NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
AIR FORCE MISSILE DEVELOPMENT CENTER

TECHNICAL REPORT

PHYSIOLOGICAL BASE-LINE STUDIES
OF ZOOLOGICAL SPECIMENS

SERUM BIOCHEMICAL VALUES OF CHIMPANZEEES

Fred W. Staten
Robert H. Edwards
Per Fahlstrom
Elijah Goins
Zirkle Cooper
Virgil Schwandt

HOLLOMAN AIR FORCE BASE
NEW MEXICO

August 1961
Qualified requesters may obtain copies of this report without charge from the Armed Services Technical Information Agency (ASTIA). Department of Defense contractors must be certified for ASTIA services, or have their need-to-know established by the military agency sponsoring their project or contract.

Requests should be directed to:

Commander
Armed Services Technical Information Agency
Documents Services Center
Arlington Hall Station
Arlington 12, Virginia

This report is for sale to the general public through the Office of Technical Services, Department of Commerce,

Washington 25, D.C.

Requests should be directed to:

U. S. Department of Commerce
Office of Technical Services
Washington 25, D.C.
Project 6892

PHYSIOLOGICAL BASE-LINE STUDIES
OF ZOOLOGICAL SPECIMENS

SERUM BIOCHEMICAL VALUES OF CHIMPANZEES

by

Fred W. Staten
Robert H. Edwards
Per Fahlstrom
Elijah Goins
Zirkle Cooper
Virgil Schwandt

Bioastronautics Research Laboratory
Deputy for Development and Test

AIR FORCE MISSILE DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Holloman Air Force Base, New Mexico
August 1961
This investigation was conducted in accordance with the principles of laboratory animal care established by the National Society of Medical Research.
ACKNOWLEDGEMENT

We are indebted to the Chief of the Veterinary Services Branch, Bioastronautics Research Laboratory, Captain (Dr.) James E. Cook, for his advice and assistance during the work and writing of this report.

Appreciation is also due Captain (Dr.) Jerry Fineg, Chief of the Vivarium Section, Bioastronautics Research Laboratory, and to Captains (Drs.) William E. Britz and Vernon L. Carter of the Vivarium Section for their support and invaluable cooperation in obtaining the many blood samples which made this work possible.

Recognition of the following personnel, who are deserving of our thanks for their share in various and diverse roles in this study, is in order: CMSG Howard W. Blackburn, TSG Roy A. Gatewood, SSG Alvin E. Wiedeman, A1C Joe M. Pace, A2C Dan Beacham, A2C Edward Graff, A2C David L. Morgan, and A3C Michael Berman.
ABSTRACT

Biochemical titres of various components in the sera of 52 chimpanzees are presented. The findings are compared with man and the Macaca mulatta monkey. The method employed for each specific analysis is briefly discussed. The concentrations of the factors in the serum of the chimpanzee herein reported are similar for the most part to those in human serum.

PUBLICATION REVIEW

This Technical Report has been reviewed and is approved for publication.

FOR THE COMMANDER

FELIX H. JONES, JR.
Colonel, USAF
Deputy for Development and Test
TABLE OF CONTENTS

I. INTRODUCTION .................. 1
II. MATERIAL AND METHODS ........ 1
   A. Subjects ..................... 1
   B. Procedures .................. 2
      1. Blood Samples ............... 2
      2. Analysis .................... 2
III. RESULTS ....................... 5
IV. DISCUSSION ..................... 6
V. SUMMARY AND CONCLUSIONS .......... 12
REFERENCES ......................... 13

LIST OF TABLES

I. Paper Electrophoresis of Chimpanzee and Human Serum Proteins ........ 7
II. Chimpanzee Serum Electrolyte Values ........ 8
III. Macaca Mulatta Serum Electrolyte Values ........ 8
IV. Serum Electrolyte Ranges in Man ........ 9
V. Serum Component Concentrations in the Chimpanzee ........ 10
VI. Human Serum Component Concentrations ........ 11
I. INTRODUCTION

There is little information in the literature concerning normal quantitative levels of serum constituents of chimpanzees. One study (Ref. 1) does include some data on liver function in chimpanzees, but only that incidental to the prime objective of producing pathological liver function titres. Serum electrolyte studies were made on the plasma of Rhesus monkeys by White and Knobil (Ref. 2 and 3). The first author cites data obtained from 10 animals and the latter data from 50 animals.

