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# The laboratory rat physiological parameters

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**Abstract**:Laboratory rats were the first mammals domesticated for research and remain a well-studied model in biomedical science. Rats have been indispensable as model organisms in research, offering valuable insights into physiological processes and also disease mechanisms due to their well-documented biology and adaptability. This review focuses on the physiological parameters linked to the cardiovascular system, respiratory system and digestive system across variants of laboratory rats. The physiological parameters of laboratory rats are influenced by both genetic background and environmental factors. Different rat strains exhibit distinct physiological traits. Physiological parameters also vary with age and sex within the same strain. By consolidating existing knowledge, this paper seeks to provide a comprehensive understanding of laboratory rats' physiological attributes and their broader implications in advancing biomedical science.

### Introduction

There are common physical characteristics across the majority of laboratory rat strains. Certain conditions along with appropriate handling and sampling techniques must be used in order to avoid any discomfort and enhance the rats' well-being as the physiological parameters can be easily altered.

#### • Laboratory rat strain databases

The National BioResource Project for Rats, Taconic Biosciences database and the Rat Genome Database are databases aiming to facilitate biomedical research by providing standardized and well-characterized rat strains.

#### • Overview of laboratory rat strain variants

Noted are two main categories of laboratory rat strains: inbred strains and outbred strains.

• Physiological parameters in laboratory rat strains

Respiratory parameters tend to differ amongst different laboratory rat strains.

Table 1. Respiratory parameters in different strains of laboratory rats after Strohl et. al. (1997)

Strain	Respiratory rate (breaths/min)	Tidal volume (ml/100g)	Minute ventilation (ml/min/100g)
Brown Norway rat	104.48 ± 4.49	0.31 ± 0.02	27.91 ± 1.87
Sprague-Dawley rat	91.86 ± 5.24	0.29 ± 0.02	28.17 ± 1.37
Koletsky rat	104.36 ± 4.45	$0.24 \pm 0.01$	24.65 ± 1.34
Zucker rat	129.17 ± 4.54	0.20 ± 0.02	28.40 ± 1.51

Table 3. Biochemical blood parameters in Sprague-Dawley, Fischer and Wistar rats

Biochemical parameters							
Parameter	Male Wistar rats [Lima, 2014]	Female Wistar rats [Lima, 2014]	Male SD rats [Alemáan, 1998]	Female SD rats [Alemáan, 1998]	Male Fischer rats [Charles River Laboratories]	Female Fischer rats [Charles River Laboratories]	
Alkaline Phosphatase (U/L)	91.63 ± 28.70	75.95 ± 19.07	110 ± 25	95 ± 20	254-484	187-334	
Alanine Aminotransfera se (U/L)	57.55 ± 11.95	45.47 ± 9.23	60 ± 12	50 ± 10	64-940	45-473	
Aspartate Aminotransfera se (U/L)	131.33 ± 43.98	107.87 ± 53.96	140 ± 40	120 ± 35	80-1001	77-969	
Total Cholesterol (mg/dL)	60.68 ± 6.51	64.86 ± 11.17	65 ± 10	70 ± 12	61-95	86-141	
Albumin (g/dL)	2.65 ± 0.30	2.41 ± 0.76	3.0 ± 0.4	2.8 ± 0.5	3.5-4.3	3.5-4.5	
Globulin (g/dL)	3.50 ± 1.15	3.69 ± 1.47	3.2 ± 0.9	3.7 ± 1.0	-	-	
Creatinine (mg/dL)	0.58 ± 0.24	0.57 ± 0.19	0.6 ± 0.2	0.7 ± 0.2	0.3-0.6	0.2-0.6	
Urea (mg/dL)	39.97 ± 6.78	39.17 ± 6.43	40 ± 7	38 ± 6	11-20	8-18	
Glucose (mg/dL)	138.72 ± 30.17	114.57 ± 36.15	140 ± 30	120 ± 25	173-405	132-348	
Triglycerides (mg/dL)	46.87 ± 18.73	54.21 ± 35.5	50 ± 15	55 ± 20	140-589	87-333	
Sodium (mmol/L)	134.03 ± 4.67	134.57 ± 3.78	135 ± 5	134 ± 4	135.2-154.0	138.4- 152.0	
Potassium (mmol/L)	5.41 ± 1.15	4.79 ± 1.95	5.5 ± 1.0	5.0 ± 0.9	5.92-11.70	5.41-9.77	
Calcium (mg/dL)	8.19 ± 1.63	8.96 ± 1.13	8.5 ± 1.2	9.0 ± 1.1	93.2-105.1 <sup>a</sup>	95.7- 111.2 <sup>a</sup>	

Heart rate, systolic, and diastolic blood pressure are essential physiological indicators for assessing cardiovascular function, while blood parameters offer insights into the rats' overall health, physiological state and responses to environmental or experimental conditions.

Table 2. Hematological parameters in Sprague-Dawley, Fischer and Wistar rats

### Hematological parameters

Parameter	Male Wistar rats [Lima, 2014]	Female Wistar rats [Lima, 2014]	Male SD rats [Alemáan, 1998]	Female SD rats [Alemáan, 1998]	Male Fischer rats [Charles River Laboratories]	Female Fischer rats [Charles River Laboratories]
Leukocytes (10³/µL)	7.63 ± 2.37	4.96 ± 1.55	8.5 ± 2.1	6.7 ±1.8	2.06-9.61	1.92- 11.64
Red Blood Cells (10 <sup>6</sup> /μL)	8.65 ± 1.11	7.83 ± 0.69	9.2 ± 0.9	8.4 ± 0.8	7.05-9.67	6.56- 9.37
Hemoglobi n (g/dL)	15.00 ± 1.45	14.33 ± 1.19	15.8 ± 1.2	14.5 ±1.1	14.0-18.9	13.1- 18.4
Hematocrit (%)	43.30 ± 3.51	40.52 ± 3.77	45.2 ± 3.4	42.1 ± 3.2	46.5-62.0	43.5- 62.0
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<sup>a</sup> measured in meq/L.

The pH and transit time in different sections of the rat digestive tract vary depending on physiological conditions. Under fed conditions, the forestomach has a pH of 5.0, while the glandular stomach is more acidic having a pH value of 3.8. In the small intestine the pH has values between 6.5 and 7.1, whereas the colon and cecum pH range from 6.6 to 6.8. In younger rats, small intestinal transit time varies from 0.14 to 1.52 cm/h, while in the large intestine, it reaches 11.02 cm/h. In older rats, small intestinal transit times fall between 0.17 and 1.64 cm/h.

#### Conclusions

Blood parameters exhibit strain-specific variations in rats, with additional differences observed between males and females within the same strain. Cardiovascular parameters vary across strains and also dependent on the age of the rat.

Digestive parameters in laboratory rats vary across different sections of the gastrointestinal tract, with pH levels and transit times influenced by feeding status and age.





differences seen across different rat strains.