Retina Picture Quiz: Answers (Figs. 1 to 6)

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Fig. 1: Central retinal vein occlusion

The large number of haemorrhages, the white cotton wool spot, and the poor vision all suggest that this is probably an ischaemic CRVO. There is a high risk that this will progress to rubeotic glaucoma within the next three months. If iris new vessels are detected, then pan-retinal laser can prevent secondary glaucoma. A high IOP greatly increases the risk of CRVO, so it is important to treat the glaucoma in the other eye.

Fig. 2: Papilloedema

There is a swollen optic disc. As the vision is normal it is unlikely to be optic neuritis, so the most likely diagnosis is papilloedema. Possible causes include raised blood pressure, and benign intra-cranial hypertension as well as intra-cranial space occupying lesions.

Fig. 3: Age-relatedmacular degeneration

There is a sub-retinal scar (retinal blood vessels pass in front of the paler scar tissue) under the macula. The dark area is due to haemorrhage. Fibrous and vascular tissue has grown from the choroid under the retina at the macula, destroying the photoreceptors at the fovea, and causing irreversible blindness. This is the commonest cause of blindness in Europe and North America.

Fig. 4: Diabetic maculopathy

Diabetic retinopathy may occur before the patient knows he has diabetes. This patient has multiple haemorrhages and cotton-wool spots, due to capillary closure, as well as hard exudates, which indicate leaking capillaries. Laser treatment at this stage reduces the risk of further loss of vision over the next five years.Diabetes is becoming a problem in developing countries and health education programmes must raise awareness of the loss of vision due to diabetes.

Fig. 5: Retinal detachment

The wrinkled surface of the retina, and the loss of the normal red reflex are characteristic of a retinal detachment. The flashes and floaters are caused by a vitreous detachment, which caused the retinal break that led to the retinal detachment. The macula is already detached, but surgery to re-attach the retina will at least restore navigational vision.

Fig. 6: Proliferative diabetic retinopathy

There are active new vessels arising from the optic disc and from the retina. Untreated, there is a high risk of blindness within five years. This can be greatly reduced by urgent pan-retinal laser treatment. Screening for diabetic retinopathy and offering appropriate treatment is essential to reduce loss of vision.

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Mould In Optical Instruments

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Mould can damage optical instruments beyond repair within only a few weeks. There is a good deal of information available on the treatment of mould in buildings, because common respiratory problems and allergic reactions can be caused by mould. Knowledge is also available in the field of conservation of books and fine art because of the high cost of mould damage. However, very little information is available on mould in optical instruments and the management of mould is often ignored by equipment manufacturers and users.

Moulds are plant organisms which form cobweb-like branching arms, from which spores project into the air (see Glossary). Moulds are very common and very widely dispersed. There are 250,000 species of mould, many of which can damage optical instruments. Among the moulds commonly found in instruments are members of *aspergillus, penicillium* and *trichoderma* species.

Conditions of Growth

Although moulds grow in almost every environmental condition on the planet, most prefer temperatures of 20–30°C and relative humidity in excess of 90%. Moulds can germinate from nutrients stored in the spore, but, for growth, they need an additional source of nutrients such as protein, carbohydrate and cellulose. The mould network produces a microclimate close to the supporting surface which can trap dust particles containing nutrients, and can maintain the conditions of temperature and humidity needed for growth. In conditions of high humidity and moisture, many of the nutrients come directly from water vapour in the air.

According to the International Organisation for Standardisation,[1] moulds cannot grow on the glass optical surfaces of lenses, prisms, mirrors or filters without access to other sources of nutrient – such as textile fibres and dust, grease and fingerprints, or varnish. This usually comes from the edges of the optical surface, from contamination left in the joint between the lens and the mounting cell during cleaning, or from varnish or other material in the mounting cell. Figure 1 shows the typical cobweb growth of a mould mycelium from the edge to the centre of a glass surface.

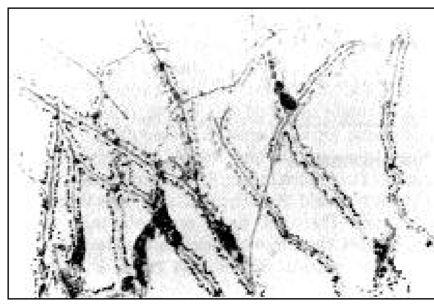

Fig. 1: Typical mould network extending from the edge to the centre of a glass surface (from Kaneko[2])

Mould can grow very quickly. It takes only a few days for mould spores to germinate, and only a few weeks to extend hyphae and grow extensively. Many regions of Africa, South-East Asia and Latin America provide ideal conditions of temperature and humidity for rapid mould growth. Even so, within these regions, the individual risk of damage to instruments varies widely. Some optical instruments are kept in operating rooms, clinics or laboratories which are continually air conditioned and so the humidity never reaches the level needed for mould growth, while others are not. Some instruments have internal fungicidal protection, while others do not. Each instrument must be individually assessed for risk, based on its environment and on the importance of mould damage to it.