The purpose of this investigation was to determine the baseline serum biochemical values for the colony-stabilized chimpanzee. The findings have assisted in health maintenance and in evaluating the effect of various experimental conditions to which chimpanzees are exposed.

II. MATERIAL AND METHODS

A. Subjects

The 52 animals used for this investigation consisted of 30 males and 22 females ranging from 18 months to 16 years of age and weighing between 11-1/4 and 129 pounds. Only 5 of these were adults, i.e. over 6 years old. Veterinary clinicians performed physical examinations of the whole group of animals throughout the study, and no data are included in the serum ranges from chimpanzees found to be clinically ill. These subjects represent the stabilized chimpanzee colony of the Bioastronautics Research Laboratory, Holloman Air Force Base, New Mexico, and were the source of the serum samples for the data of this report. Although not all biochemical determinations were made on each subject, this report includes information from over 2000 individual determinations and provides significant physiological baseline information.

Released by authors July 1961
B. Procedures

1. Blood Samples.

All blood specimens were taken from unanesthetized animals except for the few older and less manageable individuals. Following a physical examination, the subjects were strapped face down on the examination table (Ref. 4). The venipuncture was made in most instances in a great saphenous vein. Occasionally it was necessary to take the sample of blood from an antecubital vein. In most cases, a 4 to 5 ml. sample of blood was withdrawn, which furnished 2 to 2.5 ml. of serum. The whole blood was immediately centrifuged and the serum transferred into two tubes, one of which was immediately layered over with oil for carbon dioxide content determination. The remaining serum, not under oil, was used for the other determinations. All determinations were made within 48 hours, and usually within 8 hours, after the specimen had been obtained.

2. Analysis.

Whenever possible, the methods used were controlled both by the use of pure standards appropriate to the method, and a commercial reconstituted serum containing the component being measured.* All determinations were done in duplicate except the phosphatases. All techniques used were applicable to human serum.

The flame photometry determinations for sodium, potassium, and calcium were run using a Beckman Model DU spectrophotometer with a photomultiplier and flame attachment. Sodium and potassium together required 0.2 ml. of serum, and the flame photometry method for calcium required another 0.2 ml. sample.

Bilirubin, urea nitrogen, chloride, calcium, uric acid, creatinine, total protein, glucose, and inorganic phosphorus were run on the ultra-micro scale using Beckman-Spinco ultra-micro equipment. Ultra-micro tests were especially appropriate for

*For example: Lab-Trol, Dade Reagents, Miami, Florida
pediatric-aged chimpanzees since only relatively small amounts of blood were available. Several of the ultra-micro techniques were modified for ease of accomplishment and greater reliability. The ultra-micro techniques are generally more difficult than the macro techniques from which they were developed. By concurrently determining serum titres utilizing routine macro techniques on larger serum samples, the accuracy of the micro methods was found comparable to that of the macro methods.

**Sodium and potassium:** Sodium and potassium concentrations were determined by flame photometry (Ref. 5). The serum samples were run in a 1:50 dilution in a deproteinized solution containing 10 percent isopropanol, 5 percent trichloracetic acid, and water. The precipitated protein was removed by centrifugation. The spectrophotometer was set using standard inorganic salt solutions and commercial reconstituted serum samples as controls (Ref. 5). The wavelength for sodium was 588.3 μm, and that for potassium 765 μm.

**Calcium:** Calcium concentration was determined by flame photometry on a 1:50 serum dilution in 20 percent isopropanol solution containing a small amount of hydrochloric acid. This solution did not cause protein precipitation. The calcium emulsion was determined at 422.3 μm. Calcium titres were also ascertained by a modification of the method of Diehl and Ellingboe (Ref. 6). This method involves titration with EDTA, with calcein as the indicator. The titration was carried out to disappearance of fluorescence in a dark box with fluorescent lamp illumination from above. End points are more easily observed by this modification than by the original method of Diehl and Ellingboe. Titration and flame photometry techniques consistently yielded calcium content values checking within ±0.1 mg. percent. An inorganic calcium standard solution and a standard commercial reconstituted serum were used as controls. The titration technique was used for a majority of the determinations. It produced results as rapidly and as reliably as did flame photometry and required a smaller sample.

