# N O T I C E

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SYSTEMS DEPARTMENT

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SUBJECT System Parameters for Erythropoiesis Control Model: Comparison of Normal Values in Human and Mouse Model

The computer model for regulation of erythropoiesis, originally developed to represent human function, has been recently adapted to the mouse system. This was accomplished by altering the values of the system parameters describing fluid volumes, blood flows, metabolic rates, hematologic indices, etc. This report documents the values used in the mouse model and compares them to the original human model. In addition, the report summarizes the source documents and data used in obtaining the parameter values for the mouse and the rat. It is anticipated that a similar model for the rat will be implemented.

The capability of using models for two different species will greatly enhance the realism of the simulations and provide greater flexibility for spaceflight hypothesis testing. A companion report, TIR 741-LSP-8029, documents the validation of the mouse model and its utility in suggesting new experimental approaches.

The extensive literature search, summarized in the Appendices, which provided the basis for the new parameter values was conducted by Robert Chamberlain, a summer engineer trainee.

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Attachment
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## SYSTEM PARAMETERS FOR ERYTHROPOIESIS CONTROL MODEL: COMPARISON OF NORMAL VALUES IN HUMAN AND MOUSE MODEL

### Introduction

The computer model for erythropoietic control was adapted to the mouse system by altering system parameters originally given for the human to those which more realistically represent the mouse. Parameter values were obtained from a variety of literature sources as indicated in the Appendix* and in the Reference List. The immediate application of the mouse model was the study of the mouse as a potential experimental model for spaceflight. Data for the simulations were to be obtained from Dr. C.D.R. Dunn's experiments at the University of Tennessee Memorial Research Center and included studies of dehydration and hypoxia. The strain of mice used in these studies were C3H with approximate weight of 25 grams. Parameter values were chosen for this strain where possible. In certain cases, the literature values were superseded by values obtained directly from Dr. Dunn's studies. In a few cases mouse data were not available and data for the rat were substituted. Large variations in parameter values were usually observed as indicated in the Appendix, depending on mouse strain and investigator. The values finally chosen are, therefore, highly idealized.

### Basic System Parameters

This report, in addition to documenting the source material, contains a comparison of system parameters for the mouse and human models as shown in Table I. Aside from the obvious differences expected in fluid volumes, blood flows and metabolic rates, larger differences were observed in the following: erythrocyte life span (126 d vs. 42.5 d)** erythropoietin

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* The appendix also contains parameter values for the rat which were collected in anticipation of implementing a similar model for the study of that species.

** First and second numbers in parenthesis refers to human and mouse, respectively.

# TABLE I

## SYSTEM PARAMETERS FOR ERYTHROPOIESIS CONTROL MODEL

| PARAMETER | MODEL SYMBOL | PARAMETER VALUE HUMAN | PARAMETER VALUE MOUSE | REF. | UNITS |
|---|---|---|---|---|---|
| * Red Cell Mass | RCM | 2000 | 0.63 | (10) | ml |
| * Plasma Volume | PV | 3000 | 0.77 | (10) | ml |
| Blood Volume | BV | 5000 | 1.40 | (10) | ml |
| Whole-Body Hematocrit | HCT | 40.0 | 45.0 | (10) | ml packed RBC / 100 ml blood |
| * Mean Corpuscular Hemoglobin Concentration | MCHC | 0.375 | 0.300 | (1) | gm Hb/ml RBC |
| Hemoglobin Concentration | - | 15.0 | 13.5 | (1,4) | gm Hb/100 ml blood |
| * $O_2$ Capacity of Blood | - | 20.1 | 19.0 | (4) | ml $O_2$/100 ml blood |
| $O_2$ Capacity of Hemoglobin | $CHBO_2$ | 1.34 | 1.41 | (1,4) | ml $O_2$/gm Hb |
| * $PO_2$ tension at ½Hb Sat. | P50 | 27 | 39 | (21) | mm Hg |
| * Arterial $pO_2$ | PO2A | 95 | 78 | (12) | mm Hg |
| Arterial Hb Saturation | SO2A | .97 | .99 | (21) | percent |
| * Renal Metabolic Rate | MO2T | 20 | .04 | (5) | ml $O_2$/min |
| * Renal Blood Flow | BF | 1200 | 1.83 | (16) | ml/min |
| * Normal Tissue $pO_2$ | PO2T | 20 | 20 | | mm Hg |
| * Erythropoietin Half-Life | EHL | 12 | 3.25 | (11) | hours |
| * Red Cell Life Span | - | 126 | 42.5 | (12) | days |
| * Erythrocyte Maturation Time | Z | 4 | 3.5 | | days |
| * Normal RBC Production Rate | P | 22 | .0205 | (12) | ml RBC/day |
| RBC Turnover Rate | RKC | 1.1 | 3.26 | (12) | percent/day |

* Fundamental value from which other parameter values may be derived (see Table II)

# TABLE II

## RELATIONSHIPS USED TO DERIVE PARAMETERS IN MOUSE MODEL

1. Blood Volume $BV = RCM + PV = 0.63 + 0.77 = 1.4$ ml

2. Whole-Body Hematocrit

   $HCT = RCM/BV = 0.63/1.4 = .45$ ml packed RBC/ml blood

3. Hemoglobin Concentration

   $HB = HCT \times MCHC = 45 \times 0.3 = 13.5$ gm Hb/100 ml blood

4. $O_2$ Capacity of Hemoglobin:

   $$CHBO_2 = \frac{O_2 \text{ concentration of blood}}{\text{Hb concentration of blood}} = \frac{19}{13.5} = 1.41 \text{ ml } O_2/\text{gm Hb}$$

5. Arterial Hb Saturation

   SO2A = function (PO2A)

   (see oxygen-hemoglobin dissociation curve, Figure 1)

6. RBC Turnover

   RKC = turnover rate/100 = .693/RBC Half-Life

   $= .693/42.5/2 = .0326 \text{ day}^{-1} = 3.26\%$ per day

   Steady State Destruction Rate = RCM x RKC

   $= 0.63 \times .0326 = .0205$ ml/day

half-life (12 hrs vs. 3.25 hrs) and normal arterial $pO_2$ (95 mm Hg vs. 78 mm Hg). The shorter life span of the mouse RBC implies a three-fold faster turnover of erythrocytes. That is, the daily rates of red cell production and destruction (as well as reticulocyte index) are about three times higher in the mouse than the human. Other parameters found to be more similar between the two species: hematocrit (40 vs. 45), mean corpuscular hemoglobin concentration (.375 vs .30) and maximum oxygen carrying capacity of hemoglobin (1.34 vs. 1.41).

Although the arterial $pO_2$ in the mouse is much lower than in the human, the oxygen saturation of hemoglobin of both species are nearly identical (97% vs. 99%). This is a result of the distinctly different oxygen-hemoglobin dissociation curves shown in Figure 1 and reflected in the different P50 values (26.7 vs. 39.0 mm Hg). The P50 differences implies that at the same level of tissue oxygen tension, oxygen is more easily unloaded in the mouse than in the human. It should be noted that the normal $pO_2$ of arterial blood assumed here (78 mm Hg) was obtained from rat data (Ref. 4 & 11) and has been used in a previous model validated for the mouse with reasonably good results (Ref. 20). No corresponding mouse data could be located.

Values for renal blood flow of the mouse was not available and data from rats were utilized (6 ml/min-gm tissue).

## Scaled Parameters

Some parameters of the mouse model differ considerably from the human model due to scaling factors alone. That is, the values used in the model are given on an absolute basis for the whole animal rather than as a specific property in terms of "per gram of tissue." In terms of specific units the differences between the mouse and human system are much smaller as shown below.

