Assignment #3 due **Feb10th/ 2005**

Please list the names & e-mail addresses of all your team members on the group assignment.
If you think some important information is missing look for it in the lecture notes or wherever , or if everything else fails make a reasonable assumption, and justify your assunption.

P3-1 Muscle speeds of hum-ans and hum-ing birds

a)Consider a human biceps as shown in Figure 3.1(a) below. Assume a biceps length l=15 cm, and a maximum muscle contraction ?l/l=10%. Find the muscle contraction ?l,*), the deflection angle α through which the lower arm moves, and the arc length s through which of the finger tips move. Assume that the muscle contracts at the maximum power speed, V=0.3V_o . Note that the velocity V is a normalized velocity, namely the muscle contraction speed *U=?l/?t* [m/s] divided by the muscle length l[m]. Thus *V* has the unit s^{-1}, . Assume for humans $V_{o,h\text{-}man}$=3Hz. Find the speed of the tip of the muscle, U_m, and the contraction time ?t. Now assume that the hand moves up and down with a period T= 2?t, and give the frequency *f=1/T*. Determine the average speed of the finger tips U_{finger}. =s/?t. Summarize your results in a table with the columns V, ?l/l, U_m, ?l, ?t, T, f, U_{hand}. (b) Do a similar calculations for the wing tip motion of a humming bird, Figure (b), which flaps its wings at *f*=40Hz . Work your way backwards through the columns of the table starting with f= 40 Hz. Assume a wing tip arc displacement *?S*= 2cm. Muscle length l = 10mm, ?l/l=10%. Compare your calculated *V=?l/?t* with the number quoted in the lecture notes $V_{o,h\text{-}bird}$=20[s^{-1}].
Does it have to be *V*= 0.3V_O?

*)Assume that the motion ends(with the muscle contracted) when the lower arm is in the horizontal position. The muscle connection point and finger tips move on arcs. Let ?l, and ?s be vertical deflections, but note that for such small deflection angles α of the arm arc length(s) and the vertical displacement (?s) are practically the same (they differ by less than 1%)

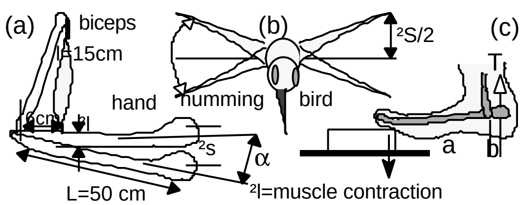

Fig 3.1 (a) Arm , (b) Wings, (c) Foot.

P 3-2 Near Surface Drag (project by Natasha Szucs, April 2002)

Natasha, a good swimmer, wants to quantify the effect of near surface drag. For that purpose she swims with the dolphin kick at various depths *y* under the water surface. She maintains a constant depth by watching a horizontal line on the pool wall. For every length she swims she measures her travel time with a stopwatch on her wrist, *see Table 3.12, p.125*. The UBC pool is slightly shorter below a depth of 1.50m (see ?x in table above). She also measures her pulse rate F_h, and only uses runs where it stays close to the same value, 140 beats per minute. (a) Calculate the average speed per run. (b) Assume a body shape like a flattened torpedo of cross section area *A*=0.07m^2, and a drag coefficient C_{D3}=0.05 to calculate the average drag force F_3 at a depth of *y*=3.0m. This is also the average propulsion force generated by the swimmer. (c) Since the heart rate is about the same at all depths one can assume that the propulsion force too is the same at all depths. Calculate the drag coefficient ration C_{Dy}/C_{D3} as function of depth *y*. (d) What advice should the UBC coach give to the swimmers?

P3-3 Landing on the Feet.

Two young people jump down from a height of h=2m onto the forest floor which has a mud hole and a rocky flat. The boy (M=70kg) lands with stiff legs on the muddy ground, which "gives" so that he depresses the ground by 5 cm when being decelerated from the impact velocity v_O to v=0. (a) determine the impact speed v_O. (b)Calculate the deceleration (negative acceleration) of the center of mass of the boy during landing, and determine the force on the soles of his shoes during impact. (c) The girl (M=65kg) lands on the rock, but in order to reduce the impact force she lands with soft knees and moves her center of gravity relative to her feet by 0.5m as she lands. What is the impact force during landing on her soles of the feet? What would have been the forces T in her tendons had she landed on her toes, as shown in Fig.c above but with stiff legs? (assume the same dimensions for the feet: a=11.5cm and b=3.2cm). Which strategy would you recommentd?

Problem 3-2 Laps times *?t*, and pulse rate F_h of Natasha while swimming at depth *y* under water

y[m]	?x[m]	?t[s]	F_h beat /min
0	25	26.24	140

0	25	26.37	136
0.5	25	25.45	140
0.5	25	25.15	140
1.0	25	23.85	140
1.0	25	27.73	140
1.5	25	22.95	144
1.5	25	22.95	140
2.0	22.86	21.90	140
2.0	22.86	21.56	144
2.5	22.86	21.60	140
2.5	22.86	21.44	140
3.0	22.86	21.15	136
3.0	22.86	21.23	140