essary to ligate. The blood-vessels of the organ are to be washed out and the original coloring matter that remains in them is to be replaced with another. The organs injected with the sulphindilate of sodium, after the blood-vessels have been washed out, are placed in a concentrated solution of calcium chloride, then in alcohol, when the coloring matter will become fixed.

Heidenhain found that the commercial indigo-carmine was composed of a mixture of substances, generally three in number: (1) indigo blue-sulphate; (2) indigo blue-hyposulphate; (3) phœnizine-sulphate of sodium. He found for the purpose of injection that 1 and 3 were the only ones useful. He injects 25 to 50 c.c. of a cold-saturated solution of one of the above salts into the vein of a medium-sized rabbit, and 50 to 75 c.c. into that of a medium-sized dog. After the animals have passed blue urine for some time they are killed by bleeding, and the coloring matter is fixed by injecting the kidney through the renal vessels with absolute alcohol.

For injecting the biliary passages of the frog, he places a piece of indigo-carmine, the size of a pea, in the lymph sac of the thigh, and closes the wound in the skin firmly. After twenty-four hours the biliary passages will be found beautifully injected.

Injection after Death.—For filling the vessels of an animal after death, or the vessels of a removed organ or tumor, we employ two kinds of injecting masses: one fluid, the other solid at ordinary temperature—cold- and warm-flowing masses.

Cold-flowing Masses.—If a solution of gelatin in water, to which is added a little ammonia, be boiled for several hours on a water bath, the gelatin is converted into metagelatin, and no longer congeals upon cooling. To this fluid, as a vehicle, may be added various coloring substances, when a good cold-flowing mass will be obtained. After injecting, the object is placed in formalin, which coagulates the metagelatin. The addition of glycerin and chloral hydrate, after Hoyer's method, will preserve the mass for some time.

Beale's Cold-flowing Fluid: Blue—Dissolve 0.777 gm. of potassium ferrocyanide in 30 c.c. of glycerin; mix 3.6 c.c. of tinct. ferri mur. with 30 c.c. of glycerin; add the iron mixture, drop by drop, to the potassium ferrocyanide solution. Then add to this mixture 5.5 c.c. of methylic alcohol, 30 c.c. of alcohol, and 88 c.c. of water, shaking strongly.

Carmine—Mix 1 gm. of pulverized carmine with a little water and sufficient ammonia to dissolve the carmine; add 50 c.c. of glycerin and shake well. Then add gradually, with constant shaking, 100 c.c. of glycerin, acidulated with 25 to 30 drops of HCl or acetic acid. Test the fluid with litmus paper, and if it is not decidedly acid add a few drops of acid. Then add 25 c.c. of alcohol and 75 c.c. of water.

Robin's Cold-flowing Fluids: Robin uses as a vehicle 2 parts of glycerin, 1 part of alcohol, and 1 part of water, combined with a third or a quarter of its volume of the following coloring masses:

Carmine—Rub up 3 gm. of carmine in a mortar with a little water and enough ammonia to dissolve the carmine; add 50 c.c. of glycerin, and filter. Add a ten-per-cent. solution of acetic acid in glycerin, drop by drop, until a slightly acid reaction is obtained.

Prussian Blue—(*a*) Potassium ferrocyanide (sat. sol.), 90 c.c.; glycerin, 50 c.c. (*b*) Liquor ferri perchloridi, 80°, 3 c.c.; glycerin, 50 c.c. Mix (*a*) with (*b*) slowly.

Green—Saturated sol. potassium arsenite, 80 c.c., and glycerin, 50 c.c., are mixed with saturated solution of cupric sulphate, 40 c.c., and glycerin, 50 c.c.

Yellow—(1) Cadmium sulphate (sat. sol.), 40 c.c.; glycerin, 50 c.c. (2) Sodium sulphide (sat. sol.), 30 c.c.; glycerin, 50 c.c. Mix (1) with (2) with constant shaking.

Warm-flowing Masses.—Robin's Gelatin Vehicle: One part of gelatin is soaked in seven, eight, nine, or ten parts of water, according to the consistence of the mass wanted, and when soft is melted on a water bath. This vehicle is then combined with any of the coloring masses just mentioned in the proportion of one part color to three parts vehicle. Filter through flannel before injecting.

Thiersch's Prussian Blue Mass: (1) A solution of gelatin, one part to two parts water; (2) saturated aqueous solution of ferrous sulphate; (3) saturated solution of potassium ferrocyanide; (4) saturated solution of oxalic acid.

Mix 12 c.c. of (2) with 30 c.c. of (1), at a temperature of 50° C. Mix at the same temperature 24 c.c. of (3) with 60 c.c. of (1), and add 24 c.c. of (4), with constant stirring. Add this solution to the solution of gelatin and iron; stir constantly until all the Prussian blue is precipitated. Heat on a water bath to 100° C., and filter through flannel.