TABLE III - ABSOLUTE VS. SPECIFIC PARAMETER VALUES

| PARAMETER | ABSOLUTE UNITS HUMAN | ABSOLUTE UNITS MOUSE | SPECIFIC UNITS* HUMAN | SPECIFIC UNITS* MOUSE |
|---|---|---|---|---|
| Red Cell Mass | 2000 | 0.63 ml | 28.6 | 25.2 ml/kg body wt. |
| Plasma Volume | 3000 | 0.77 ml | 42.9 | 30.8 ml/kg body wt. |
| Blood Volume | 5000 | 1.40 ml | 71.4 | 56.0 ml/kg body wt. |
| Renal Blood Flow | 1200 | 1.83 ml/min | 4.28 | 6.10 ml/min-gm tissue |
| Renal $O_2$ Consumption | 20 | 0.04 ml/min | 0.073 | 0.133 ml/min-gm tissue |
| Body $O_2$ Consumption | 250 | 0.51 ml/min | 0.00357 | 0.0255 ml/min-gm tissue |

* Based on: Body Weight = 70 kg man and 25 gm mouse
Renal Mass = 280 gm (.4% BWt) in man and 0.3 gm (1.2% BWt) in mouse

## Oxygen Balance

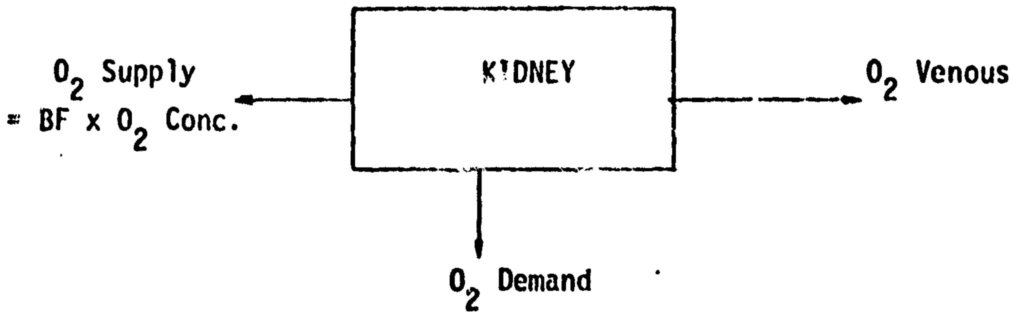
The balance of oxygen supply vs. oxygen demand is crucial to the feedback regulation of erythropoiesis. A parameter reflecting this complex balance is the tissue oxygen tension which is believed to govern the release of erythropoietin. The oxygen balances for the human and mouse systems as used in the model are given in Table IV.

Oxygen consumption per gm renal tissue in the mouse is about twice that for the human. (Overall total oxygen consumption per gm body weight is nearly seven times greater in the mouse.) This higher oxygen demand of the mouse is satisfied in two ways in the model: a) there is a 50% greater efficiency in oxygen extraction as indicated in Table IV. (Note that in both species the amount of oxygen delivered at rest is more than sufficient - i.e. roughly 10 times that required by the tissues.), b) there is a 30% higher blood oxygen supply per gm of tissue due to greater tissue blood flow in the mouse.

The resting tissue oxygen tension is arbitrarily assumed to be identical in both model systems; i.e., 20 mm Hg. The equation describing oxygen diffusivity to the tissues from venous capillaries is given in the steady-state as:

# TABLE IV

## OXYGEN BALANCE AT KIDNEY




| | | HUMAN | MOUSE |
|---|---|---|---|
| A. | Oxygen Demand | 20 | .04 ml $O_2$/min |
| | | 0.073 | 0.153 ml $O_2$/min-gm |
| B. | Oxygen Supply Parameters | | |
| | $PO_2$, arterial | 95 | 78 mm Hg |
| | $SO_2$, arterial | 97.4 | 98.6 % saturation |
| | $O_2$ concentration | 196 | 188 ml $O_2$/liter blood |
| | BF | 1200 | 1.83 ml blood/min |
| | $O_2$ Supply Rate | 235 | .343 ml $O_2$/min |
| | | .839 | 1 143 ml $O_2$/min-gm |
| C. | Oxygen Venous Parameters | | |
| | $PO_2$, venous | 56 | 57 mm Hg |
| | $SO_2$, venous | 89 | 86 % saturation |
| | $PO_2$, tissue | 20 | 20 mm Hg |
| D. | Percent Oxygen Extraction | | |
| | $= \frac{O_2 \text{ Demand}}{O_2 \text{ Supply}}$ | 8.7% | 13.4% |

Net oxygen delivery = tissue oxygen consumption

$= (pO_2, \text{vein} - pO_2, \text{tissue}) \times K$

where K = conductivity coefficient = $O_2$ Diffusivity x Capillary Surface Area

The ratio of K(man)/K(mouse) would be expected to reflect the surface area ratio between species if diffusivity were assumed similar in mouse and man. Therefore, if S = capillary surface area, then

$$\frac{S(\text{man})}{S(\text{mouse})} = \frac{K(\text{man})}{K(\text{mouse})} = \frac{O_2 \text{ consumption,man}}{O_2 \text{ consumption,mouse}} \times \frac{(pO_2,\text{vein} - pO_2,\text{tis}),\text{mouse}}{(pO_2,\text{vein} - pO_2,\text{tis}),\text{man}}$$

$$= \frac{20 \text{ ml/min}}{.04 \text{ ml/min}} \times \frac{(57.5 - 20)}{(56.4 - 20)} \text{ mm Hg} = 508$$

This is in good agreement with the surface area ratio of 650 of the glomerular derived from data in Ref. 5 (pg. 174) in the following way:

Let: R = glomerular radius = 37 μ (mouse) and 100 μ (man)

V = glomerular volume = 2.6 $mm^3$ (mouse) and 4600 $mm^3$(man)

L = glomerular capillary length

S = glomerular capillary surface area

$S = 2 \pi R \times L$ and $V = \pi R^2 \times L$

Therefore, $S = 2 \pi R \cdot V / \pi R^2 = 2 V/R$

and $$\frac{S(\text{man}}{S(\text{mouse})} = \frac{V(\text{man})}{V(\text{mouse})} \times \frac{R(\text{mouse})}{R(\text{man})}$$

$$= \frac{4600 \text{ mm}^3}{2.6 \text{ mm}^3} \times \frac{37\mu}{100\mu}$$

$$= 650$$

This agreement lends support to the general representation of the kidney in the computer model.

## Functional Relationships

Three functional relationships are included in the computer model: a) oxygen-hemoglobin equilibrium curve (EC), b) erythropoietin release as a function of tissue $pO_2$, and c) erythrocyte production rate as a function of erythropoietin concentration. The first of these is shown in Figure 1 and will be described in detail below. The form of the function curves for erythropoietin and red cell release will be assumed identical in the mouse and human models (Figures 2 and 3). There is no reason at the present time to take issue with this assumption, particularly since the bone marrow function (Figure 3) was originally obtained from the mouse. These curves (as shown in Figures 2 and 3 and as used in the models) are represented in normalized form (i.e. % of control) so that any species may be represented. The gain factors, $G_1$ and $G_2$, representing the slope of the relationships, may be different between species. This is of little concern in the basic design of the model since these parameters will be adjusted during the simulation process and their actual values estimated by "fitting" the model output to the experimental data.

The equation describing the sigmoidal OEC is a form of the Hill equation and is shown in the insert of Figure 1. The two solid lines represent human and mouse blood, respectively, and were recently obtained from single blood samples in Dr. Dunn's laboratory. The value of P50 is explicitly stated in the equation so that shifts in oxygen-hemoglobin affinity may be easily described. The value of the exponent "K", found from the best fit of the mouse curve, also provides a good fit of the human curve as shown by the symbols in Figure 1. Thus, the only difference between the equation describing the human and mouse OEC is the value of P50. The dashed line in Figure 1 is a theoretical calculation of a P50 shift of +10 mm Hg from the standard mouse curve.

## Simulations

A model representing the mouse system was implemented and verified as being substantially appropriate. The model presently exists on the UNIVAC 1110 and PDP 1140 systems at NASA/JSC as well as on the DEC facility at the University of Tennessee. Preliminary validation studies were performed and have been summarized in a companion report, TIR 741-LSP-8029.