**Carbon Dioxide:** The serum content was measured by a Natelson microgasometer utilizing the technique of Natelson (Ref. 7 and 8). A standard carbonate solution was used for calibration and control.
Bilirubin: All determinations were accomplished by Powell's method (Ref. 9). Total bilirubin only was determined. In this method, color is developed with the Van Den Bergh reaction in a benzoate-urea solution; the wave length for color measurement is 540 μm. The Malloy-Evelyn method (Ref. 10) which develops color in a methanol solution was found to be unsuitable for chimpanzee serum because variable turbidities developed in the reaction medium. The Powell method proved more suitable for detecting low bilirubin concentrations. Chimpanzee serum invariably exhibited a low titre of bilirubin. A standard curve was established using a fresh standard solution of bilirubin in chloroform, and unknown values were determined from the plotted curve. All bilirubin determinations were made within four hours after the sample was obtained.

Total Protein: A modified biuret method (Ref. 11 and 12) was utilized. Color intensity was measured at 540 μm.

Urea Nitrogen: Fearon and Friedman's method (Ref. 13 and 14) was used with diacetyl monoxime as the color developing agent. The wave length for color measurement was 475 μm.

Uric Acid: A modification of the method of Caraway (Ref. 15) was employed using urea-cyanide solution rather than sodium carbonate as a color intensifier. Color was read at 650 μm.

Creatinine: The Jaffe color reaction with alkaline picrate (Ref. 16 and 17) was used. The wave length for color measurement was 520 μm.

Glucose: These values were obtained on serum using a relatively new method (Ref. 18). It utilizes an enzyme system coupled with a color detector, and reportedly measures only glucose, tending to give lower concentration values than the Folin-Wu or Somogyi methods. No attempt was made to obtain fasting blood samples for the glucose determinations. The wave length for color measurement was 410 μm.

Inorganic Phosphorus: The method of Fiske and Subbarow (Ref. 19) was used. The wave length for color measurement was 650 μm.
Chlorides: The titration method of Schales and Schales (Ref. 20) was used. The titration is accomplished with mercuric nitrate using diphenylcarbazone as indicator.

Total Cholesterol: Two methods were utilized; one was that of Carr and Drekter (Ref. 21). It involves the use of the original Lieberman-Burchard color system in a modified manner. The second method was that of Chiamori and Henry (Ref. 22), which employs ferric chloride for color development. The latter technique has the advantage of simplicity and requires less time per sample. Although neither method has proven entirely satisfactory, the results are reliable within 15 to 20 mg. percent. Both methods require 0.2 ml. of serum per sample.

Alkaline Phosphatase: The method (Ref. 23 and 24) utilizes the release of phenolphthalein from a buffered substrate containing sodium phenolphthalein phosphate. The results are made quantitative rather than semi-quantitative by relating the findings to a curve obtained on a standard phenolphthalein solution. The color measurements were made at 550 μm.

Acid Phosphatase: The method used (Ref. 25) involves measurement of alpha-naphthol released in a buffered substrate.* It was made quantitative by comparison to an alpha-naphthol standard using a spectrophotometer at 510 μm.

Protein Electrophoresis: Beckman-Spinco equipment and the Beckman-Spinco "B" procedure (Ref. 26) was used with a serum sample of 5 ml. The dyed paper strips were scanned with a Spinco Analytrol which gave absorbance curves and automatic integration of the areas under the curves. Data on albumin, alpha, beta, and gamma globulins, and the A/G ratios are presented.

III. RESULTS

In calculating the normal ranges, 5 percent of the data was deleted from the highest extremes of the ranges and 5 percent from the lowest. The use of this 90 percent range should exclude most sub-clinical, non-recognized illness from these studies.

