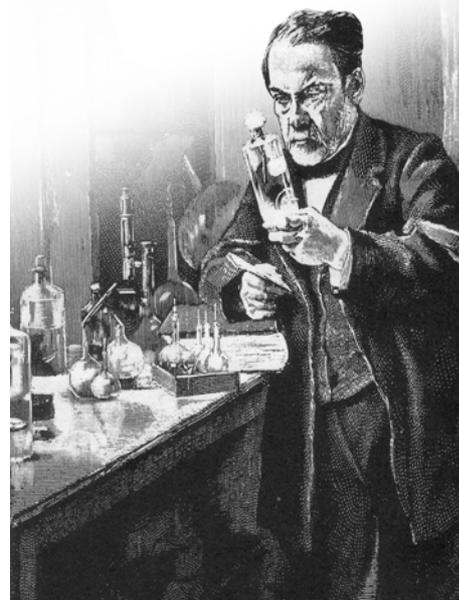


# The Microscope

The microscope (Greek: "small-viewer") and the telescope (Greek: "distance-viewer") were invented in or around the same period. About 1590 a small boy by the name of Zacharias Jansen, son of a spectacles manufacturer, was playing with two old curved-shaped lenses and discovered that they had a magnifying effect by holding them a certain distance apart. His father then constructed tubes with such glasses, attached a flea on wire to the front of the tube and sold them as flea glasses, causing sheer enjoyment among the people at the time.

In 1665, the Englishman Robert Hooke ground a lens with a 30x magnifying factor with which he discovered the cells in a piece of cork and constructed the microscopes consisting of several lenses. In about 1685, the Dutchman Antoni van Leeuwenhoek commenced scientific examination on a variety of objects in his immediate vicinity with the use of very small self-ground lenses with magnifying factors of up to 270x. This was the first step towards the discovery of the enormously large and manifold world of the small and smallest things.

Optical microscopes had their first heyday in the field of science when, as from the year 1870, Carl Zeiss and Ernst Abbé began manufacturing equipment with a quality never obtained up to that time. The design of the AstroMedia assembly kit is based on the structural appearance of the microscopes of this period. Today, the fields of medicine, biology, geology, material science and practically all spheres of natural science without the use of microscopes would be simply inconceivable. Much of the major scientific progress of our times is owed to this optical equipment. Modern optical microscopes have magnification factors of up to 1500x. Electron microscopes which function with electron beams instead of with light can even penetrate the atomic range.



## Assembly instructions for the microscope

**Contents of this assembly kit:** 4 printed and punched cardboard plates, 3 lenses (focal width +30mm), 1 rubber ring, 4 x 8 cm self-adhesive mirror foil and 2 sections of black paper.

**Before you start assembling, read each section to the end.**

The assembly itself is not difficult because all parts are pre-punched to fit exactly together and all folds are pre-grooved.

For the assembly, you will need a sharp knife in order to cut out the punched parts accurately from the cardboard plate, a thin rod to help when gluing (a pencil or a Chinese chopstick), a black felt-tip pen and a good all-purpose glue. A solvent-containing all-purpose glue is more suitable than a so-called non-solvent glue on a water basis because it does not cause any waviness of the cardboard.

Each part is marked with a part number ([A1], [A2], [B1], [B2] etc.) and with its name. The letter of the part number is the same within an assembly group. Remove only those parts from the cardboard plate that you require for assembly, or write the number of the part on its rear side.

"Fold to the rear" means: I fold along the groove away from me when I look onto the printed side. "Fold to the front" means: I fold towards myself.

Getting the glued spots to dry quicker: put a suitably thick layer of glue onto one of the sides to be glued, and then press the sides together so that the glue spreads out on both sides, and then take the parts off each other again. Then blow 2 or 3 times over the surfaces and press the parts together again, making sure of a good fit – the glue holds immediately. Do not use this method when you are sticking on the lenses.

With your AstroMedia-microscope, you have acquired a very nice and valuable piece of equipment that really functions as well. We wish you lots of fun with the assembly.

### Base plate and microscope table

**Step 1:** Detach the upper side and lower side of the base plate [A1] and [A2] from the cardboard plate. When you have removed the punched rectangle and the two squares from the upper side [A1], put a film of glue onto the rear side and place it exactly down onto the lower side [A2] and make sure that it fits properly. It is important that the base plate is thoroughly flat. For drying purposes, place it on a table surface and use books as weights.