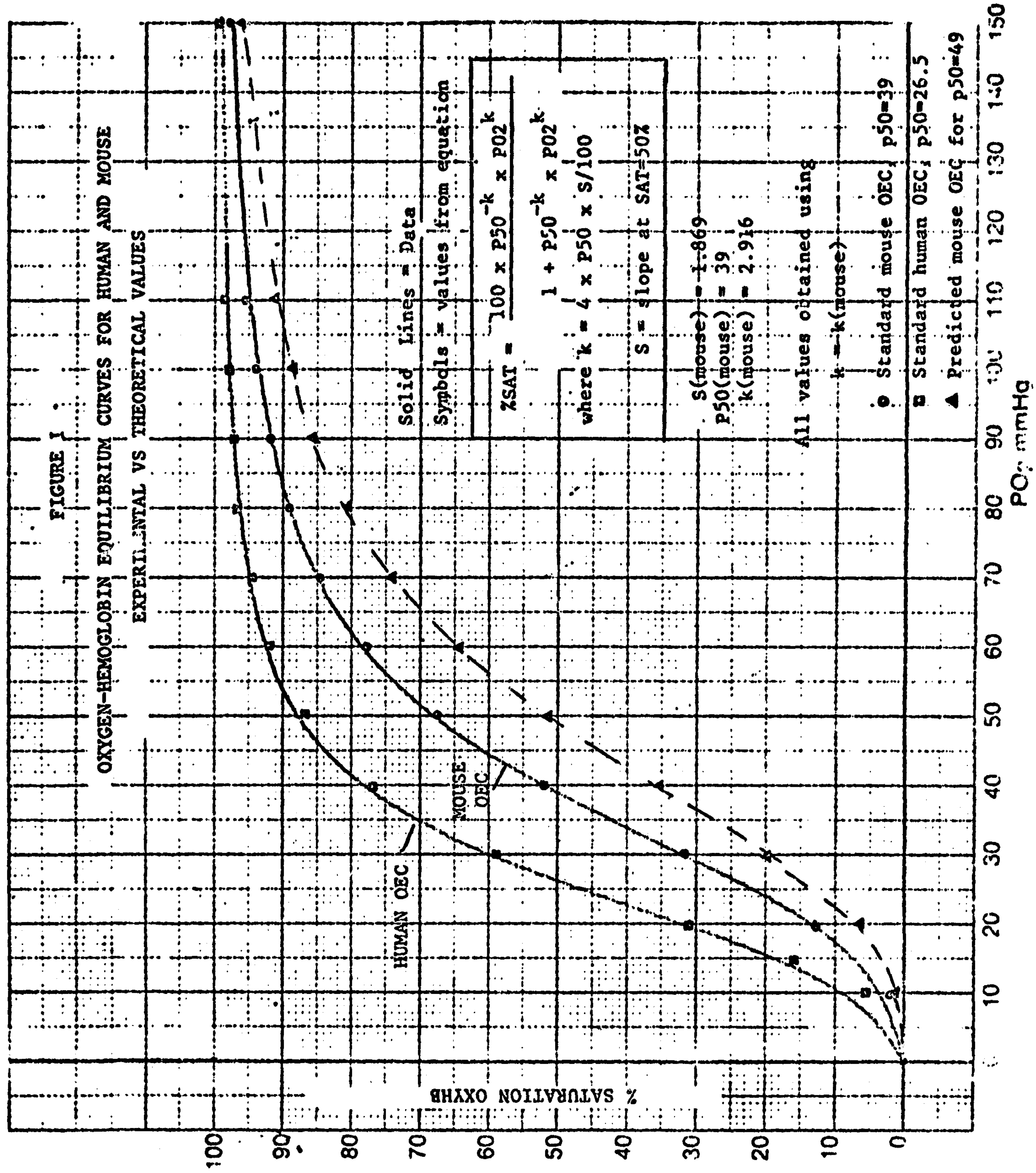
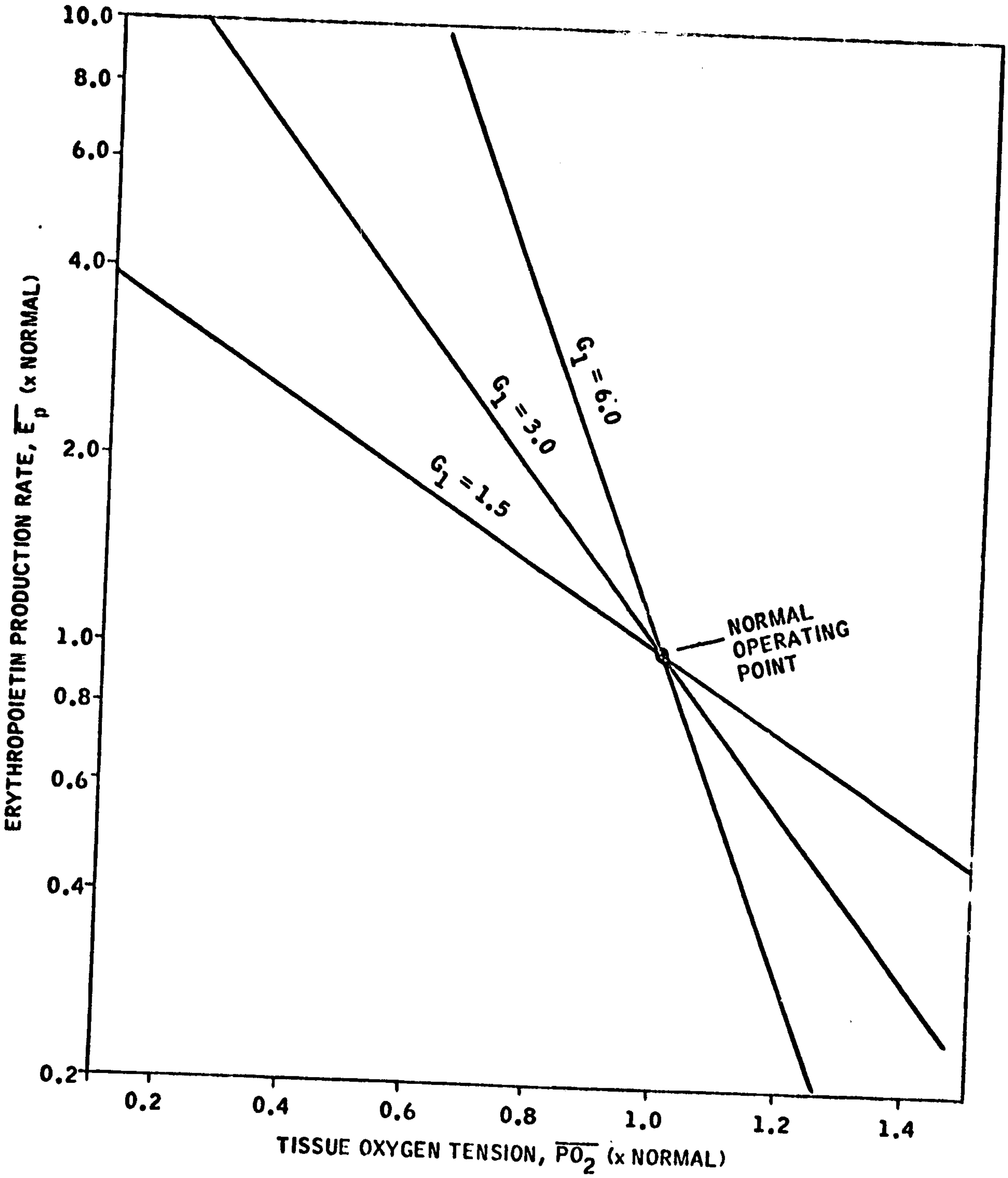


