Appendix A:

Calculation of free and bioavailable testosterone (see also www.issam.ch/freetesuit.htm)

Concentration Testosterone = FT(free) + Alb-bound-T + [SHBG]-bound-T

Testosterone = [S] + [S_A] + [SP]

- ***Albumin***

$$\frac{[S_A]}{[S]} = \text{constant} = K_A \times C_{conc.}Alb = 3.6\times10^4 \times \frac{43 g/l}{69000} = \mathbf{22.4}$$

69000 =(molecular weight alb.)
$K_A = 3.6\times10^4$
for an average albumin conc. of 4.3 g/dL

or **[S_A] = 22.43 [S]**

[S] + [S_A] = (1 + 22.43)[S] = **23.43 [S]** (1)

- ***SHBG***

[P] = free SHBG
[SP] = steroid bound SHBG
K = 10^9 M

[S] +[P] $\leftrightarrow$ *[SP]* or $[S] = \frac{[SP]}{[P][K]}$ (2)

[P] + [SP] = [SHBG] **or [P] = [SHBG] –[SP]** (3)

- ***Bioavailable***

[Bio T] = [S] + [SA]

Example :

SHBG : 40 nmol/l = 40 $x10^{-9}$

Testosterone = 288.4 ng/dl = **10 x 10^{-9} Mol = [SP] + 23.43 [S]**

[SP] = 10x10^{-9}– 23.43 [S]

From (3) [P] = 40 10^{-9} – 10 10^{-9} + 23.43 [S] = 30 10^{-9} + 23.43[S]

From (2) and (1) $\mathbf{[S]} = \frac{[SP]}{[K][P]} = \frac{10\ 10^{-9} - 23.43\ [S]}{10^9 (30\ 10^{-9} + 23.43[S])} = \frac{10\ 10^{-9} - 23.43\ [S]}{30 + 23.4\ 10^9 [S]}$

[S]{ 30 +23.43x10^9 [S]} = 10 10^{-9} – 23.43[S]

30 [S] + 23.43 x10^9 $[S]^2$ + 23.43[S] – 10 10^{-9} = 0

23.43 x10^9 $[S]^2$ + 53.43[S] - 10 10^{-9} = 0 *second degree equation* $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

a = 23.43 x10^9

b= 53.43

c = - 10 10^{-9}

$$[S] = \frac{-53.43 + \sqrt{53.43^2 + 4 \times 23.43\ 10^9 \times 10\ 10^{-9}}}{2 \times 23.43 \times 10^9} = \frac{-53.43 + \sqrt{2855+937}}{48.86\ 10^9} = \frac{-53.43+61.58}{48.86\ 10^9}$$

[S] = 1.7388 10^{-10}

$$[S]\ \% = \frac{1.7388^{-10} \times 100}{10\ 10^{-9}} = 1.74\ \%$$

$$FT = \frac{1.7388 \times 288.5}{100} = 5.02\ ng/dl$$

- ***Bioavailable***

Bio T = [S] + [SA] = [S] + 22.43 [S] (for the default albumin concentration of 4.3 g/dL)

Bio T = 5.02 ng/dl x (22.43 + 1) = 118 ng/dL