**Step 2:** In the same way, glue the upper side and the lower side of the table [A3] and [A4] against each other after you have removed the cardboard residuals from the punched openings and after you have folded forwards the 3 tongues on the rectangular section. The tongues are **not** glued against each other. Ensure that the table plate is thoroughly flat.

**Step 3:** Glue the two table legs [A5] and [A6] together to form square tubes. On one end, fold the small triangular tongues outwards and glue the legs with these tongues into the square sections on the lower side of the table. The tips of the tongues slide exactly up to the tips of the two squares. Make sure that both legs are standing vertical.

**Step 4:** Push the round table leg collars 1 and 2 [A7] and [A8] with the non-printed side in the lead over the table legs and glue them solidly on the table lower side. The gluing tongues of the table legs are covered in the process.

**Step 5:** Now, push the table leg collars 3 and 4 [A9] and [A10] with the printed side in the lead over the table legs, then fold the triangular tongues at the table leg ends outwards and glue the two legs as in Step 3 into the square recesses of the base plate. After drying, push the collars down fully and, as in Step 4, glue them solidly on the base plate. In this case also, the two legs should stand exactly vertical on the base plate.

### Microscope Column

**Step 6:** Detach the column [B1] from the cardboard plate and remove the cardboard from the punched rectangular slots. The punched round disk [B2] in the lower part of the column is the central turning axle for the rear illuminating mirror, the remaining hole is the axle bearing.

**Step 7:** Glue the central turning axle [B2] full surface onto the centre of the internal turning axle [B3]. Make sure that there is no glue at the rims and let the glued section dry well.

**Step 8:** Place the axle, from the rear side, onto the axle bearing in the column [B1]. The central turning axle [B2] fits exactly into the axle bearing and flushes on the outside with the surface of the column. Now glue the outer turning axle of the rear illuminating mirror [B4] from the outside and flat onto the central turning axle [B2]. So that it has an exact seating on the middle, you can put a needle through the middles of both disks before gluing and then push the disks towards each other. **Important: No glue shall be allowed to pour into the axle bearing – otherwise the axle and the rear illuminating mirror cannot turn later as required.** After drying, make sure that the axle can turn by holding with your thumb and first finger from the outside and on the middle of the axle and turning it.

**Step 9:** Now fold the column to form a rectangular tube which gets somewhat narrow on its upper end and is closed off on the top and below with a cover. All folds go to the rear, only the middle fold at the two narrow sides of the tube go to the front.

**Step 10:** Now fold the gluing tongues of the internal reinforcement of the column [B5] to the rear and glue the longer of the two gluing tongues from the inside onto the front side of the column, approximately at that location where the microscope table will be glued on at the outside, meaning, a good centimetre below the two narrow rectangular slots. The printed side of the internal reinforcement then points towards the upper end of the column.

**Step 11:** Now glue the two short gluing tongues of the internal reinforcement solidly to the side parts of the column and then glue the wider part of the column to form a rectangular tube where, at the same time, the last tongue of the internal reinforcement is glued in during the process. When you press the long gluing tongue of the column, you can produce a back pressure from the inside by using a wooden stick (e.g., a pencil).

**Step 12:** Glue the two narrow sides of the column, first with the short middle part solidly to the tongues lying underneath, as a result of which the slants at the column occur, and then the rest. The wooden stick is helpful here also.

**Step 13:** Glue the bottom cover solidly, and the tongues in the interior of the column disappear in the process. Press the column while drying with the foot onto a flat surface in order to make sure that the bottom glues into position at a rectangle as required.

**Step 14:** Finally, glue the cover onto the tongues at the upper rim of the column and then glue solidly the ornamental tongues of the cover outside at the column.

**Step 15:** Detach the two insert pockets for the preparation holder [B6] and [B7] from the cardboard plate and fold each of the two internal grooves forwards, the two external ones to the rear. Into each of the two slots on the front side of the column, push an insert pocket in fully and glue the swung external parts solidly on the column.

**Step 16:** Place the column without glue into the rectangular recess of the base plate and push it simultaneously into the corresponding recess in the table, where the ornamental tongues of the lower and upper sides of the table lie smoothly against the walls of the column. Check and make sure that the table legs and the column are in parallel to each other and are standing vertically on the base plate. The recess in the base plate has a little clearance so that you can move the column a little as required.