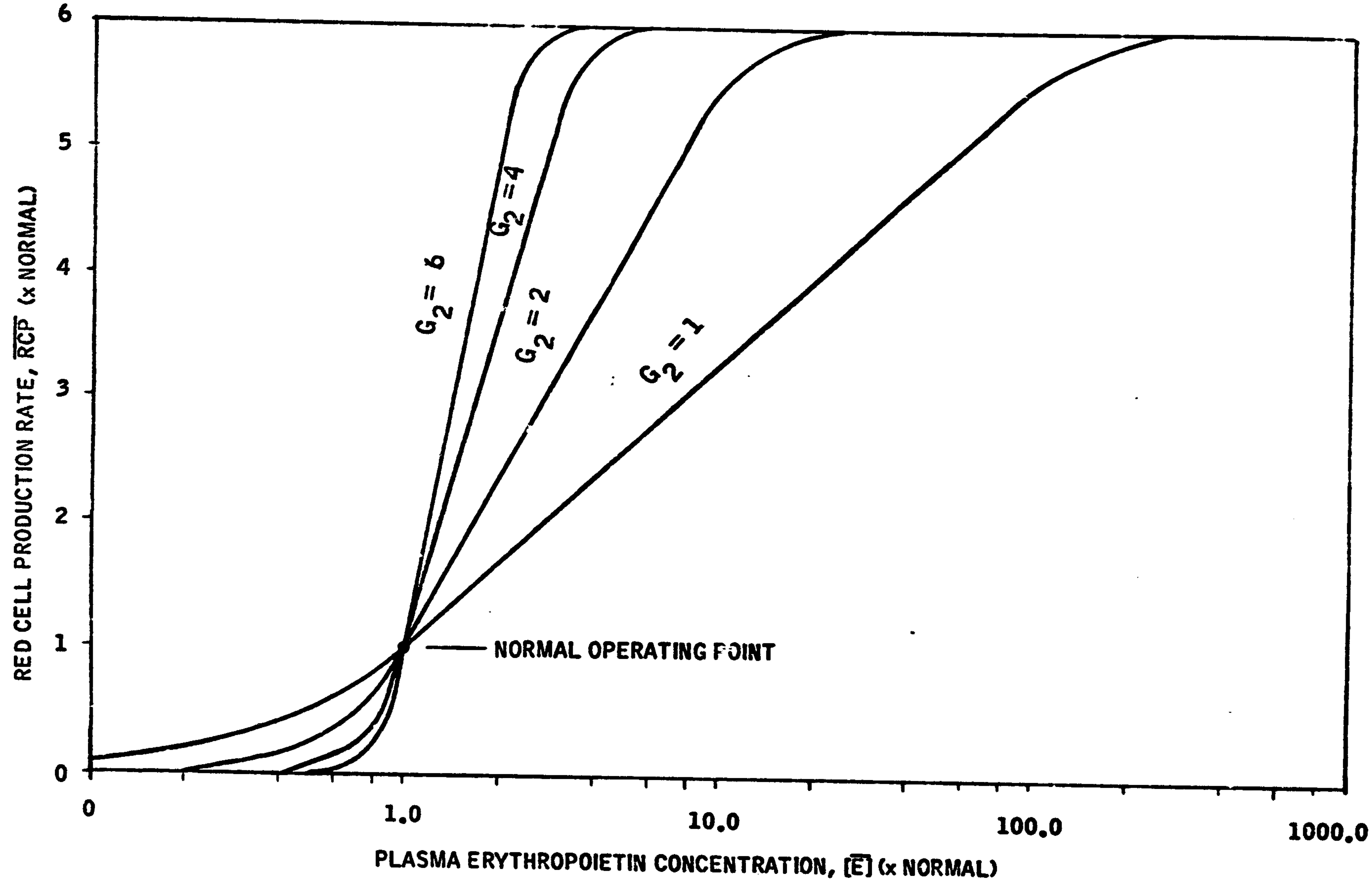

FIGURE I

OXYGEN-HEMOGLOBIN EQUILIBRIUM CURVES FOR HUMAN AND MOUSE
EXPERIMENTAL VS THEORETICAL VALUES




RENAL ERYTHROPOIETIN PRODUCTION RATE FUNCTION CURVES

FIGURE 2




BONE MARROW RED CELL PRODUCTION FUNCTION CURVES

FIGURE 3

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# APPENDIX

## SYSTEM PARAMETERS FOR THE MOUSE (1)

| STRAIN | RBC millions/mm$^3$ | Hct. % | MCV, | Hb g/100 cc blood | Hb g/cc cells | Ret. % |
|---|---|---|---|---|---|---|
| A/J | 9.42 ± 0. | 42.5 ± 0.4 | 45.1 ± 1.4 | 12.9 ± 0.2 | 0.30 | 3.5 |
| A/HeJ | 9.48 ± 0.18 | 42.5 ± 0.5 | 44.8 ± 1.0 | 12.7 ± 0.2 | .30 | 2.9 |
| AKR/J | 9.38 ± 0.24 | 45.6 ± 1.0 | 48.5 ± 1.6 | 13.9 ± 0.2 | .30 | 2.3 |
| BALB/e AnJ | 10.14 ± 0.15 | 46.5 ± 0.8 | 45.9 ± 1.1 | 14.5 ± 0.2 | .31 | 3.3 |
| BALB/e J | 10.51 ± 0.16 | 48.0 ± 0.7 | 45.7 ± 1.0 | 15.0 ± 0.2 | .31 | 2.9 |
| CBA/J | 10.04 ± 0.27 | 45.0 ± 1.3 | 44.8 ± 1.8 | 13.5 ± 0.2 | .31 | 2.6 |
| C3H/J | 8.79 ± 0.24 | 39.5 ± 0.7 | 44.9 ± 1.4 | 12.2 ± 0.4 | .31 | 2.8 |
| C3H/SeJ | 9.63 ± 0.26 | 43.0 ± 1.0 | 44.7 ± 1.6 | 13.2 ± 0.3 | .30 | 2.2 |
| C57BL/6pJ | 9.70 ± 0.15 | 43.4 ± 0.8 | 44.7 ± 1.0 | 13.0 ± 0.3 | .30 | 2.5 |
| C57BL/6J | 9.66 ± 0.09 | 44.0 ± 0.4 | 45.5 ± 0.6 | 13.3 ± 0.2 | .30 | 2.6 |
| C57BR/edJ | 10.54 ± 0.17 | 50.0 ± 0.5 | 47.4 ± 0.9 | 14.6 ± 0.2 | .29 | 2.1 |
| C576/HeJ | 9.82 ± 0.20 | 50.6 ± 0.4 | 51.5 ± 1.1 | 14.9 ± 0.2 | .29 | 2.6 |
| DBA/1J | 10.52 ± 0.27 | 43.8 ± 0.6 | 41.6 ± 1.2 | 13.2 ± 0.2 | .30 | 1.5 |
| DAB/WaJ | 9.93 ± 0.27 | 43.0 ± 0.6 | 43.3 ± 1.1 | 12.5 ± 0.2 | .29 | 2.6 |
| DBA/2J | 10.30 ± 0.25 | 42.6 ± 0.5 | 41.4 ± 1.1 | 12.7 ± 0.1 | .30 | 3.1 |
| I/J | 10.27 ± 0.27 | 46.8 ± 0.7 | 45.6 ± 1.5 | 13.5 ± 0.1 | .29 | 2.4 |
| RHI/J | 9.63 ± 0.25 | 44.5 ± 0.6 | 46.2 ± 1.3 | 13.7 ± 0.2 | .31 | 2.8 |
| ST/J | 9.88 ± 0.19 | 44.1 ± 1.1 | 44.6 ± 1.4 | [illegible] ± 0.2 | .31 | 2.1 |

### MOUSE ERYTHROCYTES & HEMOGLOBIN

| Author | # | RBC(millions) | Hb |
|---|---|---|---|
| Hirschfield 1897 | 6 | 5.2-9.15(7.06) | 85-100(93.3) |
| Kabierski 1961 | 33 | 8.2-14 (10.7) | 97.0 |
| Levy 1926 | 55 | 5.5-13.98(9.8) | 75-125 (97.1) |
| Klieneberger 1927 | 17 | 7.3-11.7 (9.7) | 94-128 (116) |
| Haam 1931 | 20 | 8.16-11.46(9.42) | 76-112 (94.2) |
| Albritton 1955 | -- | 7.7-12.5(9.3) | 10-19 (14.8) gm% |
| Schermer 1967 | 34 | 6.14-11.5(9) | 70-103 (90) |

