10.2.3

Macular Degeneration

Macular degeneration (also called **age-related macular degeneration** or **AMD**) is the leading cause of vision loss in America. AMD is the loss of central vision due to degeneration of the macula lutea. Blurred vision is a key symptom. Risk factors include advancing age, family history of the disease, history of smoking, obesity, hypertension, genetics (more prevalent in females and Caucasians). AMD is classified as dry or wet. **Dry AMD** develops first and may actually have no symptoms. It presents and progresses slowly. Over time, however, vision loss is gradually noticed by individuals (such as greying or dark spots in their central vision) and this is often the time that they seek medical attention. Dry AMD is characterized by the accumulation of an extracellular substance called **drusen**, which is yellowish in color and builds up between Bruch's membrane (the membrane separating the retinal pigment epithelium and the choriocapillaris) and the pigmented epithelium.

As mentioned earlier, the retinal pigment epithelium plays an important role in recycling the photopigments (all-trans-retinal back to 11-cis-retinal) necessary for photoreceptor function. Bruch's membrane allows oxygen and nutrients to pass from the choriocapillaris to the pigmented epithelium and photoreceptors. Fully functional pigmented epithelial cells and a healthy Bruch's membrane effectively provide necessary nutrients to the photoreceptor cells and dispose of photoreceptor waste products by passing them on to the choriocapillaris for disposal.

Dry AMD begins to develop when aging pigmented epithelial cells begin to accumulate intracellular residual products known as lipofuscin. Lipofuscin is debris from the rods and cones that is typically digested by the retinal pigment epithelium. At the same time, breakdown, thinning, and decreased permeability of Bruch's membrane leads to the extracellular accumulation of the waste product, drusen inside Bruch's membrane. While the relationship between lipofuscin and drusen has yet to be established, both serve as markers of AMD onset. The accumulation of drusen is particularly notable as drusen activates inflammation, especially the complement cascade. This explains why polymorphisms on chromosome 1 in the gene that codes for complement factor H (CFH), which inhibits the complement cascade, increases the risk for development of AMD. Smoking is also known to decrease levels of CFH, which increases risk for AMD.

As drusen accumulates and enhances inflammation, retinal cells release VEGF which stimulates inappropriate neovascularization of the choriocapillaris into Bruch's membrane and the retinal pigment epithelium. Since these new vessels are leaky and damage easily, the resulting macular edema and hemorrhages constitute what is known as **Wet AMD**. In this later stage, patients may not be able to recognize faces and may only be able to see with their peripheral vision. The vessels eventually become involuted (decrease in size after being enlarged) and finally form scar tissue.

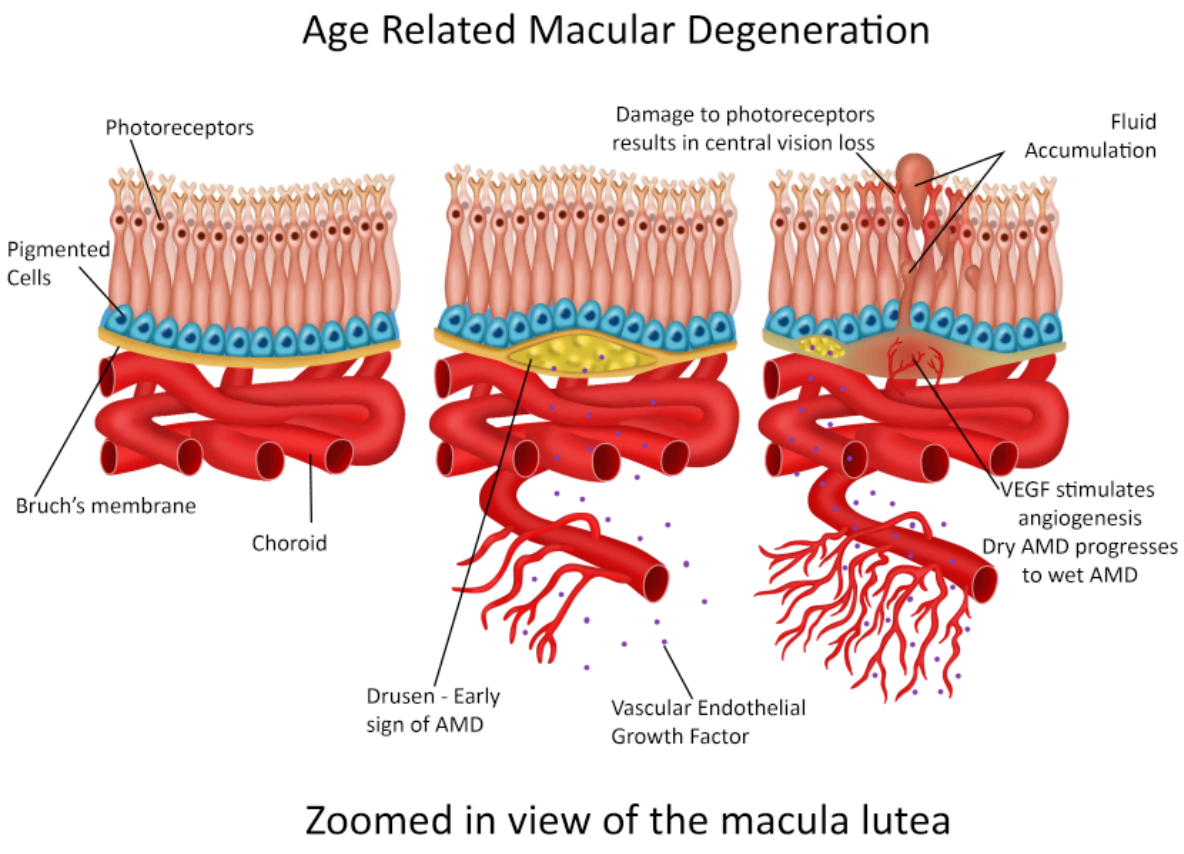

Image by Becky T. BYU-I W20

Individuals at risk for macular degeneration should be aware of any changes in central vision such as blurred vision or scotomata (absent or depressed areas in the visual field). One way to test yourself for macular degeneration is by utilizing a straight-line grid known as the Amsler grid (try a google search for this). If the lines of the grid do not appear to be straight but instead are wavy, this may indicate AMD and you should schedule an eye exam.

Treatment therapies for wet AMD include laser photocoagulation, photodynamic laser therapy, and intravitreal injection of VEGF inhibitors like ranibizumab (Lucentis) and bevacizumab (Avastin) to reduce angiogenesis. Dietary supplementation with high doses of antioxidants such as vitamins E and C, zinc, and beta-carotene have been shown to reduce the risk of AMD. Eating a salad a day with leafy greens such as spinach and kale (contain high levels of lutein and zeaxanthin which are antioxidants localized specifically to the eye) may also help reduce risk.