Ranvier's Prussian Blue Mass: Prepare the Prussian blue as follows: Add to a saturated solution of ferrous sulphate, in water, a saturated aqueous solution of potassium ferrocyanide. Filter through a double filter of felt and paper. Wash with distilled water for several days, until the filtrate has a deep blue color. The Prussian blue has now become soluble. The precipitate is then dissolved in distilled water, and the solution kept in bottles until wanted.

Twenty-five parts of this solution are mixed with one part of gelatin. The gelatin is soaked for half an hour in water, and melted in the water it has absorbed, on a water bath. Heat the Prussian blue fluid to the same temperature, and mix with the gelatin solution, gradually, under constant stirring. Filter through flannel.

Thiersch's Carmine Mass: Carmine, 1 part; ammonia, 1 part; water, 3 parts. Dissolve and filter. Make a solution of gelatin in water, 1 to 2. Heat to 50° C. on a water bath, and add 1 part of carmine fluid for every 3 parts of gelatin solution. Then add acetic acid, drop by drop, stirring, until the free ammonia is used up. Inject at a temperature of 30° to 35° C.

Gerlach's Carmine Mass: Dissolve 5 gm. of carmine in a mixture of 4 c.c. of water and 0.5 c.c. of ammonia. Allow it to stand several days, and mix with 8 parts of a solution of gelatin, 1 to 2. Filter and inject at a temperature of 40° C.

Ranvier's Carmine Mass: Rub up 2.5 gm. carmine with a little water, and just enough ammonia to bring the carmine in solution. Soak 5 gm. of gelatin in water, and melt on a water bath in the water it has absorbed. Add the carmine fluid slowly, with constant agitation. Neutralize the free ammonia by adding, drop by drop, a mixture of acetic acid and water, 1 to 2. Filter through flannel.

Thiersch's Yellow Mass: (1) One part of gelatin in 2 parts of water; (2) 1 part of neutral potassium chromate in 11 parts of water; (3) 1 part of plumbic nitrate in 11 parts of water. Mix 4 parts of (1) with 2 parts of (3). In another vessel mix 4 parts of (1) with 1 parts of (2). Heat both mixtures to 30° C., and then combine, with constant stirring. Heat on a water bath to 90° C., and filter through flannel.

Thiersch's Transparent Green Mass: Combine the blue injection mass in various proportions with the yellow mass.

Frey's White Mass: Precipitate 125 to 185 c.c. of a cold-saturated, aqueous solution of barium chloride by adding sulphuric acid drop by drop. Allow the precipitate to settle for twenty-four hours, and decant the clear fluid. The remaining mucilaginous mass is mixed with an equal volume of strong gelatin solution.

Hartig's White Mass: Dissolve 125 gm. of lead acetate in enough water to make the whole weigh 500 gm. Dissolve 95 gm. of sodium carbonate in enough water to make the whole weigh 500 gm. One volume of each of the above solutions is mixed with two volumes of strong gelatin solution.

Fol's Dry Masses: Carmine—An indefinite quantity of ammonia is mixed with four times its volume of water, and carmine is added; after it has been standing an hour, with occasional shaking, no deposit should remain; then filter. Soak gelatin, in shreds, for two days in a sufficient quantity of the carmine solution. Then melt on a water bath with a small quantity of the solution. When melted add acetic acid until the color becomes blood-red, taking care not to add an excess of acid. Too little acid is not a disadvantage; too much will cause a granular precipitate. Allow the mass to cool, and tie up in a piece of coarse net, and by pressing with the hands, under water acidulated with 0.1 per cent. acetic acid, force the mass out into vermicelli-like strings. These are placed in a sieve, washed well with running water, and dried on waxed paper.

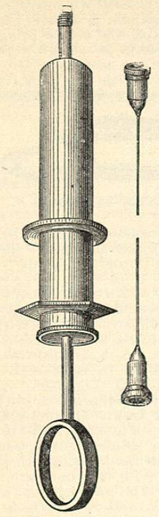


FIG. 2692.—Injecting Syringe.

Blue Mass—The mass is prepared according to Thiersch's formula. After cooling press out into vermicelli, as above, and dry on waxed paper. For use, soak the vermicelli in water; when soft, melt with enough saturated solution of oxalic acid to render the mass fluid.