### RETICULOCYTE COUNT (3)

2.8 - 3.5% (Kunze)
3.2 - 8% (Isaacs)
1.8 - 1.9% (Schermer ——→ larger values in juvenile mice)
40% at birth to 5% 6 weeks later (Seyfarth & Jurgens)
44$ at birth to 20% 14 days later (Kunze)

HCT. 41.5% (Albritton) (3)

Serum Viscosity 1.47 (Frank) 1.41 - 1.50 (3)

Specific Gravity of Blood 1.057 (Albritton) 1.052 - 1.062 (3)

## ERYTHROCYTE AND HEMOGLOBIN VALUES

| | RBC count million/ 1 blood | RBC packed volume ml/100 ml blood | RBC Volume 3 | Hb g/100 ml blood | Hb g/100 ml RBC | RBC Hb Content pg | RBC Dimensions (4) |
|---|---|---|---|---|---|---|---|
| Musculus | 9.3 (7.7 - 12.5) | 41.5 | 49(48-51) | 14.8(10-19 | 36 (33-39) | 16(15.5-16.5) | 6.0 |

| RBC millions/mm3 | HCT ml/100 ml | Reticulocytes % of total RBC | RBC diam. μ dry film | RBC vol. cu μ | Blood (Hb) g/100 ml blood | RBC (Hb) g/100 ml RBC | RBC Hb content μ μg | |
|---|---|---|---|---|---|---|---|---|
| 9.3(7.7-12.5) | 41.5 | 4.0 | 6.0 | 49(48-51) | 14.8(10-19) | 36 (33-39) | 16 (15.5-16.5) | (5) |

| | RBC/mm3 x 10 6 | HB g/100 ml | PCV % | HCV cu μ | HCH μμg | MCHC % | Retics % | (7) |
|---|---|---|---|---|---|---|---|---|
| C57Bl/6xA 6 | 8.6 | 14.8 | 43 | 49 | 17 | 35 | --- | |
| Charles River 2 | 7.9 | 11.9 | 41 | 52 | 15 | 29 | --- | |
| C57Bl/6Jax | 10.0 (9.9) | 16.2 (13.4) | 48 (45) | 48 (45) | 16 (13) | 34 (30) | --- (2.5) | |
| Strong CBA | 9.0 | 15.3 | --- | --- | 17 | --- | --- | |
| C57Bl | 7.4 | 12.7 | 42 | 57 | 17 | 30 | 0.8 | |
| Final Est. | 8.6 | 14.2 | 45 | 51 | 17 | 33 | 2.0 | |

| | HCT % | [Hb] g/100 ml | RBC count millions/mm3 | (9) |
|---|---|---|---|---|
| mouse | 50 | 16.7 | 10.5 | |

| HCT % | RBC (No. x $10^6$/ μ 1) | (10) |
|---|---|---|
| 47.9 ± 0.7 | 9.5 ± 0.8 | |

## OXYGEN

### TENSION OF 1/2 SATURATION

| $pCO_2$ mm Hg | pH | Temp. °C | Tension 1/2 sat mm Hg (5) |
|---|---|---|---|
| 40 | --- | 38 | 72 |

EHL

| | RBC LIFESPAN | HALF-LIFE | RBC LIFESPAN AND/OR 1/2 LIFE PROCEDURE USED FOR DETERM. | |
|---|---|---|---|---|
| TE | 40-43 days | | $C^{14}$- labeled glycine or Hb precursor | |
| C3H | 40-43 days | | $C^{14}$- labeled glycine or Hb precursor | |
| (C57 BL x CBA) $F_1$ | 40-43 days | | in vivo $P^{32}$-labeled duropropylfluorophorphate | |
| | | 20 days | transferred isologous normal $C^{51}$-labeled (Goodman & Smith) | |
| | | 25.6 days | transferred isologous $C^{51}$-labeled (Bernstein) | (1) |
| sev. inbred strains (avg.) | 50-55 days | 15-20 days | " " " " | |
| DBA/2 | | 19.7 (18.5-- 20.8) days | " " " " | |
| BALB/C | | 16.6 (11.5 - 20.3) days | " " " " | |
| (BALB/C x A/JAX) $F_1$ | | 15.0 (12.5 - 17.2) days | " " " " | |
| (C57BL/6 x DBA/2)$F_1$ | | 19.0 (17.5 - 20.3) days | " " " " | |
| (C57L x A/JAX)$F_1$ | | 17.6 (14.8 - 19.7) days | " " " " | (2) |
| (C57BL x 101)$F_1$ | | 19.7 (16.1 - 21.7) days | " " " " | |
| (C3H x 101)$F_1$ | | 18.4 (13.1 - 22.7) days | " " " " | |
| (101 x C3H)$F_1$ | | 16.6 (14.1 - 19.4) days | " " " " | |
| Sprague-Dawley Rats | 60 days | 19 (15.8 - 20.5) days | " " " " | |

RBC Life Span of about 20 days (Guess)[9]

ERYTHROPOIETIN HALF-LIFE (IN PLASMA)[11] => 3.25 Hours

Normal erythropoietin level = 0.02 units/ml (Int. Ref. Prep. units/ml) in plasma

Blood volume est. at 7% of total body weight

Maximum erythropoietin level = 0.3 units/ml in plasma at 14,500 ft (440 mm Hg)

ERYTHROCYTE LIFE SPAN[12]

| | |
|---|---|
| Method used was intraperitoneal injection of 1 $\mu$ c of | 46.9 days at 1 atm |
| raticactively labelled diuropropyl phorphorofluorodate | 44.0 days at .7 atm |
| [$DF^{32}P$] => very accurate at S.S. | 39.2 days at .5 atm |

Normal life span using $^{51}Cr$ dilution has been det. to be from 23-63 days; 19 days using the sulfhemoglobin method.

two other studies by Van Putten using $DF^{32}p$ => 40.7 and 44.6 days

Mus Musculus

DATA FOR CONSTRUCTING BLOOD OXYGEN DISSOCIATION CURVES(4)

| Blood or Blood Fraction | Solvent $[P_{CO_2}$, mm Hg$]$ | pH | Temp. °C | P50 mm Hg | BOHR Effect | n $[\Delta \log P_{50}/°C]$ |
|---|---|---|---|---|---|---|
| Whole Blood | ----- | 7.40 | 37 | 52 | ---- | ---- |
| | [40] | 7.4 | 37 | 41.5 | ---- | ---- |
| Free Solution | 0.03 M $PO_4$ | 6.8 | 37 | 34.2 | ---- | ---- |
| | 0.1 M $PO_4$ | --- | 20 | 12.3 | -0.93 | 2.4 |
| | 0.1 M $PO_4$ | 7.16 | 35 | 26.0 | -0.96 | 2.80 |

MORPHOMETRIC PARAMETERS OF LUNG (4)

mouse

| # | Wt, kg | lung volume, ml | Alveolar surface, $m^2$ | capillary surf, $m^2$ |
|---|---|---|---|---|
| 5 | 0.023 ± 0.002 | 0.74 ± 0.075 | 0.068 ± 0.009 | 0.059 ± 0.006 |

| | |
|---|---|
| Capillary volume, ml | 0.084 ± 0.009 |
| Mean thickness of alveolar - capillary tissue barrier, μm | 1.25 ± 0.08 |
| Harmonic mean barrier thickness, μm | 0.32 ± 0.0006 |
| Minimal barrier thickness, | 0.15 |
| Harmonic Mean thickness of plasma layer, μm | 0.11 ± 0.002 |
| Maximal diffusion capacity of lung | 0.147 ± 0.015 |
| Ratio of capillary to alveolar surface | 0.87 |
| Capillary volume per alveolar surface, $ml/m^2$ | 1.23 |

Mus musculus

## LUNG VENTILATION

| Respiration Freq. breath/min. | Tidal Volume (ml) | Minute Volume (L) $\left[\begin{matrix}(\text{resp.freq.})\\ \times \text{ T.V.}\end{matrix}\right]$ [5] |
|---|---|---|
| 163 (84 - 230) | 0.15 (0.09-0.23) | 0.023 (0.011 - 0.036) |