In countries where the conditions for mould growth are optimum, mould is often seen on the outside surfaces of optical instruments such as the eyepiece and objective lens surfaces. Mould on internal surfaces may be seen through the instrument if it is close to a focal plane, but usually it is only evident by reduced light transmission or reduced image quality caused by scattering or absorption of light in the mould mycelia. If there is a rapid loss of light transmission or image quality, the possibility of mould should always be considered.

Mould can also damage instrument electronics through short circuits and corrosion, but this can usually be repaired. Damage to optical surfaces is rarely cost effective to repair. A growing mould mycelium produces organic acids which etch the glass surface with minute grooves, leaving behind a print of the mould network (Figure 2) and, as optical components cannot be resurfaced economically, the instrument is then destroyed.

Some glass types are attacked by mould much more readily than others.

Anti-reflection coatings seem to have little effect on the susceptibility of glass surfaces to mould attack, and these coatings are etched along with the glass substrate.

Inhibition of Mould Growth

Two methods are commonly used to inhibit mould growth in instruments.

1. **Environmental control**. Some military optical systems are filled with a dry gas and then sealed, but this method is not used in commercial instruments. Storing the instrument at a relative humidity of less than 65% will prevent the growth of most moulds. This can be achieved either by storing in an air conditioned room, or in a sealed container (a sealed plastic bag may be enough) with a drying agent. If a drying agent is used, it is essential to use one which changes colour when it is saturated and dry or replace it when this becomes necessary.
2. **Fungicides**. Fungicides have been added to instrument varnishes, waxes and cements, to surface coatings of lenses, and to replaceable strips and pellets. The fungicide must provide a concentration throughout the instrument sufficient to prevent mould growth, but, at the same time, not sufficient to condense on optical surfaces or corrode components. In Australia, defence optical instruments have had the fungicide, ethyl mercury thiosalicylate incorporated into paints, cements and waxes to inhibit mould growth. Some optical instruments have also used radioactive or fungicidal surface coatings on optical components, but this is not common and, according to the International Organisation for Standardisation,[1] is not effective. The useful life of a fungicide is necessarily limited by evaporation of the active ingredients unless the instrument is completely sealed, and so attempts to incorporate a permanent fungicide have largely been replaced by the use of replaceable fungicidal pellets. These can be obtained from many instrument manufacturers, and have a useful life of about three years.

Cleaning Mould Contamination

Moulds do not have roots attached to the optical surfaces, and so can be wiped away easily. A mixture of alcohol and ether is often used to clean optical surfaces. Care must be taken in choosing the cleaning agent, as many solvents such as acetone may damage antireflection coatings, paint work and plastics.

Ordinary facial tissues should not be used to clean optics. The paper often contains grit particles that scratch, and lint that is electrostatically charged and is hard to remove. A commercial lens cloth, or a cotton cloth that has been washed several times, should be used. Cotton buds are suitable and can reach some of the internal optical surfaces that are difficult to clean.

It is hard to remove mould spores completely once they have become established, and optical instruments that have been affected by mould should be cleaned regularly to prevent regrowth.

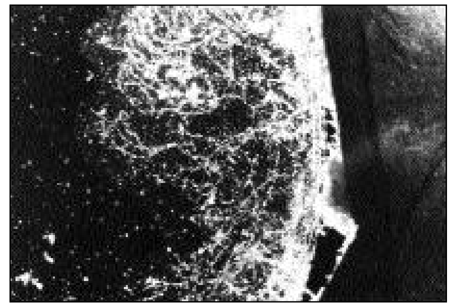

Fig. 2: Grooves etched into a glass surface by organic acids from a mould mycelium (from Kaneko[2])

Rules for Managing Mould in Optical Instruments:

1. Do not wait until mould appears on the outside surfaces of an instrument. By then it may be too late.
2. Inhibit mould growth, if possible by installing a fungicide in the instrument and changing it at recommended intervals, and by storing the instrument in a relative humidity of less than 65%.
3. Inspect the instrument regularly, and clean the accessible surfaces with a disinfectant.

References

1 International Organisation for Standardisation. *Optics and optical instruments- Environmental test methods – Part 11: Mould Growth.* ISO 9022–11:1994.

2 Kaneko N. Optical instruments and mould. Nikon Kogaku KK Bulletin MCCD-01 TEM 603–10/1.

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GLOSSARY

Fungus: A sub-division of the *Thallophyta* division of the plant kingdom. Fungi are simply organised plants, either single celled or made of cellular filaments, and lacking in green colouring matter (chlorophyll).

Fungicide: Any substance which destroys fungus.

Germination: The sprouting or budding of a mould; production of the initial shoot of a hypha.

Hypha: A filament of a fungus, composed of one or more cylindrical cells. Hyphae increase in length by growth at the tips and give rise to new hyphae by lateral branching.

Mould: Any superficial growth of a fungus mycelium.

Mycelium: The collective term for the mass of hyphae that constitutes the growing part of a fungus.

Nutrient: Any substance that provides nourishment to the mould.

Spore: Single – or multi-celled reproductive body that becomes detached from the mould and gives rise to a new individual. Spores are usually microscopic, and are produced in a variety of ways. They are often produced in enormous numbers and are distributed widely, serving for a very rapid increase in the population of the mould. Spores may be able to survive over long periods that are unfavourable to growth.