Brown and Black Masses—Soak 50 gm. of gelatin in 200 c.c. of water in which is dissolved 14 gm. of sodium chloride. Melt on a water bath, and stir in briskly a solution of 30 gm. of silver nitrate, dissolved in 100 c.c. of distilled water. This produces a fine-grained, white emulsion, which is allowed to cool. When cold, press out into vermicelli, as above, wash in running water, and by clear daylight mix with the following: Cold-saturated aqueous solution of potassic oxalate, 300 c.c.; cold-saturated aqueous solution of ferrous sulphate, 100 c.c. When the mass has become black throughout, wash in running water for several hours, and dry the vermicelli on waxed paper. The color of this mass, by transmitted light, is sepia-brown. If a gray-black tint is wanted, substitute 24 gm. of potassium bromide for the sodium chloride in the first solution.

Injecting with a Syringe.—The syringe for this purpose should be made of brass or German silver, and should be of the form of that shown in Fig. 2692. Such a syringe, with half a dozen cannulæ of various sizes will answer all purposes for which a syringe can be used. It can be used only for injecting small organs.

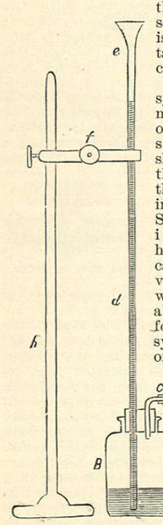


FIG. 2693.—Mercurial Injecting Apparatus.

A cannula is tied in the vessel and filled with a three-fourths-per-cent. salt solution. The syringe is then filled with the injecting mass, and to exclude all air the syringe is held vertically, nozzle up, and a few drops of the injecting mass are expelled. The nozzle of the syringe is then inserted in the cannula and the injection made slowly and steadily. On account of the difficulty of keeping up a steady pressure by the hand, the method of injecting with the syringe has been practically discarded.

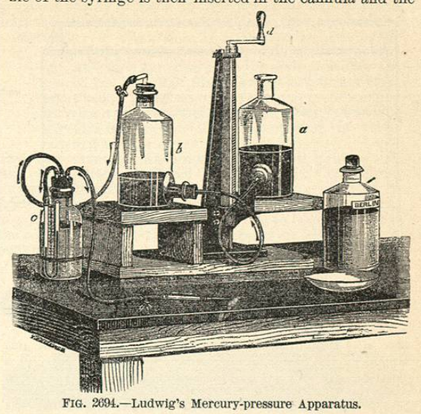


FIG. 2694.—Ludwig's Mercury-pressure Apparatus.

Injecting with Constant Pressure.—The pressure is obtained in this case by a column of mercury or water.

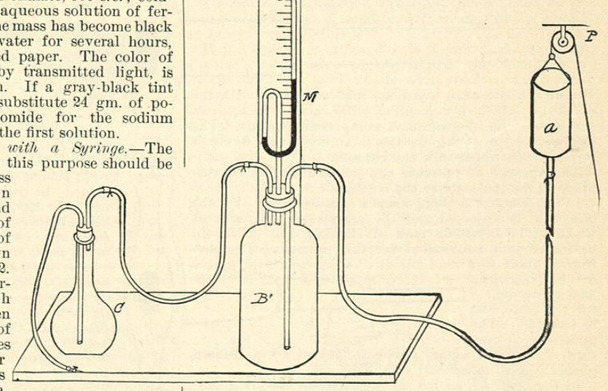


FIG. 2695.—Water-pressure Injecting Apparatus.

In Fig. 2693 is shown a simple form of a mercurial apparatus. The bottle *A* is filled two-thirds full with the injecting mass, which flows through the rubber tube *i*. The bottle *A* is connected with the bottle *B*, which is partially filled with mercury. The tube *d*, with a funnel end *e*, is fitted air-tight into the cork *B* (all joints must be air-tight). Upon pouring mercury into the tube *d*, it flows down into *B*, compressing the air, which in turn compresses the air in *A*, and forces the injecting mass out through *i*.

In Fig. 2694 is shown the more satisfactory apparatus of Ludwig. It consists of two Wolff's bottles, *a*, which

contains the mercury, and *b*, into which, owing to the difference in the level of the two bottles, the mercury flows. This compresses the air in *b*, which, acting on

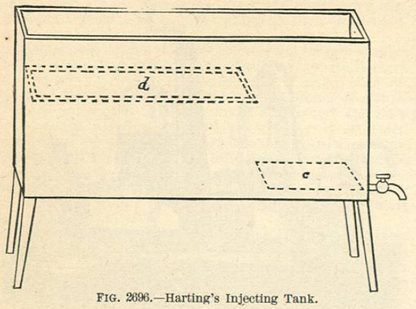
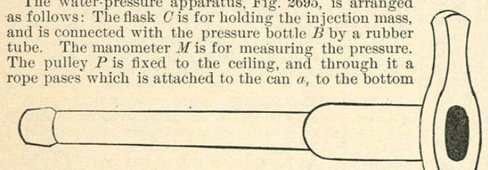


FIG. 2696.—Harting's Injecting Tank.

the injecting fluid in *c*, causes the latter to flow out through the tube *g*. The pressure bottle *a* rests on a wooden support, which is raised by the screw *d*, until sufficient pressure is obtained. The mercurial manometer attached to the bottle *c* is for indicating the amount of pressure. If a gelatin mass is employed, the bottle *c* must be placed in a vessel of warm water.