*Phosphatabs, Warner-Chilcott Co., Morris Plains, N.J.
Data obtained by paper electrophoresis on the proteins in chimpanzee sera, are set forth in Table I together with some data for human sera.

Tables II, III, and IV give data on serum electrolytes of chimpanzees, Rhesus monkeys, and man.

Other serum components of chimpanzee serum may be found in Table V; Table VI shows similar human data for purposes of comparison.

IV. DISCUSSION

The findings from this study indicate that there is a high degree of similarity between the biochemical values for chimpanzee and human sera. The differences found cannot be considered significant, especially since the published human sera data do not agree.

The results obtained by protein electrophoresis of chimpanzee serum exhibit some definite qualitative differences as compared with human sera. Chimpanzee serum contains three definite alpha-globulin fractions similar to those found in monkeys (Ref. 31).

The range for total protein concentration found for chimpanzees is somewhat wider than that quoted for man.

The electrolyte ranges observed in chimpanzees were not as wide as those for Rhesus monkeys, but more nearly resemble the narrower ranges found in man.

Total bilirubin values in chimpanzees were uniformly low, as compared to those of humans. No instance has so far been found where the bilirubin content was above 0.4 mg. percent. Somewhat higher levels of bilirubin were found by other investigators (Ref. 1) but they used the Malloy-Evelyn method. This laboratory found the Malloy-Evelyn method unsuitable because variable turbidities developed in the reaction medium. It was also observed to be less sensitive at low concentrations than the Powell technique. Nelson (Ref. 30) states that normal human adult bilirubin values may reach 0.8 mg. percent. Miller (Ref. 32) gives 1.0 mg. percent as a top normal level for bilirubin in humans.
TABLE I

Paper Electrophoresis of Chimpanzee and Human Serum Proteins

<table>
<thead>
<tr>
<th>Protein Component</th>
<th>Number of Tests</th>
<th>Range* (Percent of Total)</th>
<th>Median (Percent of Total)</th>
<th>Mean (Percent of Total)</th>
<th>Human Ranges** (Percent of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>39</td>
<td>50.9-69.2</td>
<td>63.1</td>
<td>62.0</td>
<td>51.6-65.6</td>
</tr>
<tr>
<td>Alpha Globulins</td>
<td>39</td>
<td>5.2-15.9</td>
<td>10.8</td>
<td>10.7</td>
<td>8.0-14.8</td>
</tr>
<tr>
<td>Beta Globulins</td>
<td>39</td>
<td>8.8-14.0</td>
<td>11.0</td>
<td>11.0</td>
<td>9.3-15.7</td>
</tr>
<tr>
<td>Gamma Globulins</td>
<td>39</td>
<td>9.7-31.0</td>
<td>14.5</td>
<td>16.0</td>
<td>14.5-20.7</td>
</tr>
<tr>
<td>A/G Ratio</td>
<td>39</td>
<td>1.04-2.26</td>
<td>1.70</td>
<td>1.67</td>
<td></td>
</tr>
</tbody>
</table>

* The range given includes 90 percent of determined figures. Five percent of the data were deleted from both extremes of the ranges.

** Electrophoresis results of ten normal human sera (Ref. 27).
TABLE II
Chimpanzee Serum Electrolyte Values

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Range*</th>
<th>Median</th>
<th>Mean</th>
<th>No. Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium mEq/L</td>
<td>139-147</td>
<td>144</td>
<td>145</td>
<td>101</td>
</tr>
<tr>
<td>Potassium mEq/L</td>
<td>3.4-4.7</td>
<td>4.0</td>
<td>4.0</td>
<td>83</td>
</tr>
<tr>
<td>Chlorides mEq/L</td>
<td>96-111</td>
<td>103</td>
<td>103</td>
<td>128</td>
</tr>
<tr>
<td>Calcium mEq/L</td>
<td>4.75-5.75</td>
<td>5.05</td>
<td>5.1</td>
<td>86</td>
</tr>
<tr>
<td>Calcium mg. percent</td>
<td>9.5-11.5</td>
<td>10.1</td>
<td>10.2</td>
<td>86</td>
</tr>
<tr>
<td>CO₂ mM/L (Content)</td>
<td>17.9-27.9</td>
<td>23.2</td>
<td>23.2</td>
<td>169</td>
</tr>
<tr>
<td>CO₂ Vol. percent  (Content)</td>
<td>39.7-61.9</td>
<td>51.4</td>
<td>51.4</td>
<td>169</td>
</tr>
</tbody>
</table>

*The range given includes 90 percent of the data. Five percent of the data were excluded from both extremes of the ranges.