## TISSUE OXYGEN CONSUMPTION

| Mouse | Med. | $-Q_{O_2}$ | Tissue | Medium | $-Q_{O_2}$ |
|---|---|---|---|---|---|
| | | | Mouse (concluded) | | |
| Adrenal | A | 6.0 | Ovary | A | 9.0 |
| Brain cortex | $D^1$ | 32.9 | Placenta, 0.4 mg | A | 7.5 |
| Cerebral cortex | E | 11.0 | 10.9 - 13.7 mg | A | 6.4 |
| Embryo | $B_1$ | 10.4 | Pituitary | A | 8.0 |
| Kidney cortex | $D^1$ | 46.1 | Skin, newborn | $B_1$ | 6.1 |
| Liver | B | 8.8-13.8 | Spleen | $D^1$ | 16.9 |
| Liver | $E_1$ | 18.7 | | | |
| Liver | $D^1$ | 23.1 | | | |
| Lung | $B_1$ | 7.3- 8.0 | | | |
| Lung | $D^1$ | 12.0 | | | |

A = Serum

B = Ringer Glucose

D = Ringer Phosphate $Ca^{++}$ free

E = Ringer Solution

## OXYGEN CONSUMPTION [4]

| # | Body Wt. gm | Ambient Temp. °C | $O_2$ Consumption ml/gm hr | Deviation % |
|---|---|---|---|---|
| 47 | 35.7 | 32 | 1.59 | + 4.6 |

## OXYGEN CAPACITY AND BOHR EFFECT [4]

| # | Method of Measurement | Temp. °C | $P_{50}$ mm Hg | $O_2$ Capacity ml $O_2$/100 ml blood | BOHR Effect |
|---|---|---|---|---|---|
| 31 | micromanometric | 37.0 | 34 | 19 | 0.63 |

Arterial $PO_2$ => 78 mm Hg [11,20]

Maximum $O_2$ capacity of Hb => calculated => 1.41 using 13.4 g Hb/100 ml blood[1] and 19 ml $O_2$/100 ml blood as oxygen capacity[4]

## BODY TEMPERATURE [5]

| | °C |
|---|---|
| Mouse, deer (Peromyscus leucopus) | 37.4(33.6-41.2) |
| Mouse, deer (P. maniculatus) | 37.9(35.7-40.1) |
| Mouse, house (Mus musculus) | 36.5(35.2-37.9) |
| Mouse, jumping (Zapus hudsonicus) | 37.3(35.3-39.3) |
| Mouse, meadow (Microtus pennsylvanicus) | 39.3(34.7-43.1) |
| Mouse, pocket (Perognathus hispidus) | 36.5(34.9-38.1) |
| Mouse, red-backed (Clethrionomus gapperi) | 37.3(35.3-39.3) |
| Mouse, red-backed (C. rutilus) | 38.3(36.6-40.0) |

## BLOOD PRESSURE mm Hg [5]

| SYS | DIA |
|---|---|
| 147 (133-160) | 160 (102-110) |

## HEART RATE beats/min [5]

| | |
|---|---|
| Mus musculus | 600 (328-780) |
| Peromyscus rp. (deer) | 534 (324-858) |

## BLOOD VOLUME [3]

2-2.5 ml (Isaacs) in a 25 gm mouse
7.6% of body weight (6.3-8.3) Welker
6.6% of body weight (5.4-8.3) Jolly & Lafond

## PLASMA VOLUME [5]

57.4 ml/kg (dessication)

## BLOOD INDICES ARE GREATLY INFLUENCED BY NATURE OF BLOOD SAMPLING, AGE [3]

| | Venous blood from tail | | | Blood from femoral artery | | |
|---|---|---|---|---|---|---|
| | RBC's | Hb (%) | WBC | RBC | Hb (%) | WBC |
| 1 | 10.6 | 120 | 16,000 | 10.25 | 120 | 8,250 |
| 2 | 10.745 | 125 | 13,000 | 10.625 | 125 | 10,568 |
| 3 | 11.225 | 125 | 31,600 | 11.03 | 125 | 10,900 |
| 4 | 12.385 | 133 | 16,086 | 10.475 | 133 | 7,500 |
| 5 | 8.89 | - | 18,500 | 9.2 | 95 | 6,200 |
| 6 | 11.64 | - | 12,750 | 8.75 | 120 | 6,000 |
| 7 | 9.15 | - | 7,000 | 7.73 | 95 | 2,000 |

Erythrocyte counts are 1.3 million higher on the average if tail is immersed in warm water.[3]

| | RANGE OF VARIATION | MEAN VALUE [3] |
|---|---|---|
| RBC | 6-2 million | 9 million |
| Reticulocytes | 2-5% | 3% |
| Hemoglobin | 70-100% | 90% |

## KIDNEY MEASUREMENTS[5]

| | | Wt. of 1 Kidney | | Glomerulus | | | |
|---|---|---|---|---|---|---|---|
| | Body wt. (kg) | g | % body wt. | Radius ( μ ) | 1000's/kidney | Vol/kidney cu mm | Vol/g Kidney cu mm |
| Mouse | 0.02 | 0.12 | 0.61 | 37 | 12.4 | 2.6 | 21 |

Specific gravity of whole mouse blood is 1.057 (1.052 - 1.062) [5]

Spleen and bone marrow transit time => 3-4 days[1]

Renal mass = 0.12 g or 0.61% BW (5)

## HEPATIC BLOOD FLOW[4]

| | | | | |
|---|---|---|---|---|
| Mouse | Anesthetized | Det. by ext. counting of head<br>Single injection of colloidal $\left[{}^{198}Au\right]$ gold<br>ICG Injection | $63.0 \frac{ml*kg}{min}$ *body wt. | (93-103)<br>102 $ml*min^{-1}*100g*liver^{-1}$<br>35 $ml*min^{-1}*100\ g*liver^{-1}$ |

## SYSTEM PARAMETERS FOR THE RAT [4]

| RBC Count millions/µl blood | PCV RBC Packed Vol. ml/100 ml blood | RBC Vol. $\mu^3$ | (Hb) g/100 ml blood | g/100 ml RBC | RBC Hb Content pg | RBC Dimensions µ |
|---|---|---|---|---|---|---|
| 8.9 (7.2 - 9.6) | 46 (39 - 53) | 61 (57 - 65) | 14.8(12.0-17.5) | 32 (30 - 35) | 17 (15 - 19) | 7.5 (6.0 - 7.5) |

| RBC millions/$mm^3$ | HCT ml/100 ml | Reticulocytes % of total RBC | RBC Diameter (Any film) µ | RBC Volume $\mu^3$ | Blood (Hb) 2/100 ml blood | Blood (Hb) 2/100 ml RBC | RBC Hb Content µµg |
|---|---|---|---|---|---|---|---|
| 8.9 (7.2 - 9.6) | 46 (39 - 53) | 2.9 (0.6-4.9) | 7.5(6.0-7.5) | 61(57-65) | 14.8(12-17.5) | 32 (30-35) | 17 (15-19) |

| | RBC/$mm^3$ x $10^6$ | HGB g/100 ml | PCV % | MCV cu | MCH µµg | MCHC % | Retics % [7] |
|---|---|---|---|---|---|---|---|
| Chas.River | 8.2 | 15.7 | 40 | 49 | 20 | 40 | --- |
| | 7.5 | 15.4 | 38 | 52 | 21 | 40 | --- |
| Wistar | 7.9 | 16.6 | 53 | 67 | 21 | 31 | --- |
| | 7.5 | 16.4 | 52 | 70 | 22 | 31 | --- |
| | 7.7 | 17.0 | 49 | 64 | 22 | 35 | --- |
| | 7.2 | 16.7 | 48 | 67 | 23 | 35 | --- |
| Long-Evans | 7.1 | 14.2 | 43 | 61 | 20 | 33 | 0.99 |
| Mixed Stock | 6.6 | 13.0 | 39 | 61 | 20 | 32 | --- |
| Sprague Dawley | 6.1 | 13.5 | 40 | 65 | 22 | 34 | --- |
| Fischer Axenic | 9.0 | 14.6 | 47 | 54 | 16 | 31 | --- |
| | 8.0 | 13.8 | 44 | 58 | 17 | 31 | --- |
| | 8.2 | 14.8 | 43 | 53 | 18 | 35 | --- |
| Final Est. | 7.3 | 15.2 | 45 | 62 | 21 | 34 | 0.7 |

| # | HCT % | Hb | |
|---|---|---|---|
| 10 | 40.8 | 13.1 g/100 ml; 2.39 g total | determined by co method at sea level [14] |
| 53 | 49.4 | 15.0 g/100 ml | RBC millions/µl / 9.1 ml |

| RBC/$mm^3$ | HTC % | Hb g% [13] |
|---|---|---|
| 8.4 x $10^6$ ± 2.5 | 43 ± 5.2 | 12.0 ± 0.52 |