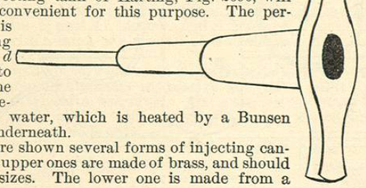
The water-pressure apparatus, Fig. 2695, is arranged as follows: The flask *C* is for holding the injection mass, and is connected with the pressure bottle *B* by a rubber tube. The manometer *M* is for measuring the pressure. The pulley *P* is fixed to the ceiling, and through it a rope pases which is attached to the can *a*, to the bottom



of which is attached a rubber tube connected with the bottle *B*. The can *a* is filled with water which, upon raising the can, flows into *B*, compressing the air. The compressed air acting on the injecting mass, forces it through the rubber tube and cannula.

The amount of pressure can be regulated by the distance of the can *a* above the bottle *B*.

In using warm-flowing masses it is necessary that the object to be injected and the masses should be kept warm. The injecting tank of Harting, Fig. 2696, will be found very convenient for this purpose. The perforated shelf *c* is for the injecting flasks, the shelf *d* for the object to be injected. The tank is filled one-third full with water, which is heated by a Bunsen burner placed underneath.



In Fig. 2697 are shown several forms of injecting cannulæ. The two upper ones are made of brass, and should be of different sizes. The lower one is made from a

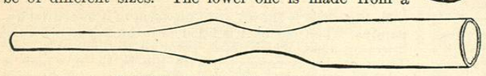


FIG. 2697.—Injecting Cannulæ.

piece of glass tubing. Several stopcocks, Fig. 2699, fitted to the brass cannulæ, are to be provided. Also a dozen or more serres fines (Fig. 2698), which are used for clamping leaking vessels.

Injecting an Entire Animal.—The animal—a rabbit or guinea-pig—is rendered insensible with chloroform. The thorax is opened by making an incision through the skin over the sternum and cutting out a small window over the base of the heart. The pericardium is opened, the heart pulled out and its apex cut off, the animal being allowed to bleed to death. The aorta is exposed, care being taken not to injure the vessels; a cannula is introduced (Fig. 2697) through the left ventricle into the aorta and fastened firmly with a ligature, the ends of the latter being tied around the arms of the cannula, or around the constriction of the glass one, if it be used. If a glass cannula be used, a piece of rubber tubing is attached to the large end and the whole filled with a three-fourths-per-cent. salt solution. The latter is retained by placing a spring clip upon the end of the rubber tube. The cannula is then introduced as above and tied.

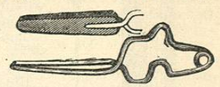


FIG. 2698.—Serres Fines.

The vessels are now washed out with a three-fourths-per-cent. salt solution. This is accomplished as follows: The animal is placed upon the shelf, *d*, of the injecting tank, Fig. 2696, the water in which has been heated by a Bunsen burner placed underneath. A flask, filled two-thirds with salt solution, is placed on the shelf *c*, and connected with the pressure bottle *B*, Fig. 2695. A piece of rubber tubing attached to a stopcock is connected with the delivery tube of the flask. The pressure is now applied by raising the can *a*, Fig. 2695, until the manometer registers about 50 mm. Now the stopcock is opened and all the air allowed to escape; then the stopcock is connected with the cannula introduced into the aorta. The salt solution is allowed to run through the vessels until it escapes perfectly clear from the right side of the heart.

The stopcock is now closed and disconnected from the cannula, and a flask containing the injecting mass is substituted for the one containing the salt solution. The stopcock is opened, and as soon as the injecting mass flows free from air bubbles the stopcock is connected with the cannula as above. The injection is continued until the mass flows from the right side of the heart, and is allowed to run for from twenty minutes to half an hour. A ligature is then tied around the vessels connected with the right side of the heart, and the injection is continued, the pressure being gradually increased to not over 100 mm., until the vascular system is filled, which can be judged from the color of the ears, lips, etc. When the injection is completed the vessels at the base of the heart are ligated, the stopcock is disconnected, and the animal put in a cold place until the gelatin has set. The organs and parts wanted are then removed and hardened in alcohol.

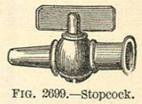


FIG. 2699.—Stopcock.

