1: Photochemcad is available at [www.photochemcad.com](http://www.photochemcad.com) and has been published in applied spectroscopy.

Other resources are:

Oregon Medical Laser Center at the Oregon Graduate Institute
[http://omlc.ogi.edu/spectra/](http://omlc.ogi.edu/spectra/)

and Thermo Galactic Spectra online has moved to FTIRsearch.com where IR absorption and Raman scattering is listed.

Chlorophyll has an absorption maximum at 410nm and a second absorption peak at 660nm. When comparing the irradiance from for example San Diego July 6 2000 you can see that the absorption profile almost matches the emission profile of the sun. There is almost no sun light below 320nm and chlorophyll does not absorb above 440nm but catching all higher energy photons in the blue.

2:

At 420 and 880nm the molar extinction coefficients is:

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>420</th>
<th>880</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar Extinction Coefficient</td>
<td>480360</td>
<td>1154</td>
</tr>
<tr>
<td>in cm⁻¹/M</td>
<td>407560</td>
<td>726.44</td>
</tr>
</tbody>
</table>

Assuming 150g Hb/liter and a molecular weight of 64500 as well as an oxygenation of 80% we can calculate an absorption coefficient \( \mu_a \) at 420nm of

\[
2.303(0.8(480360) + 0.2(407560)) (160)/64500 = 2600 \text{ cm}^{-1}
\]

and 6.1 cm⁻¹ at 880 nm.

With a pool of blood being 1mm thick (0.1cm) we will attenuate at 420 \( \exp(2661*0.1) \) which is about 10⁻¹¹ and a factor of 2 at 880nm.

If the pool of blood is only 0.1mm thick the attenuation will be lower but it is still large at 420 nm.

We can safely say that all light is transmitted in the NIR with 0.1mm and half the light with 1mm thick pool. There is not light transmitted in the blue under both configurations, except if you can measure 11 orders of magnitude attenuation on a spectrophotometer which is out of reach for most instruments.

3:

The Mie calculator requires refractive index of water 1.33 and fused silica 1.46. As usual with all materials the refractive index depends on wavelength and for fused silica (quartz) decreases by approx 1-2 % per 100nm. The refractive index describes the speed of light of these materials compared to standard air which is almost the same as in vacuum.

The wavelength of the laser in vacuum is 514nm which is almost the same as in air. However in the water, it would shrink to \( \frac{1}{n_{medium}} \times \text{wavelength} \). There are 1000 nanometers in one micron. We assume the glass does not absorb therefore the imaginary part of the refractive index is zero.

Assuming a density of 0.1spheres per cubic micron our scattering coefficient is 912 cm⁻¹ and we will need to lower it to reach 100cm⁻¹ (scattering coefficient, not the reduced scattering coefficient). For example 0.011 spheres per cubic micron is pretty close. One sphere is \( \frac{4}{3}\pi \times 0.5^3 \) microns in size and 0.011 spheres per cubic micron are 0.0058 cubic microns of glass per cubic micron. For 10ml we would need 0.0058*10ml \( \text{ (1ml=1cm}^3\text{) spheres and with a density of 2.2 g/cm}^3 \text{ for fused silica, that would be 130 milligrams which should be in the range of a standard analytical balance. Anisotropy is 0.953 which is comparable to tissue.} \)