103.

- This is answered very clearly on p. 137 of the text book (starting with "CAUTION!" at the bottom of the first column). See also Fig. 6-12.
- You would see a hole in an image of a star if the star were out of focus, though. But provided the telescope is in focus, all the rays of light come to a point, and the only effect of the obstruction is to dim the total light a bit.

104.

- The focal length is 20 x 2.5m = 50m.
- s = f θ, where θ is in radians. Now, 1 arcmin = 1/60 deg x 1 deg/57.3 rad. So θ=0.000291 rad.
- Therefore s = 0.000291 x 50m = 0.0145m = 1.45cm

104a.

- The physical size of the moon (theta = 1/2 deg = 0.0087 radians) is s=f*theta = 0.0087 * 50 mm = 0.436 mm (note that theta has to be in radians).

- So 0.436 mm = 4.36 x 10^{-4} m = 436μm (where μm means "micron" = 10^{-6} m). The total area of the image is then pi * (436 mu /2)**2 = 1.49 x 10^5 μm**2.

- Now, 1 pixel of the detector is 15μmx15μm=225μm**2. So there are 1.49x10^5/225 = 664 pixels in the image.

101.

- Angular size of Betelgeuse = 2 x 1AU / 150pc rad

  = 2 AU /(206265 AU/pc x 150 pc) rad = 6.46E-8 rad

  [Note: 2AU, not 1 AU! need the diameter.]

λ = 550nm: resolution angle is given by θ[rad] =λ/D;

D= λ/θ = 5.50e-7 m / 6.46e-8 = <u>8.5 m</u>

λ = 5μm: D= λ/θ = 5.00e-6 m / 6.46e-8 = <u>77m</u>

102.

(a) Again, θ[rad] $=\lambda/D$ = 5.5e-7m / 5e-3m = 1.1e-4 rad = 23 arcsec

(b) See Appendix A-1 for Jupiter. θ=143000km/(7.78e8km)

= 0.000183 rad = 37.9 arcsec

See Appendix A-3 for moon: θ=3476km/384400 km =

= 0.00904 rad = 1865 arcsec (~1/2 deg)

So it's not too surprising that we can resolve the moon: the eye's resolution angle is much smaller than the moon's size. Jupiter is a bit more interesting. We should be able to see it as slightly resolved.

[You don't have to say this as part of your answer, but in fact we cannot resolve Jupiter or in fact anything under about 2 arcmin - the eye is limited by the rods and cones in the retina rather than the theoretical resolution limit of the pupil!]

105.

(a) Effective collecting area = $\pi D^2_{prim}/4 - \pi D^2_{sec}/4 = 1963cm^2 - 314cm^2$
$= 1649cm^2$

(b) Detection rat = $(10 \text{ phot } s^{-1} \text{ cm}^{-2} \text{ nm}^{-1}) \times 1649cm^2 \times 100nm$
$\times 0.85 \times 0.85 \times 0.3 = 3.57e5$ photons/sec