**RETICULOCYTES %**

| | |
|---|---|
| 2.9 (0.6 - 4.9) | Albritton |
| 2-5 | Scherher |
| 2.3 | Hulse |
| 3-5 | Seyfarth |

**RBC DIAMETER µ**

| | |
|---|---|
| 6.2 (5.7 - 7) | Klieneberger |
| 6.8 (6.0 - 7.5) | Albritton |

**HEMOGLOBIN gm/100 ml** [15]

| | |
|---|---|
| 16.5 (11.4-19.2) | Wirth |
| 14.8 (12- 17.5) | Albritton |
| 15.4 | Hulse |

**HEMATOCRIT %**

| | |
|---|---|
| 50 | Farris & Griffith |
| 46 (39-53) | Albritton |
| 50.5 | Hulse |

## DATA FOR CONSTRUCTING BLOOD OXYGEN DISSOCIATION CURVES(14)

| | Blood or Blood Fraction | Solvent ($PCO_2$, mmHg) | pH | Temp. °C | $P_{50}$ mmHg | BOHR Effect | m Δ log $P_{50}$/°C |
|---|---|---|---|---|---|---|---|
| Rattus norvegicus | Whole Blood | 40 | 7.4 | 37 | 38 | --- | --- |
| Long-Evans | Whole Blood | 35 | - | 37 | 49 | --- | --- |
| | Free Solution | 0.1 M $PO_4$ | 7.40 | 20 | 6.0 | -0.78 | --- |
| White | Whole Blood | --- | 7.40 | 37 | 38 | --- | --- |
| | Free Solution | 0.03 M $PO_4$ | 7.2 | 37 | 19.7 | --- | --- |
| Wild | Whole Blood | --- | 7.40 | 37 | 39 | --- | --- |
| | Free Solution | 0.03 M PO | 7.2 | 37 | 20.3 | --- | --- |

| | # | Method of Measurement | Temp. °C | $P_{50}$ mmHg | $O_2$ Capacity ml $O_2$/100 ml blood | BOHR Effect |
|---|---|---|---|---|---|---|
| Rattus norvegicus, Wistar I | 16 | Micromanometric | 37.0 | 35 | 23 | --- |

| Body Temp. °C | Sample Blood | Plasma pH (7.26-7.44) | Hb* mM/L | Cell Vol. % | $CO_2$ COMB Power mM/L | $CO_2$ Total mM/L | $CO_2$ Pressure mm Hg | $H_2O$ g/L |
|---|---|---|---|---|---|---|---|---|
| 38.2 | Arterial | 7.35 | 9.0 | 46 | 19.5 | 24 (20-28) | 42 | 946 |

* Assumed [ ] of 20 mM Hb/L RBC; 1 mM (single Fe - atom structure, molecular weight 16,500) combines with 22.4 ml of $O_2$, S.T.P. when saturated.

* 1/2 sat (tension of 1/2 saturation) of rat in mm Hg at 37°C and pH of 7.4 is = 40

| Tidal Vol. (ml) | Minute Vol. (L) |
|---|---|
| 1.5 (1.4-1.6) | 0.100 (0.075 - 0.130) |

Respiratory Exchange Characteristics = RQ or $CO_2/O_2$ is 0.894 (0.754 - 1.072)

### TISSUE OXYGEN CONSUMPTION(15)

1 atm 37°C

| Tissue | Medium | $-QO_2$ |
|---|---|---|
| 32 Kidney | M | 15.8 |
| 33 Kidney | N | 38.0 |
| 34 Kidney | O | 23.2 |
| 35 Kidney | L | 23.1 |
| 36 Kidney | I | 34.0 |
| 37 Kidney | $K_1$ | 26.0 |
| 38 Kidney Cortex | D | 38.2 |
| 39 Liver | C | 7.2 |
| 40 Liver | L | 8.1 |
| 41 Liver | I | 9.0 |
| 42 Liver | I | 10.7 |
| 43 Liver | $J_1$ | 25.0 |
| 44 Liver | D | 17.2 |
| 45 Liver fetus | A,B | 7.1 |

cu mm $O_2$ per mg dry wt. tissue in one hour

A = Serum
B = Ringer
D = Ringer Phosphate
I = Lactate
J = Succinate
K = Pyruvate
L = Glucose
M = No substrate added
N = Alanine
O = Butyrate

Intravenously injected erythropoietin 1/2 life in plasma is 1 hour[17]

Long-Evans ♀ Rats

Erythropoietin 1/2 life is 1-5 hours

Half life of ESF in perfused Rat Liver is 3.5 hours

RBC Life span = 55 days[19]

Erythrocyte Life Span and Half Life[2]

Sprague-Dawley 60 days life span and 19 days half life

Rattus norvegicus body temperature of 37.3 (34.5-40.0)°C [5]

## BLOOD VOLUME

Blood Volume = 5.29 ml/100 gm BW[18]

Blood Volume[15]

5-8% of body weight (Schulz and Von Kruger)

6.7 ml/100 gm body weight (Cartland & Koch)

## HEPATIC BLOOD FLOW[14]

| | | | | |
|---|---|---|---|---|
| Rat | Normal | Single injection of colloidal | I - albumin | 66.2 ml min$^{-1}$ kg body wt$^{-1}$ |
| | Normal | Thermoelectric | | 79 (75-92) ml. min$^{-1}$ 100g liver$^{-1}$ |
| | Anesthetized | Thermoelectric | | 42 ml min$^{-1}$ 100 g liver$^{-1}$ |

## KIDNEY FUNCTION[15]

S.A. = surface area = 0.18 sq. m in 0.2 kg rat

| | | |
|---|---|---|
| Effective renal blood flow | 8 ml/min | 221 ml/min per sq. m. S.A. |
| Effective renal plasma flow | 4.4 ml/min | 145 ml/min per sq. m. S.A. |
| Glomerular Filtration rate | 1.7 ml/min | 40 (23-96) ml/min per sq. m. S.A. |
| Filtration fraction GFR/ERPF [(% Plasma filtered)] | 28 | |

## PLASMA VOLUME ml/kg[15]

| | | | |
|---|---|---|---|
| Very young | 54.7 (49.6 - 59.8) | ♂290-350g | 45.1 (31-59) |
| Pubescent | 65.0 (59.2 - 70.8) | | |
| Adult | 41.5 (29.5 - 53.5) | | |

Comparison of mean values for total blood flow (RBF) in one kidney in vivo by different techniques in nondiuretic rats (16)

| Technique | RBF ml min | Mean AP mmHg [a] | Strain of Rat [b] | No. of Animals |
|---|---|---|---|---|
| Electromagnetic flow transducer | 6.0 g KW[c] | 114 | SD | 13 |
| | 6.1 g KW[d] | 112 | SD | 6 |
| PAH clearance | 6.2/g KW[d] | 112 | SD | 6 |
| | 5.4/g KW | 112 | W | 6 |
| | 6.5/g KW[f, g] | | | 28 |
| | 6.4/250 g BW[g, h, i] | | | 124 |
| | 6.2/250 g BW | | SD | 7 |
| | 5.5 | 112 | SD | 9 |
| | 6.6 | 120 | SD | 8 |
| | 3.9/250 g BW[j, k] | | W | 10 |
| | 8.5/g KW | | W | 10 |
| Microsphere | 5.8 | | SD | 11 |
| Antiglomerular basement membrane Antibody | 6.8/g KW | | SD | 14 |
| | 7.5 | | SD | 6 |
| | 6.3 | 127 | SD | 6 |
| K uptake | 4.4/250 g BW | | | 17 |
| | 7.1/250 g BW | | | 23 |
| RH uptake | 3.6/g KW | | W | |
| Macro puncture of superficial nephrons | 4.8 | 130 | MW | 7 |
| | 4.8 | 122 | MW | 8 |
| | 3.9 | 109 | MW | 18 |
| XE washout | 4.2/g KW | | | 28 |
| | 3.4/g KW | 114 | W | 15 |
| Renal venous outflow | 3.5/250 g BWk | | W | 20 |
| | 3.9/250 g BWk | | W | 16 |
| High frequency microcinematographic | 3.1/250 g BWk | | W | 9 |

