havior of the fish as the temperature is allowed to slowly rise to normal?

Place some fish in a container and slowly warm the water. What is the response the fish make? As the temperature increases, is the available oxygen in the water increased or decreased? The increase of temperature may be carried to the lethal point, or returned to normal before the fish die.

Is the water of the natural habitat of the fish likely to become too warm for them in the summer? Is it likely to have too little oxygen if it contains normal plant life? If decaying material is present are the fish likely to suffocate?

What are some reasons for Gambusia remaining near the surface of water during the warmer months?

8. Enemies. Are any parasites found on the *Gambusia*. If any are present, they may furnish the basis for some interesting studies.

Are *Gambusia* a part of any food chain? If any sunfish, other carnivorous fish, or various species of turtles are available, put a few *Gambusia* in the water with them. What forms of life will eat *Gambusia?*

The resourceful teacher will find many other ways of using *Gambusia* in his teaching of biology. It is hoped that the suggestions offered here will open the way to some stimulating activities in which the students will participate wholeheartedly.

Blood Under The Microscope

DONALD S. LACROIX
Amherst High School, Amherst, Massachusetts

Along with the development of the microscope has come the development of our knowledge of blood. Leeuwenhoek, the father of the microscope, was the first person to describe red corpuscles of human blood, and as time went on and the microscopes improved more was revealed concerning blood. Today, the family physician as well as the surgeon depends upon results of blood examinations before going ahead with diagnoses or operations. Just stop a moment to consider the importance of red blood corpuscles. They are saturated with an iron-containing pigment called hemoglobin which is capable of taking on or giving up oxygen. Thus, a reduction in the number of red corpuscles in a person's circulatory system means a reduction in the oxygen supply in the body, hence the significance placed on relative numbers of red corpuscles. Similarly, white blood cells, of which there are several kinds, have a lot to do with infection and an increase or decrease in their numbers each has its implication in a doctor's investigations. From these suggestions, then, it is evident that microscopic study of blood is of considerable value to the biologist, doctor, medical student, and nurse.

The microscopic examination of blood is by no means difficult and can be carried out by anyone having the equipment found in most biology laboratories. It is particularly fascinating to see how one's blood looks, especially in this age of blood banks, transfusions, plasma, corpuscle counts and sedimentation tests and other terms heard in the doctor's office, hospital, and home. To see the structure of blood under a magnification of 440 times

is to reveal something new to most persons. Floating in the plasma may be found erythrocytes or red corpuscles and leucocytes or white corpuscles, the two chief types of cells in blood's make-up. Under certain circumstances blood platelets may be seen, but these ephemeral fragments disintegrate rapidly when in contact with foreign substances or air.

The technique of making blood smears is not involved and can be performed by anyone who is careful and who observes the rules of cleanliness and sterility of equipment. Slides and cover glasses must be free from dirt or grease. Even a clean finger can leave a trail of grease on a glass slide which will interfere with subsequent manipulation. Cleaning of glassware may be accomplished by the usual washing, followed by an alcohol rinse; a good wiping with a clean towel, then a soaking in acetone and another wiping with smooth, clean toweling. Flame all slides just before using.

Blood is obtained by puncturing the skin of a finger tip or an ear lobe. If taken from a finger, use an area between a finger nail and the first joint, somewhat to one side, rather than directly in the middle on the "ball" of the finger. The latter is more sensitive. Try the middle finger. Swab the area to be punctured with cotton dipped in alcohol. Allow skin surface to dry. Use a sterile needle or better a blood lancet, and puncture just deep enough to draw a few drops. If a needle must be used, grasp as a pencil in writing and jab quickly. Wipe away the first drop, and do not squeeze the area as this tends to dilute the blood with tissue fluid. Using subsequent drops as they appear, follow one or both of the techniques described below.

Wet Blood Film. When it is deemed necessary to observe fresh blood, touch a thoroughly clean slide to a very small drop of blood, cover gently with a clean cover-slip and ring with a wax-petrolatum-paraffin mixture to hold cover in place and to prevent air from reaching the film. Examine under a 44× objective and then under an oil immersion lens. The uninitiated will be disappointed because the brilliant red color of fresh blood pales to a straw-yellow in the thin film beheld under magnification. However, the erythrocytes are clearly visible as circular cells lacking nuclei.