**Step 17:** Then glue the column into the recess of the base plate and, at the same time, to the two long middle ornamental tongues of the table. Wait for this gluing to be dry, and then glue solidly each of the 2 lateral ornamental tongues of the table.

**Step 18:** Finally, fold the bottom corner strips [B8], [B9], [B10] and [B11] forwards and glue as connecting pieces into the angle between base plate and the four sides of the column. The microscope frame is now completed.

## Rear illumination mirror

*This mirror can be swivelled by 2 axes and is secured underneath the table at the front side of the column. It illuminates the preparations from underneath through the round opening in the table.*

**Step 19:** Fold the two joint parts for the rear illumination mirror [C1] and [C2], the somewhat wider half-round tongue forwards, and glue the two joint parts with the non-printed side to each other. The half-round tongues are not glued together.

**Step 20:** Detach the axle-disks [C3] and [C4] from the arm parts for the rear illumination mirror [C5] and [C6] and glue them exactly onto each other so that they form a round block. Then, glue this axle block exactly in the

centre onto the marked section of the mirror joint [C1/C2]. Wipe away superfluous glue and allow the whole object to dry well as required.

**Step 21:** Glue the two arm parts [C5] and [C6] against each other, after you have folded the half-round tongues forward. The holes at the end of the arm form the axle bearing and must match exactly. Ensure good drying. Then, press the joint with the axle block into the axle bearing and make sure that it can turn against the arm. Move it a few times to each side and ensure that the surface of the axle block remains flushed with the surface of the axle bearing.

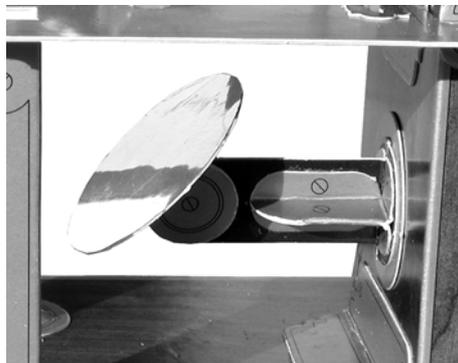
**Step 22:** Glue the two joint disks [C7] and [C8] first to each other and, after drying, onto the surface of the axle block which looks out of the axle bearing of the arm. In this way, arm and joint are joined together solidly and retain turning movement. **Important: Be sure that no glue gets into the axle bearing or onto the arm because the joint will be blocked in this case.** After drying, check and make sure that the joint has good turning movement.

**Step 23:** Fold the two mirror supports [C9] and [C10] in the middle to the rear and the tongues at the sides as well as the quarter-circle tongues at the ends forward. Then glue the two longitudinal elements in the middle against each other.

**Step 24:** Without glue at first, place the one support with the lateral tongues onto one side of the mirror arm and press the quarter-circle tongues against the half-round tongue of the arm in such a way that they also form a half-circle there. Glue the support solidly in that position. Do exactly the same with the other support on the other side of the arm.

**Step 25:** Bend apart the two half-round tongues at the joint and glue them in the middle onto the marked location of the rear illumination mirror [C11]. Then glue one half = 4 x 4 cm of the enclosed mirror foil onto the disk of the rear illumination mirror and cut off the projecting rim.

**Step 26:** Glue the mirror arm with its two half-round tongues onto the revolving disk of the mirror axle which can be seen on the front side of the column under the table. Make sure that, after drying, it can turn as required.



## Incident light mirror

*The incident light mirror has a movable arm whose joints have the same structure as the rear illuminating mirror. It is glued to one of the two coverings for the holes over the table legs and illuminates the preparations from above.*

**Step 27:** Detach the axle disks [D1] and [D2] from the two parts of the upper joint [D3] and [D4] and glue them together to form an axle block as described in Step 20.

**Step 28:** Fold the somewhat wider half-round tongue of the upper joint [D3] and [D4] forwards and glue the two joint halves onto each other. Make sure that the holes of the axle bearing coincide exactly with each other. The half-round tongues are **not** glued together.

**Step 29:** Glue the two parts of the upper arm [D5] and [D6] with the non-printed side onto each other so that they flush, and the axle block [D1/D2] in the middle onto the marked location at one end of the arm. After drying, press the upper joint [D3/D4] with its axle bearing onto the axle block and make sure that it can turn as required. Then glue the two joint disks [D7] and [D8] first onto each other and then onto the axle block and, after drying, make sure that the joint has turning movement.