VISCOSITY OF BLOOD (15)

| | |
|---|---|
| min | 1.44 |
| max | 1.96 |
| avg. | 1.54 |

RENAL BLOOD FLOW (16)

| Arterial pressure mmHg | Blood flow |
|---|---|
| >100 | 6 ml/min .g kidney wt. |

## EFFECT OF VARIATIONS IN ARTERIAL PRESSURE ON RENAL BLOOD FLOW AND RENAL VASCULAR RESISTANCE(16)

| | PRESSURE RANGE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | 90-100 | 100-110 | 110-120 | 120-130 | 130-140 | 140-150 |
| AP, mm Hg | 45.3 ± 3.2 | 54.5 ± 2.0 | 64.6 ± 0.9 | 75.2 ± 1.0 | 84.9 ± 1.1 | 94.5 ± 1.2 | 104.7 ± 1.3 | 114.0 ± 1.4 | 123.1 ± 2.9 | 132.7 ± 1.5 | 144.4 ± 2.2 |
| RBF, ml/min.g KW | 2.82 ± 0.69 | 3.39 ± 0.65 | 4.29 ± 0.82 | 4.76 ± 1.05 | 5.24 ± 1.05 | 5.66 ± 0.91 | 5.90 ± 0.93 | 5.95 ± 0.82 | 6.05 ± 0.88 | 6.13 ± 0.80 | 6.14 ± 0.86 |
| RVR, mmHg/ml. min.g KW | 14.9 ± 2.9 | 15.1 ± 2.9 | 14.4 ± 2.9 | 15.5 ± 3.6 | 15.9 ± 3.7 | 16.2 ± 2.8 | 17.3 ± 3.1 | 18.8 ± 3.1 | 20.1 ± 3.2 | 21.2 ± 2.9 | 23.2 ± 3.2 |
| No. of animals | 9 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 5 |

Values are means ± 1 SD.

## SPECIFIC GRAVITY OF BLOOD(5)

Whole 1.054 (1.046 - 1.061)
Plasma 1.023 (1.018 - 1.028)

## HEPATIC BLOOD FLOW(4)

Basal thermoelectric 79 (75-92) ml/100g tissue per min.

## ARTERIAL BLOOD PRESSURE mm Hg(4)

| Sys. | Dias. |
|---|---|
| 116 (88-130) | 90 (60-100) |

## CAPILLARY BLOOD PRESSURE (MESENTERY) cm $H_2O$(4)

| Arterial | Venous |
|---|---|
| 30.0 (22.0 - 34.0) | 17.0 (15.0 - 20.0) |

## CARDIAC OUTPUT (4)

| | Body Wt. (kg) | S.A. (rq. m.) | Stroke Vol. ml/beat | L/min Cardiac Output | L/sq m/min Cardiac Index |
|---|---|---|---|---|---|
| Anesthetized | 0.18 | 0.0[illegible] | 1.3 - 2.0* | 0.047 (0.015-0.079) | 1.[illegible] |

* .5 ml/kg = > animals 2.5-4 kg

## HEART RATE Beats/min (4)

328 (261 - 600)

Cardiac Output = 286 ml/kg min
Heart Rate = 420 beats/min
Arterial Blood Pressure = 130

Arterial Oxygen Saturation = 91.3%

| | Range of Variation | Mean (15) |
|---|---|---|
| RBC | 5.5 - 10 million | 8 million |
| Retics | 2-5% | --- |
| Hb% | 80-129 | 100 |
| Hb gm/100 ml | 11.4 - 19.2 | 16.0 |

Max. $O_2$ Capacity of Hb is 1.55 (calculated)

Renal Mass is .37% BW

$2.8 \pm 0.1$ ml RBC/100 gm BW

$O_2$ Capacity of Blood is 23 ml $O_2$/100 ml blood

## MORPHOMETRIC PARAMETERS OF LUNG (4)

| | |
|---|---|
| Number of Subjects | 8 |
| Body Wt., kg | 0.14 ± 0.007 |
| Lung Vol., ml | 6.3 ± 0.5 |
| Alveolar surface, $m^2$ | 0.39 ± 0.02 |
| Capillary surface, $m^2$ | 0.41 ± 0.02 |
| Capillary Vol., ml | 0.48 ± 0.02 |
| Mean thickness of alveolar-capillary tissue barrier, μm | 1.42 ± 0.07 |
| Harmonic mean barrier thickness, μm | 0.38 ± 0.02 |
| Harmonic mean thickness of plasma layer, μm | 0.18 ± 0.005 |
| Minimal barrier thickness | 0.15 |
| Maximal diffusion capacity of lung | 0.83 ± 0.03 |
| Minimal diffusion capacity of lung | ---- |
| Ratio of capillary to alveolar surface | 1.05 |
| Capillary volume per alveolar surface | 1.23 |

| | # | Body wt.$_g$ | Temp. °C Body | Temp. °C Ambient | $O_2$ Consumption ml $g^{-1}$ $hr^{-1}$ | Deviation % |
|---|---|---|---|---|---|---|
| Rattus norvegicus | 40 | 545 | 37.5 | 28 | 0.84 | +15 |

MEASURED VALUES / CALCULATED VALUES(14)

| Rat No. | Hct | OXYGEN Capacity, mM | OXYGEN Content, mM | OXYGEN Satur., % | pH | $(CO_2)b$, mM | $P_{CO_2}$, mmHg | $(HCO_3^-)p$, mEq/liter | Buff. base, mEq/liter |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 50 | 8.2 | 7.8 | 95.1 | 7.39 | 21.4 | 43.5 | 25.8 | 50.0 |
| 2 | 45 | 8.5 | 8.2 | 96.5 | 7.39 | 18.6 | 36.0 | 21.6 | 45.0 |
| 3 | 45 | 9.4 | 8.2 | 97.2 | 7.41 | 20.4 | 38.0 | 24.0 | 47.7 |
| 4 | 42 | 8.1 | 7.2 | 88.9 | 7.42 | 20.7 | 37.0 | 23.8 | 47.7 |
| 5 | 44 | 8.4 | 7.7 | 91.7 | 7.42 | 17.7 | 32.8 | 20.1 | 44.0 |
| 6 | 42 | 8.3 | 7.3 | 88.0 | 7.38 | 19.0 | 37.0 | 21.6 | 46.5 |
| 7 | 46 | 8.6 | 8.0 | 93.0 | 7.41 | 21.2 | 40.0 | 25.0 | 50.0 |
| 8 | 46 | 8.9 | 8.2 | 92.1 | 7.39 | 19.1 | 37.4 | 22.3 | 46.0 |
| 9 | 45 | 9.1 | 8.1 | 89.0 | 7.39 | 20.9 | 40.0 | 23.9 | 46.7 |
| Mean | 45.0 | 8.6 | 7.9 | 91.3 | 7.40 | 19.9 | 38.0 | 23.1 | 47.1 |
| ± SD | 2.4 | 0.44 | 0.39 | 3.19 | .015 | 1.32 | 3.12 | 1.83 | 2.04 |
| ± SEM | 0.80 | 0.15 | 0.13 | 1.06 | .005 | 0.44 | 1.04 | 0.61 | 0.68 |

In this and subsequent tables, b = blood; p = plasma