For injecting a single organ—the kidney—the animal is killed by bleeding, the abdominal cavity is opened, and the intestines are pushed aside. The renal artery is separated from its surroundings with forceps; then the renal vein in the same way. The artery is opened by a valvular opening, a cannula is inserted and firmly tied. An opening is then made in the vein. The organ is washed out with salt solution, which is followed by the injecting mass. The constant-pressure apparatus is to be used. After the injection is completed a ligature is passed around both vessels close to the organ, which is removed and hardened in alcohol.

For injecting pathological new formations, cold-flowing masses are to be preferred. The pressure employed

must be moderate on account of the thinness of the walls of the blood-vessels. The serres fines will be in great demand for checking the leakage from the numerous lateral branches of the blood-vessels.

Double Injections.—Double injections are best made by injecting the artery and vein at the same time, with different colored masses—carmine for the artery, blue for the vein.

FIG. 2700.—Pipette.

A T-tube is attached to the outlet tube of the pressure bottle *B*, Fig. 2695, and from each arm a rubber tube is carried to flasks containing the injecting masses. These are then connected with the cannulæ fastened in the artery and vein. By this means both sets of vessels are filled at the same time and under the same pressure. The pressure at first must be low, so that the arteries and veins shall be completely filled before either mass passes into the capillaries. The pressure is finally increased, and each set of capillaries will be filled with its proper mass.

Injection of Lymphatics.—For injecting lymphatics the puncture method is the one chiefly employed. The puncture can be made from the cavity of a blood-vessel into the surrounding tissue, with the idea that a lymph vessel may be opened and that thus both sets of vessels may be injected. Or it may be made into the tissue and the injection made from this. The puncture must not be made at random, but in the direction in which small lymphatics are supposed to exist. The injection is made with a syringe fitted to the small cannula used for puncturing, and cold-flowing masses are to be used. If the extravasation is small and remains so, the injection is

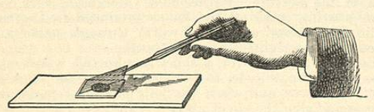


FIG. 2701.—Placing the Cover Glass in Position.

likely to succeed; but if the extravasation grows rapidly, the procedure is a failure and a new attempt is to be made.

METHODS OF MOUNTING.—Specimens, after being duly prepared, are mounted on glass slides for study and preservation. The usual form of slide is known as the English. It is made of plate glass, measuring one by three inches, with the edges ground smooth. For covering the specimen thin pieces of glass, either circular or square in form, and of a size suitable to the specimen, are used. These are known as cover glasses.

The slides and covers, as received from the dealers, are generally covered with an oily material, making it difficult to clean them. This material may be removed in the following manner: Soak the slides and covers for twenty-four hours in a mixture of potassium bichromate, 960 gm.; sulphuric acid, 88 c.c.; water, 738 c.c.; then wash well in water. Wipe the slides dry with a clean linen cloth; place the cover glasses in alcohol until needed. Slides and covers that have been used are treated as follows: Put them into a mixture of equal parts of alcohol and hydrochloric acid, and, after a few days into the bichromate solution and treat them as new ones. Scrape the slides free of all balsam and put them in the bichromate solution.

In some cases, when we have an exceedingly delicate specimen, it is necessary to protect it from the pressure of the cover-glass. This can be accomplished by placing a hair under the cover, or we may make a shallow cell by painting a ring of some cement on the slide (see Fig. 2703). Again, we may have a thick specimen, or we may wish to use an aqueous mounting medium. In these cases thin glass cells are to be cemented to the slide, the specimen placed in them, and the mounting media added until the cell is filled; the cover-glass is then applied.

Mounting in Glycerin.—The specimens are either soaked in a small dish of glycerin until transparent, and then transferred to the slide; or they are placed on the slide from water, the excess of the latter being absorbed with filter paper or sucked up with a pipette (Fig. 2700), and a drop or two of glycerin is placed on the specimen, and the whole covered with a cover glass. In covering a specimen, care must be taken not to include air bubbles. If the cover glass is placed in position in the manner shown in Fig. 2701, any that may be present will be forced out with the excess of glycerin. The cover being in position, the superfluous glycerin is to be removed and the cover cemented down. All traces of glycerin must be removed, or the cement will not adhere to the glass.

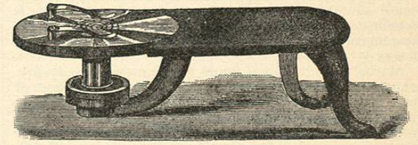


FIG. 2702.—Turn-table.

This is accomplished by washing out a camel's-hair brush in alcohol, absorbing the greater part of the alcohol by wiping the brush on filter paper until it is only moist, and then going over the slide in a systematic manner with the brush until all the glycerin is removed. A brush simply moistened with alcohol will not suck up the traces of glycerin; it must be well washed in the alcohol and dried very frequently.

