Probllometry Set

1. The Antarctic Icefish (*Chaenocephalus aceratus*) is an interesting species physiologically because its blood contains no haemoglobin and its body surface contains no scales. In his Ph.D. dissertation, George Holeton (1974) used morphometric data to test the hypothesis that the scaleless condition permitted the body surface to pick up oxygen as partial compensation for the blood lacking hemoglobin. A data set including body mass Mb, length L, body surface area Sb, gill surface area Sg, and ventricle mass Mv is provided below.

Mb [g]	L [mm]	Sb [$m^2 \times 10^4$]	Sg [$m^2 \times 10^4$]	Mv [g]
1235	574	2177	1656.5	2.72
1456	600	2466	1716.0	4.42
860	520	1695	1089.3	2.82
1112	530	1782	956.0	2.06
1250	550	2133	1626.5	3.81
522	440	1163	730.2	1.23
1020	520	1950	1307.9	2.62
627	455	1352	712.2	1.31
1570	595	2213	2076.6	4.35
370	417	1132	454.7	0.90
1013	560	1884	1217.4	2.30
2240	668	3214	3360.0	6.40
548	460	1335	672.0	1.34
945	525	1802	1205.1	1.80
342	420	1139	405.4	0.87
1015	540	1995	1301.1	2.97
1335	590	2316	1745.3	4.44
1560	590	2491	1682.2	5.65
1534	595	2612	2025.6	3.96
1216	544	2073	1480.4	3.22
408	415	1169	489.8	0.92
1823	610	2579	2041.0	4.30
604	425	1268	745.9	1.21
1630	615	2413	1738.0	3.74
897	525	1789	1139.6	2.31
513	420	1361	646.8	1.50
665	475	1564	916.0	1.93
1530	590	2441	1825.2	4.87
1857	650	2707	3514.2	6.27
320	398	1058	400.2	0.56
1746	630	2619	3944.0	6.77
2293	650	3030	3337.0	6.93

As a Computational Biologist, you must be pining to test for yourself the hypothesis that the body surface might be used for respiratory gas exchange! If you were to falsify this hypothesis, then you might propose some other way in which this curious fish can compensate for its haemoglobinless blood.

Please use regression analysis to determine 4 power functions relating body mass (as the independent variable) and length, body surface area, gill surface area, or ventricle mass, respectively (as the dependent variable; body mass is used as the independent variable because it can be measured with the least error).

Please interpret each power function as concisely as possible (*i.e.*, please state how each dependent variable scales with size and what implications this scaling has for the hypothesis that you are testing).

2. A data set (derived from Schmidt-Nielsen 1984) including body mass Mb and erythrocyte (*i.e.*, red blood cell) diameter Ed is provided below.

Animal	Mb (kg)	De (µm)
Shrew	0.003	7.5
Mouse	0.03	6.6
Rat	0.21	6.8
Dog	11.41	7.1
Sheep	39.7	4.8
Human	78.6	7.5
Cow	431.0	5.9
Horse	702.0	5.5
Elephant	4017.0	9.2
Humpback whale	7543.0	8.2

Please use body mass as the independent variable in a regression analysis to determine a power function relating Mb and De and interpret the result biologically (*i.e.*, please interpret the parameters a and b in a biological manner; hint: in least-squares regression analysis, the best-fit line always passes through the point that represents the mean for the two variables).

3. A data set (derived from McKinney 1988) including length L (anterior-posterior distance) and height H for two cassiduloid sea urchin species is provided on the next page. The variable length is measured more accurately than is height.

Please describe concisely how these two species differ in how they grow.

Please predict for each species the typical height for a specimen with L = 12.0 mm and, on the basis of the data, whether this is biologically realistic.

Please predict for each species the typical length for a specimen with H = 31.0 mm and, on the basis of the data, whether this is biologically realistic.

Please predict the length at which a typical specimen from each species would exhibit the same height and, on the basis of the data, whether this would occur.

L [mm]	H [mm]	L [mm]	H [mm]
11.0	4.9	17.9	10.3
16.1	7.1	25.9	16.7
18.6	8.0	28.0	20.1
20.1	9.0	29.1	18.8
21.5	9.5	29.2	20.0
22.4	9.5	32.3	28.6
24.8	10.8	33.7	26.8
25.9	12.1	34.8	28.7
27.7	11.5	35.9	26.8
30.0	12.2	38.7	32.0
31.0	12.2	38.8	30.3
31.1	12.9	42.9	32.1
34.8	14.6	43.0	36.2
35.9	15.5		
41.1	17.4		