Dry Film (Stained). When it is necessary to differentiate between kinds of cells and between cell structures, staining must be resorted to. A very thin smear is best and can be produced by placing a drop of blood near the end of a thoroughly cleaned slide. Then, holding another slide at a 45-degree angle, bring it into contact with the drop of blood. See accompanying photos. The

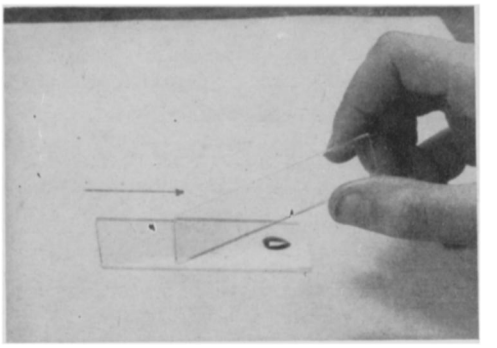

Fig. 1. Draw top slide towards drop of blood, holding it at angle as shown.

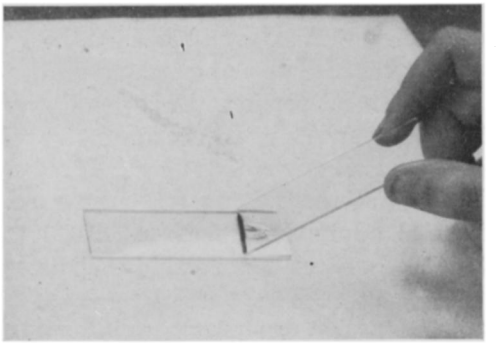

Fig. 2. Let blood spread along line of contact of two slides.

blood will spread out along the line of intersection of the two slides. Slowly and carefully push the upper slide away from the drop towards the other end of the lower slide. This will carry a thin film along and spread the drop without crushing the corpuscles. Air dry—if necessary, hold over a lighted incandescent lamp.

Stain with Wright's blood stain,[1] adding enough with a dropper to cover the smear. After one minute, dilute with an equal volume of distilled water, adding this drop by drop. In four minutes rinse off carefully with distilled water, dry and examine with a 44× objective or an oil immersion lens.

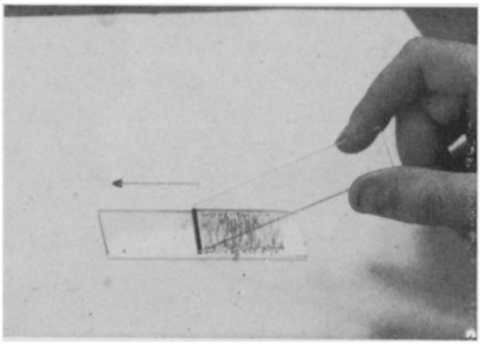

Fig. 3. Push upper slide away from drop so that a thin smear of blood is left behind.

The red corpuscles, erythrocytes, are biconcave discs about seven microns across and two microns thick, pale reddish-yellow in color as observed directly under the microscope. Because the cells are biconcave the central portion of each is thinner than the edge, hence the appearance of being lighter colored in the central portion. This peculiarity in shape permits rapid exchange of oxygen from all parts of the cell. It is believed that there is no cell membrane. Normal adults have from 4,500,000 to 5,500,000 red cells per cubic millimeter of blood. Exercise, excitement and high altitude cause an increase as do some diseases. Anemia causes a decrease in numbers. (Wright's stain intensifies the red color.)

[1] Wright's blood stain should be purchased from a biological supply house, as it is rather difficult to prepare correctly.