If the cover is a square one, it is cemented by passing a camel's-hair brush along the edge of the cover, whereby the latter as well as the slide receives a stripe of cement. Circular covers are easily cemented by aid of the turn-table (Fig. 2702). Concentric circles engraved on the surface of the table, according to the size of the covers, show where the brush is to be applied. The brush is to be held perpendicularly, and is filled with a cement of such a consistence that it will flow—it is not to be painted—on the cover and slide while the table is rotated. The manner of holding the brush and rotating the table is shown in Fig. 2703.

The glycerin penetrates the specimen, rendering it transparent, but on account of its high index of refraction, in some cases it renders the specimen too transparent, thereby concealing some of the minute structure.

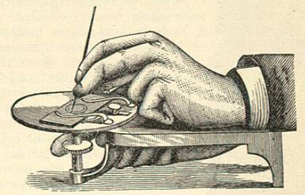


FIG. 2703.—Cementing Covers.

This objection can be overcome by mixing the glycerin with various proportions of water. As a rule, pure glycerin is to be used for mounting.

For cementing covers there are innumerable cements. Those that have stood the test of time are the following:

Asphalt Varnish. This can be procured from any painter's supply store, and is to be diluted with turpentine to the required consistency. Kitton recommends asphalt dissolved in benzol; to this solution he adds a little gold size.

Gold Size. What is known in commerce as Japan gold size is to be used. This sets very quickly, and may be used uncolored or colored with any of the mineral pigments.

Shellac Varnish. Shellac should be dissolved in alcohol, so as to obtain a thick solution. The addition of twenty drops of castor oil to each ounce of the solution has a tendency to render it less brittle. This is an excellent cement for specimens that are to be examined with oil-immersion lenses, as it is not attacked by the immersion fluid.

Gelatin. If the covers are first painted around with a warm, strong solution of gelatin in water, allowed to dry, and then painted with a saturated solution of potassium bichromate, an insoluble cement is formed which adheres firmly to the glass, and by the absorption of a small amount of glycerin that may be on the slide, is rendered semi-elastic. This is also a good cement for specimens to be examined by homogeneous immersion lenses.

Marine Glue. This is found in commerce already prepared. It is soluble in ether, naphtha, or solution of potash. It is used chiefly for making shallow cells, and cementing glass cells to the slide.

Mounting in Canada Balsam.—This process is divided into three steps: (*a*) dehydrating; (*b*) clearing; (*c*) enclosing in balsam.

(*a*) Dehydrating. As water is not miscible with the reagents used for clearing, or with the Canada balsam, it is to be removed. This is accomplished by soaking in absolute alcohol. The specimen is first washed in ordinary alcohol to remove the surplus of water, and then placed in the absolute alcohol for from three to five minutes.

(*b*) Clearing. For this purpose we must use a reagent that is miscible with both alcohol and balsam. The specimen is to be carefully removed from the alcohol with a spatula, the adhering fluid removed by filter paper, and the section floated off into the clearing medium. If the section is perfectly anhydrous it will float on this, and in the course of a few moments become transparent and sink to the bottom.

For clearing we use chiefly the essential oils. Of the most commonly employed are the oils of cloves, cedar, anise, origanum cretici, bergamot, and the white oil of thyme. Carbolic acid, creosote, xylol, benzol, turpentine, and chloroform are also used. Old samples of wood creosote, xylol, benzol, chloroform, oil of origanum or thyme, are to be used for specimens embedded in celloidin, when we wish to retain the embedding material.

FIG. 2704.—Balsam Bottle.

It is sometimes best to clear large or delicate specimens on the slide. First float the sections on the slide, and absorb the surplus alcohol with filter paper; then drop the clearing reagent on the specimen and place the slide under a bell-jar until the specimen is transparent; absorb the surplus of the clearing reagent, and add the balsam and cover.

(*c*) Enclosing in Balsam. The transparent section is removed from the clearing reagent with a spatula (Fig. 2687), and floated upon a slide, care being taken that it lies perfectly flat and that it is not wrinkled or folded upon itself. The excess of the clearing reagent is sucked up with a pipette (Fig. 2700), or soaked up with filter paper. A drop of balsam is placed upon the specimen, and the cover glass laid on as in glycerin mountings (Fig. 2701). As the balsam hardens in time, there is no need of cementing the cover. In all these manipulations great care must be taken to have the slides, covers, and all instruments perfectly dry—any moisture will cause a precipitation of the balsam, and thus cause an opacity of the specimen.

Canada balsam as found in commerce should never be used. The commercial balsam is heated on a sand bath until all volatile matter is driven off, and it becomes brittle when cold. This hard balsam is then dissolved in xylol, benzol, or oil of cedar, enough of the solvent being used to give the required consistence. These solutions, with the exception of that in oil of cedar, set quickly. The solutions of balsam are to be kept in capped bottles (Fig. 2704), or in tin tubes, such as are used for the oil colors of the artist.