**Step 30:** Of the two parts of the lower joint [D9] and [D10], fold the half-round tongue forwards and glue the rest of the two joint halves against each other. The half-round tongues are **not** glued together.

**Step 31:** Detach the 4 axle disks [D11], [D12], [D13] and [D14] from the two parts of the lower arm [D15] and [D16], and glue 2 each to one axle block together. Then, glue one of the in the middle onto the marked location of the lower joint [D9/D10] and the other to the free end of the upper arm [D5/D6].

**Step 32:** Glue the two parts of the lower arm [D15] and [D16] together. It has an axle bearing at each end. After drying, insert one of them onto the axle block at the lower joint [D9/D10] and the other onto the axle block at the free end of the upper arm [D5+6]. Glue the joint disks [D17] and [D18] as well as [D19] and [D20] together and cover the two axles in the process. Make sure that all joints have good turning movement after drying.

**Step 33:** At the one joint, bend the two half-round tongues apart and glue them in the middle onto the marked location of the incident light mirror [21]. Then, glue onto this the rest of the mirror foil and cut off the projecting rim.

**Step 34:** The coverings for the holes over the table legs consist of a round sleeve which closes off with a disk. Fold the two rectangular tongues of the sleeve [22], at whose end a half-round tongue is connected, forwards and draw the wider central part over an edge so

that it rolls in somewhat and allows itself to bend to a round sleeve. The two rectangular tongues with their respective surfaces are now lying on each other and form the diameter of the sleeve (see sketch above, right). In this position, glue the tongues onto each other.

**Step 35:** After this, fold apart the two half-round tongues and glue them blunt onto the rim of the sleeve and simultaneously onto the rear side of the cover disk [23]. Then, glue the lower joint of the incident light mirror with its two half-round tongues to the cover disk.

**Step 36:** Proceed in the same way with the sleeve [D24] and the cover disk [D25] as in the case of the other sleeve. Now you can insert at random the incident light mirror into one of the openings over the table legs and close the other with the covering.

## Preparation holder

*With the two movable arms provided with an elastic spring effect, not only flat preparations but also preparations up to a several centimetres high can be held and observed with incident light.*

**Step 37:** Glue the 2 preparation holders from the parts [E1] and [E2] as well as [E3] and [E4] together. With the hook-shaped tip at one end, you can click them into the slots of the two insert pockets at the front at the microscope holder.

**Step 38:** Glue the two hole reinforcements [E5] and [E6] over the two rectangular holes in the table.

**Step 39:** Draw the enclosed rubber ring, up to a half of it, through one of the two holes. A bent paper clip with a narrow U-shaped end can be very helpful here. Take one of the preparation holders and insert it through the loop of the rubber ring and push it, with the end that hold the hook tip below, fully into the insert pocket. Then draw the rubber ring tightly under the table and route it through the other hole in the table again upwards. Pull it out far, push the other preparation holder through it and hang it also into its insert pocket.

## Microscope tube with optical system

The optical unit of the microscope consists of the main tube with the eyepiece lens, two lenses and the body tube with the body lens. As the three lenses are identical, it makes no difference where you use them. **Important: Never put glue on the lens but only on the cardboard so that no glue gets accidentally onto the lens where you look through, and make sure that the lens is free from dust etc.**

**Step 40:** Glue the main tube [F1] and the small body tube [F2] together in such a way that each of them forms a hexagonal tube. Fold the tongues at the body tube to the outside.

**Step 41:** Remove the inner punched hexagon from the body tube holder [F3] and fold the swung ornamental tongues to the rear. Insert the body tube from the rear through the hexagonal cut-out and solidly glue its tongues on the non-printed rear side of the body tube holder. During drying, press the tongues onto a flat surface in order to make sure that the body tube is located vertically in its holder. Blacken out the hexagonal rear side of the body tube holder and/or the tongues glued to

it with a felt pen. In this way, the last residuals of scattered light are avoided.

**Step 42:** Remove the small disk on the body lens holder [F4] and blacken out here also the non-printed side of the hexagon. Over the round hole, and exactly on this side, glue one of the lenses into position with the curved side facing downwards. As the lens on this side has a peripheral ligament, only this is glued to the cardboard.

