, form, or the like, and in relation to which symmetry is determined.
Caption	A heading or title; legend for a picture or graph, it is placed below the figure in scientific literature.
Cephalic	Pertaining to or toward the head.
Distal	Away from the point of attachment.
Dorsal	Toward or pertaining to the back or upper surface.
Equal	Evenly proportioned; the same in quantity.
Homologous	Of like source in structure and embryonic development from primitive origin.
Label	A word or phrase descriptive of a structure.
Labial	Pertaining to lips.
Lateral	Of or pertaining to the side.
Lingual	Pertaining to the tongue.
Longitudinal	Pertaining to or extending along the long axis of the body.
Median	Situated in or pertaining to the middle.
Metamere	Any one of a series of homologous parts in the body.
Neophyte	A beginner.
Parallel	Extending in the same direction, equidistant at all points.
Perpendicular	Meeting a given line or surface at right angles.
Posterior	The hinder part or toward the tail end; away from the head.
Prothorax	The most anterior of the three segments of the thorax.
Proximal	Toward or nearer the place of attachment.
Segment	A part that is marked off or separated from others.
Seta	A bristle or slender stiff bristle-like structure.
Spiracle	In insects, an external opening to the tracheal or respiratory system.
Terminal	Situated at or forming the end or extremity of something.
Thorax	The division of an animal next to or behind the head; in insects it bears the legs and wings.
Ventral	Toward the lower side or belly; away from the back.

that requires drawings, it is necessary to use follow-up work to ensure that students establish proper drawing and labeling habits. The students' success in mastering the anatomical terms can be determined very easily by including them in laboratory quizzes. We give the students a weekly quiz on their laboratory material from the previous week's work and often include one or two questions taken from the laboratory exercise they are to complete that week. This encourages or forces them to read their laboratory instructions before coming to lab.

The results we have obtained show that this type of exercise combined with appropriate follow-up work is

valuable to students. About 20 years ago, an exercise similar to this was required in all introductory biology classes; then it was dropped as a requirement for about 10 years. Two years ago we reintroduced the present exercise because students seemed to be having difficulty preparing drawings in an acceptable form. This not only gives students experience in preparing drawings and learning biological terms, but provides the instructor with a measure of their past experience and indicates their ability to complete such an exercise. The instructor can, if he or she wishes, provide certain students with some additional work in this area. It was quite a

coincidence that while preparing this exercise for publication, I received a postcard from a former student concerning the use of this type of exercise. He stated "For many years, I have used a humbug exercise for teaching terms used in body parts: anterior, apical, etc. This was drawn from memory from an old introductory biology class I had with you in about 1965???. Do you still conduct a humbug worksheet/lab? If so could you provide a copy of the instructions? I will credit you and Indiana State University in any class use." At least one former student, now a teacher, found the exercise of considerable value.

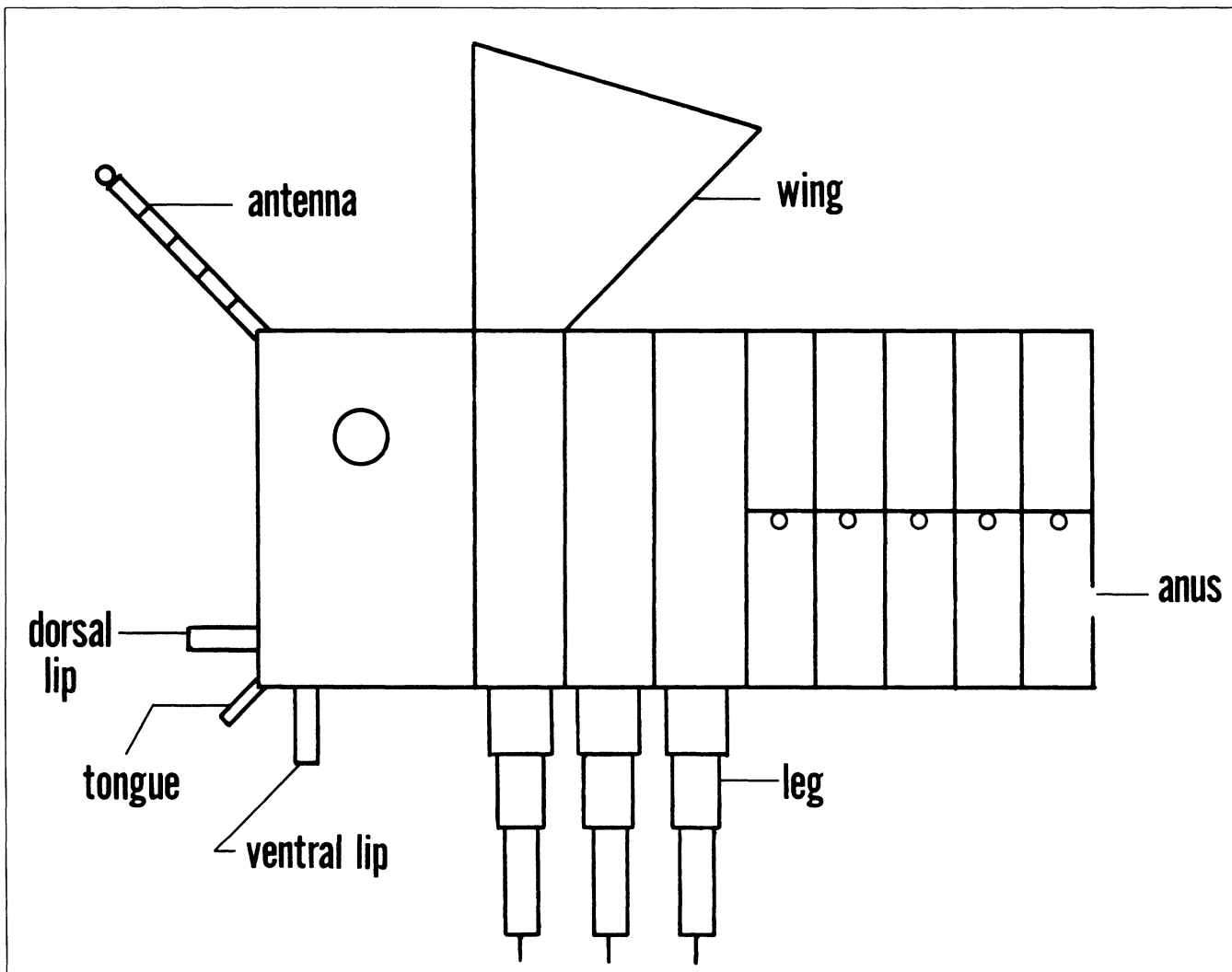


Figure 1.