Hard balsam is also used for mounting, especially sections of hard bone and teeth, in which we wish to demonstrate the lacunæ. The process is as follows: A bit of hard balsam is placed in the centre of a slide and warmed gently over the flame of a lamp, care being taken not to let it boil, or bubbles will be formed. When melted, the specimen is plunged into it and covered quickly, and the slide is placed on a cold surface, which sets the balsam immediately and prevents its entering any of the lacunæ, which, being filled with air, show as dark spaces.

Instead of Canada balsam, dammar varnish and other preparations of dammar may be used. Gum dammar dissolved in xylol or oil of cedar is now generally used in place of the above mixtures.

Glycerin Jelly.—Of the numerous published formulæ for this medium, that of Kaiser is the best. He soaks one part, by weight, of French gelatin for two hours in six parts, by weight, of distilled water; then adds seven parts of glycerin and 1 gm. of carbolic acid for every 100 gm. of the mixture; warms on a water bath, with constant stirring, until all the flakes produced by the carbolic acid disappear; filters warm through paper and preserves in a tightly stoppered bottle.

Soak the sections for a short time in this warm mixture, and then transfer to a melted drop of the same on a slide. Cover, and when the jelly has set, remove any excess and ring the cover glass.

For Weigert's hæmatoxylin method, and its modifications, for the central nervous system; Golgi's methods of impregnation with silver chromate; Nissl's method for staining nerve cells; Ehrlich's method of staining nerve fibres with methylene blue, and its modifications; Marchi's method for staining degenerated nerve cells; and Weigert's and other neuroglia stains—see *Brain, Histology of*, Vol. II., pp. 322–331.

For further details of histological methods consult "The Microtomist's Vade-Mecum," Bolles Lee; "Pathological Technique," Mallory and Wright; *Zeitschrift für wissenschaftliche Mikroskopie.* *George Cornell Freeborn.*

HODGKIN'S DISEASE.—(Synonyms: Pseudo-leukæmia, lymphadenoma, anæmia lymphatica, adenia, lymphosarcoma, malignant lymphoma, lymphomatosis.)

DEFINITION.—A disease characterized by a progressive enlargement of the lymph glands and often of the spleen, a gradually developing anæmia, and secondary growths of lymphoid tissue in the liver, spleen, kidney, alimentary tract, bone marrow, and other structures of the body.

The affection differs from leukæmia chiefly in the absence of a marked leucocytosis.

ETIOLOGY.—The disease occurs most frequently in males under forty years of age. The exact etiology of Hodgkin's disease is as obscure as that of leukæmia. The fact that the disease often follows inflammatory processes and runs a rapid febrile course suggests an infectious origin. Bacteriologic examination of the blood and lymph glands has revealed micro-organisms in over fifteen cases. The Staphylococcus pyogenes aureus, the Streptococcus pyogenes, the pneumococcus of Fraenkel,

and unidentified bacilli have been cultivated. Roux and Lannois claim to have reproduced the disease by injecting animals with a coccus cultivated by them from the blood and lymph glands of a case. Delbet claims the same for a bacillus. The multiplicity of organisms found suggests that all are probably accidental.

PATHOLOGY.—The most important morbid changes in Hodgkin's disease are hyperplasia of the lymph glands, enlargement of the spleen, and the presence of lymphoid growths in the liver, bone marrow, and intestinal tract.

Lymph Glands.—As a rule, the lymph glands show the greatest change. The glands involved in order of greatest extent and frequency are the cervical, axillary, inguinal, retroperitoneal, bronchial, mediastinal, and mesenteric. In addition, the popliteal and epitrochlear glands may be enlarged. The lymphatic structures of the mouth and alimentary tract are relatively infrequently involved. Lymphoid nodules in the liver are often observed. Microscopic collections of lymphoid cells may be found in various organs that present no abnormal naked-eye appearance. The glands of the neck are usually largest. They vary in size from a hen's egg to minute nodules; unless crowded together, the glands are freely movable, and not attached to the skin. Glandular enlargement is usually symmetrical, although one side may be more extensively involved. Rarely the process is confined to one side. The natural shape of the enlarged gland is round or oval. Pressure may produce many alterations in form. A thin capsule surrounds each gland, and when not crowded together, loose connective tissue unites them in chains. The enlarged glands may be soft or hard. On section, if no secondary changes, such as hemorrhage, have occurred, the surface presents a soft mass, grayish-white in color, with a faint tinge of red or yellow. In the soft variety the cut surface bulges beyond the capsule, and a turbid fluid, made up largely of lymphoid cells, may easily be expressed. No stroma is apparent. The hard variety possesses a relatively greater reticulum than a normal gland. Little or no fluid exudes from its cut surface. Enlargement of the thoracic glands may compress the bronchi or trachea. Thrombosis of large thoracic veins may occur from pressure. The heart and lungs may be displaced by enlarged glands. Lymphoid growths may occur in the lungs; rarely the aorta, thoracic duct, and œsophagus are compressed by the posterior mediastinal glands. The recurrent laryngeal nerve may be injured. In the abdomen the retroperitoneal glands are most frequently involved; the mesenteric seldom reach a large size. Displacements of the uterus and compression of the ureters have resulted from growth of the pelvic glands.