**Step 43:** Glue the body lens holder with the lens to the end of the body tube.

**Step 44:** Form the smaller of the two black paper sections to a tube of 3 cm in height and insert inside into the body tube. A small drip of glue is sufficient to maintain the position.

**Step 45:** Remove the punched disk from the interior of the eyepiece lens holder [F5], fold the 6 rectangular tongues forward and blacken the non-printed rear side of the hexagon. Glue a lens onto the blackened side exactly over the round hole, this time with the flat side. Do not put too much glue near the hole because it can flow over into the viewing field of the lens. Ensure good drying.

**Step 46:** Push the inner eyepiece lens holder with the lens in the led into the upper end of the main tube [F1], which lies nearer to the millimetre and inch scale, and to such a depth until the tongue ends flush with the tube edge, and glue the tongues solidly in this position. A small hexagonal chamber with black internal walls has formed in the process.

**Step 47:** Remove the punched disk from the outer eyepiece lens holder [F6], fold the 6 rectangular tongues to the rear and blacken the non-printed rear side of the hexagon. Then glue the third lens onto the blackened side over the round hole exactly, again with the flat side. Again, do not allow any glue to get onto the viewing field of the lens. Ensure good drying.

**Step 48:** Glue the outer eyepiece lens holder with its ornamental tongues onto the end of the tube, in which the internal eyepiece holder is already inserted.

**Step 49:** Form the larger black paper section to a tube of 13 cm length, push it into the open side of the body tube and fix it in position with a drop of glue.

**Step 50:** Now glue the body lens holder with the lens onto the open end of the main tube. *The optical system is then completed. Now it only has to be secured at the microscope.*

## Tube holder

*It consists of the collar in which the microscope tube can be slid up and down, and the collar holder which establishes the connection to the column. The 6 long tongues at each end of the collar are turned inwards but not glued. In this way, they exert a slight pressure onto the microscope tube and hold it in the set height as required.*

**Step 51:** Fold all grooves of the tube collar [G1] to the rear and turn the 12 long tongues completely around so that they lie on the non-printed side of the collar. Do not glue these tongues. Place the collar with the printed side downwards onto the working surface, place on this the microscope tube and close the collar to a wide hexagonal ring by placing the narrow gluing tongue underneath the opposite side. The side of the tube, which lies between the two scales, then comes under the white side of the collar holder and all 12 long tongues of the collar lie hidden in the interior of the ring. Now glue the collar in this form together. Make sure that the tube is not glued with it.

**Step 52:** Fold all tongues of the collar holder [G2] to the rear and glue the long narrow gluing tongue behind the opposite side so that a trapezoidal body is established.

**Step 53:** Glue the two covers onto the opposite-located gluing tongues and glue the two ornamental tongues at each cover on the outside.

**Step 54:** Glue solidly the collar holder with its wide surface at the marked location of the column. Ensure an evenly flat gluing and good drying as required.

**Step 55:** Glue the marked side of the tube collar onto the collar holder and ensure that the tube is exactly vertical over the table.

**Your AstroMedia-microscope is now completed.**

## Observations with the microscope

From the enclosed PET-foil, cut out some object carriers approx. 2.5 x 7.5 cm and some 2.5 x 2.5 cm large covering glasses for very small objects. You can, of course, use object carriers and cover glasses from real glass which are commercially available.

Place the preparation onto the object carrier and put the covering glass on top of it. A drop of water on the preparation beforehand can also be very helpful. For large opaque objects which are observed with incident light, you need neither object carrier nor covering glass. The preparation holder with spring effect can hold objects which are either flat or several centimetres high.

Many objects really show their hidden beauty if you cut off a very thin slice with a razor blade or a suitable cutter and observe them with rear illumination light. Such objects would include parts of plants, fruit, cork etc. These

slices can also be given a colouring with a slight film of iodine tincture from the chemist's, and then the strong parts in plant preparations are made visible.

What can you observe? Practically everything. Each object reveals a different and sometimes surprising appearance under the microscope. Even in the ordinary household, there are enough items to keep the microscope user very busy for weeks: carrots, plant stems and leaves, onion skin, old flower or well water, blossom dust, hairs, wings and other parts of dead insects, fish scaling, feathers, all forms of textile strands, torn paper edges, dust, sugar and salt, biscuit crumbs, the hairs of a tooth brush, electronic small parts from defective equipment, the edge of an knife or a razor blade, and, and ...

**We wish you endless hours of interesting enjoyment with your microscope.**