INTRODUCTORY PHILOSOPHY
The ocular fundus represents a group of tissues that is sometimes challenging to examine and whose lesions are often difficult to interpret. In this session we will demonstrate, 2 potentially novel means for examining the fundus of animals. The first approach acknowledges that the fundus is a compound structure that can be best understood by “constructing” it and that the fundic exam findings might best be interpreted by “deconstructing” them and considering them in light of those basic elements from which the fundus is composed. Secondly, we will approach the fundic exam by asking 5 questions designed to systematically interpret what you are seeing “back there” in a clinically applied and relevant manner.

THE “BUILD A FUNDUS” APPROACH TO INTERPRETING FUNDIC EXAM FINDINGS
The fundus is a collective term describing all structures in the posterior portion of the globe that can be viewed with the ophthalmoscope [sclera, choroid, tapetum [in most cats (and dogs)], retinal pigment epithelium (RPE), neural retina, optic nerve head, and retinal vasculature]. Normal appearance of each of these structures varies widely and is further altered by the appearance of each overlying structure. Therefore, knowing the order of these layers and how they hide or alter the appearance of those layers behind them is critical.

Sclera
The sclera is tan-white and usually not visible due to overlying layers of the fundus. However, if other layers are thinned or absent, then sclera can be seen. An example would be a subalbinotic animal with little melanin. In such animals, sclera is seen between the larger choroidal vessels.

Choroid
The choroid (posterior uvea) is composed of large blood vessels with variable amounts of melanin typically arranged in a somewhat linear fashion between blood vessels. The choroidal vessels need to be distinguished from the retinal vessels that overly them. Choroidal vessels are generally larger, more orange, and branch less overtly than retinal vessels.

Tapetum
The tapetum is technically part of the choroid but, because it is variably present and differs in appearance so much from the choroid proper, is considered separately here. The tapetum occupies a variable percentage of the dorsal fundus where it overlies and obstructs view of the choroid and sclera. Tapetal size can vary greatly but tends to be large in cats (and large dogs, but smaller in small dog breeds). Primary tapetal pathology is rare, however (like all other fundic layers) changes in funduscopic appearance of the tapetum are observed very frequently. These result from changes in the subjacent choroid and/or overlying retina.

Retinal pigment epithelium (RPE)
The retinal pigment epithelium (RPE) is variably pigmented but uniformly present in the normal fundus. It is the outermost layer of the retina but is dealt with separately here because it has a distinctly different appearance from the neurosensory retina. It lies between the neurosensory retina and the tapetum (if present) or choroid (if no tapetum is present. It is predictably non-pigmented where it overlies the tapetum and is usually a relatively homogenous liver to dark brown/black colour in the ventral (inferior) non-tapetum. The most frequent pathologic changes involving the RPE are alterations in the degree of melanosis; i.e., regions of depigmentation and hyperpigmentation due to “pigment migration” secondary to any chronic, inflammatory process.
Neurosensory retina
The neurosensory retina is composed of the other 9 layers of the retina and lies upon the RPE. It is slightly translucent and therefore reduces the intensity of light reflected from the tapetum to the observer. Therefore, “tapetal hyper-reflectivity” is actually not a tapetal finding but represents retinal thinning which allows more light to be reflected from a normal tapetum. Conversely, thickening of the retina due to oedema, cellular infiltration, haemorrhage, or pigmentation will reduce or even obstruct the tapetal reflection.

The retinal vasculature, which lies within the neurosensory retina, varies between individuals and species. Both arterioles and venules can be seen in cats and dogs. In both species, blood vessels should extend to the retinal periphery, bifurcating frequently but without excessive tortuosity. Changes visible funduscopically are usually due to systemic diseases (vasculitis, hypertension, anaemia, hyperlipidemia, hyperviscosity), or local retinal vascular changes such as attenuation as seen with retinal degenerations.

The optic nerve head (ONH or optic papilla or optic disc) in the cat is a small, relatively dark grey/red, non-myelinated circle within the tapetal region. Variable degrees of ONH myelination in dogs dictate that normal ONH appearance may range from small, flat and circular through larger, raised, and irregular triangular-shaped. ONH position in dogs relative to the tapetal/non-tapetal border is extremely variable and dependent on tapetal size. Frequently observed ONH pathology includes inflammatory changes (hyperaemia, oedema, haemorrhage, or cellular infiltration), “cupping”, or atrophy.

THE FIVE FUNDIC QUESTIONS AND “FUNDIC MATHEMATICS”
When I am training veterinarians and veterinary students to interpret their observations from the fundic examination, I have found “The 5 Fundic Questions” and the principle of “Fundic Mathematics” to be really useful. These 2 approaches utilize principles we have introduced in the last section on “building a fundus”. The 5 fundic questions are:

1. Can I get all parts of the fundus in focus at once? If not, then the defocused region is almost certainly protruding in front of the normally positioned tissues (e.g., retinal detachment, ONH swelling, subretinal granulomas/masses, and orbital masses impressing the globe). Other alternate mechanisms that may explain this are fortunately seen very rarely but might include that the defocus is due to regions of the fundus being further behind the normal plane (e.g., scleral ectasia and out-pouching of the rest of the fundic structures), or due to vitreous debris between you and a normal fundus. Of all of these, retinal detachment is “far and away” the most common reason for difficulty focusing on all parts of the fundus at once.

2. What is the general tapetal “sheen” over the whole fundus? Don’t forget to wobble or “shimmy” the indirect lens back and forth and assess the fundus from different directions before making this judgment. If the tapetum is hypo-reflective, then there is likely addition of material in front of the tapetum - in the subretinal space, RPE, or retina. If the tapetum is hyper-reflective, then there is likely subtraction of material from in front of the tapetum. This is almost always retinal thinning due to retinal degeneration. This principle of addition or subtraction introduces the concept of fundic mathematic – “every fundic change can be explained by addition of something that is not supposed to be there (and reduction in your view of a normal structure) or subtraction of a layer that is supposed to be there (with exposure of another layer that you usually do not see at all or so clearly).

3. Are there any focal areas of unusual colouration within the fundus? If so, what colour are they and do they represent an “addition” of a “new” cell or structure in the fundus or exposure of a normally hidden layer or structure within the fundus due to “subtraction” of a normal constituent? (Another example of fundic mathematics).

4. How is the retinal vasculature?
   a. Normal
   b. Prominent (hypertension, hyperviscosity, congenital abnormalities)

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c. Reduced in size or intensity (anaemia, hypovolemia, retinal degeneration)

5. How is the optic nerve head?
   a. Inflamed (optic neuritis/papilledema)
   b. Small (hypoplasia or atrophy)
   c. Cupped (glaucoma)

REFERENCES