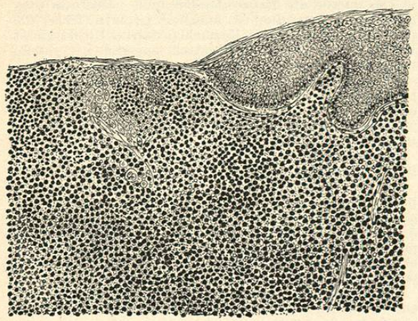


FIG. 2705.—Adenoid Growth in the Skin. (Author's case of Hodgkin's disease.)

Histology of the Lymph Glands.—The microscope shows hyperplasia of all the elements of a lymph gland. In the soft variety the increase in the lymphoid cells is relatively much more marked than that of the connective tissue. Cells presenting the appearance of ordinary lymphocytes are crowded together and held in position by an exceedingly fine network of fibrils. In the hard variety the parenchyma is likewise made up of lymph cells but the connective-tissue increase predominates. Widely varying grades of sclerosis may exist in the different cases and in the various groups of glands in the same case. The gross appearance and histologic change in the lymph glands are practically identical with those in lymphatic leukæmia.

Spleen.—Hyperplasia of the spleen exists in eighty per cent. of all cases. In the splenic variety of the disease the hyperplasia may be enormous, the organ at times filling the greater part of the left half of the abdominal cavity. In the majority of cases of the usual type of the disease, the enlargement is moderate in degree, the spleen rarely exceeding thirty ounces in weight. The organ is firm and its original shape is preserved. Local thickening of the capsule due to perisplenitis may exist. The enlargement may be a true hypertrophy. In about seventy-five per cent. of the cases in which the spleen is enlarged, however, lymphomata are found varying in size and number. The histologic structure of the spleen approaches more closely than normal the picture of a lymph gland. As a rule, the pulp is relatively more increased than the lymph sinuses and reticular tissue. Even in the hard variety of splenic enlargement the increase in the lymphocytes predominates. Sclerosis of the Malpighian bodies is now and then found. Degenerative changes in the lymphoid cells do not occur, as a rule.

Liver.—The organ is often slightly enlarged. Lymphoid growths varying in size from a minute point to a hazelnut invade the liver structure. They develop in the interlobular spaces, and may grow between the liver cells.

Bone Marrow.—A fœtal condition of bone marrow is usually present, similar to that in pernicious anæmia. Adenoid growths are found in the medulla.

Alimentary Tract.—Adenoid growths in the digestive canal seldom attain large size. They may be scattered along its entire length. The tonsils, glands at the base of the tongue, Peyer's patches, and solitary follicles may become hyperplastic. Ulceration of adenoid growths in the stomach may take place. Lymphomata may develop in the kidney, lung, testicle, thymus and thyroid glands. They are sometimes found in the dura; now and then they involve the cranial and peripheral nerves. Lymphomatous growths are practically never found in the brain and spinal cord. Adenoid growths have been found in the heart. In rare cases the skin is the seat of adenoid growths. Retrograde metamorphoses in the new-formed tissue rarely take place in true Hodgkin's disease. When marked changes are present, the condition is usually tuberculosis or mixed infection.

SYMPTOMS.—In the majority of cases Hodgkin's disease begins insidiously and progresses gradually to a fatal termination. In rare instances, however, the onset is severe; and its course rapid. The important symptoms of the disease are progressive enlargement of the lymphatic glands, a gradually developing anæmia, associated with a relative increase in the lymphocytes, enlargement of the spleen, loss in strength and weight, irregular temperature, œdema, and grave cachexia.

Lymph Glands.—As a rule, the earliest symptom noted by the patient is enlargement of the lymph glands superficially located. In most instances the cervical glands are the first involved; rarely the inguinal or the axillary glands are the first to become affected. A few cases have been described in which anæmia, loss of weight and strength, apparently preceded glandular enlargement. At times the deep thoracic or abdominal glands are diseased first, producing early pressure symptoms, such as pain in the chest, cough, dyspnœa, or pain in the abdomen or legs, with œdema. If the cervical group is primarily affected, the enlargement is usually confined to one