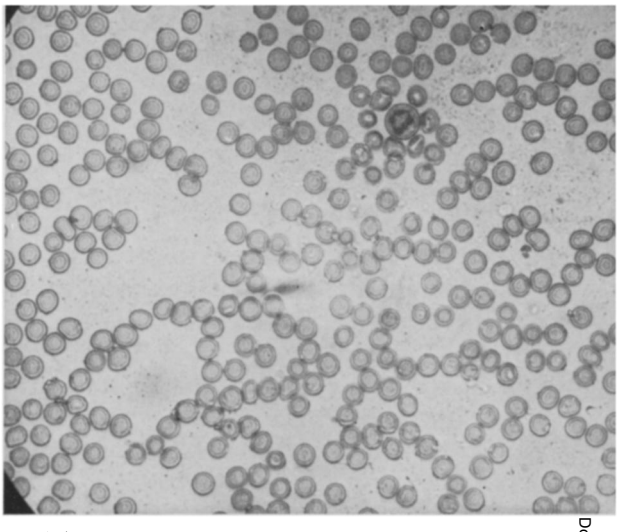

Fig. 4. Photomicrograph of a blood smear made by a tenth grade biology student, showing red corpuscles and one white corpuscle (larger than the red and having a large, irregular nucleus).

The white corpuscles, leucocytes, are colorless cells of several varieties and can best be studied after having been stained. The commonest type of leucocyte (3,000 to 7,000 per cubic millimeter of blood) is about 11 microns in diameter, lavender-pink with a nucleus which in some is horse-shoe shaped and in younger cells is kidney shaped. In older cells the nucleus shrinks and finally looks like two lobes connected with each other by a fine thread. The nuclei stain blue to blue-black. Variations in numbers and in stages of development of these cells are interpreted by physicians to mean variations in severity of infection.

Blood platelets are tiny bodies from 2 to 4 microns in diameter, not true cells, rounded, fragment-like, light blue when stained, with purple or reddish granules in the central portion. There are 300,000 to 400,000 per cubic millimeter of blood, they disintegrate readily to form a substance necessary in blood clotting.

The actual flow of corpuscles within the capillaries can be observed by wrapping a live gold-fish, tadpole, or frog in

a wet cloth and placing the tail of either of the first two under a 44× objective and focussing on the thinner parts of tissue. By focussing on the web between the toes of a frog's foot, the same phenomenon may be witnessed. In each case, corpuscles should be seen coursing through the capillaries at every heart pulsation. A chick embryo can also be used to demonstrate the same thing.

COMING SOON—*Graduated Test Questions, Special-preparation Topics* chosen by biology pupils, *Study of Twigs in Winter,* the place of the biology teacher in an improved health program, a comparison between laboratory and non-laboratory sections, a paper on the teaching of genetics, *Biology at Christmas Time* . . . and of course, book reviews, *By the Way* items (don't forget to send in some) and *Biological Briefs.* . . .

The Use of the Key in Teaching Biology

DWIGHT E. SOLLBERGER
State Teachers College, Indiana, Pennsylvania

Most biologists have used, at one time or another, a key to identify biological objects. Waiving the question as to the merits of naming specimens as a part of a biology course, it is a safe conclusion to assume that the identification of biological specimens usually occupies a not inconsiderable effort on the part of the student and teacher of biology. For this reason an examination of certain aspects of the problem of the use of keys would seem desirable.

WHERE ARE KEYS USED?

In the Laboratory

Keys may be used in the laboratory or outdoors. In the laboratory the usual procedure is for the instructor to bring in the specimens, number them, and distribute them, having previously provided the students with keys. Students may also bring in specimens, but the wise teacher sees to it that specimens showing particular characteristics are available to the students. Permanent collections may be made with such laboratory exercises in mind. In this way the presence of the groups which the teacher wishes to emphasize may be assured. Care should be taken to see that the specimens show the structures used in the key. If Lycopodiums are collected, certainly specimens with the fruiting structures should be included. Skulls should be collected with mammal skins, although they need not be the skulls of the particular skins. That is not to say that the skin and skull of the same animal are not essential. It is just an impossibility to provide both in all cases.

The writer has found that pairs of students may key specimens with little loss of learning and with the advantage that it reduces the number of specimens by one half. After an introduction to the use of the key in general and to characteristics of the particular forms being studied, the students number sheets of paper with the same numbers as are on the specimens. The problem for each student or pair of students is to determine the name of the specimen with the aid of the key. The teacher may, if he deems it advisable, allow the students to work by themselves, and turn in their papers at the end of the period for evaluation. However, experience indi-