TABLE III
Macaca Mulatta Serum Electrolyte Values

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Range*</th>
<th>Mean*</th>
<th>Range**</th>
<th>Mean**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium mEq/L</td>
<td>146.4-161.4</td>
<td>153.0</td>
<td>142.3-177.6</td>
<td>153.8</td>
</tr>
<tr>
<td>Potassium mEq/L</td>
<td>2.5-5.3</td>
<td>4.2</td>
<td>3.5-5.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Chlorides mEq/L</td>
<td>103.0-114.1</td>
<td>110.2</td>
<td>91.5-124.0</td>
<td>107.7</td>
</tr>
</tbody>
</table>

*These data were for 10 monkeys (Ref. 2).
**These data were for 50 monkeys (Ref. 3).
TABLE IV
Serum Electrolyte Ranges in Man

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Range Hawk, Oser, Spector (Ref. 28)</th>
<th>Range Summerson (Ref. 29)</th>
<th>Range Nelson (Ref. 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium mEq/L</td>
<td>132-144</td>
<td>130-144</td>
<td>133-143</td>
</tr>
<tr>
<td>Potassium mEq/L</td>
<td>3.6-4.8</td>
<td>4.1-5.6</td>
<td>4.1-5.6</td>
</tr>
<tr>
<td>Chlorides mEq/L</td>
<td>97-108</td>
<td>98-106</td>
<td>100-106</td>
</tr>
<tr>
<td>Calcium mEq/L</td>
<td>4.8-6.1</td>
<td>4.5-5.75</td>
<td>5-6</td>
</tr>
<tr>
<td>CO₂ Vol. percent</td>
<td></td>
<td>55-75</td>
<td>45-70</td>
</tr>
<tr>
<td></td>
<td>(content)</td>
<td>(capacity)</td>
<td>(content)</td>
</tr>
<tr>
<td>CO₂ mM/L</td>
<td>24-31</td>
<td></td>
<td>20.3-31.5</td>
</tr>
<tr>
<td></td>
<td>(content)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE V

Serum Component Concentrations in the Chimpanzees

<table>
<thead>
<tr>
<th>Component</th>
<th>Range*</th>
<th>Median</th>
<th>Mean</th>
<th>No. Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorg. P. mg. percent</td>
<td>3.4-6.0</td>
<td>4.3</td>
<td>4.6</td>
<td>47</td>
</tr>
<tr>
<td>Urea N. mg. percent</td>
<td>6.1-15.7</td>
<td>10.0</td>
<td>10.3</td>
<td>41</td>
</tr>
<tr>
<td>Uric Acid mg. percent</td>
<td>2.7-5.8</td>
<td>4.2</td>
<td>4.1</td>
<td>50</td>
</tr>
<tr>
<td>Creatinine mg. percent</td>
<td>0.8-1.8</td>
<td>1.2</td>
<td>1.2</td>
<td>41</td>
</tr>
<tr>
<td>Total Protein mg. percent</td>
<td>6.08-8.85</td>
<td>6.95</td>
<td>7.06</td>
<td>92</td>
</tr>
<tr>
<td>Glucose mg. percent</td>
<td>72-137</td>
<td>98</td>
<td>97</td>
<td>54</td>
</tr>
<tr>
<td>Bilirubin mg. percent</td>
<td>0.10-0.31</td>
<td>0.20</td>
<td>0.21</td>
<td>53</td>
</tr>
<tr>
<td>Alk. Phosphatase BU**</td>
<td>3.0-13.2</td>
<td>9.5</td>
<td>8.6</td>
<td>23</td>
</tr>
<tr>
<td>Acid Phosphatase BU**</td>
<td>0.3-1.1</td>
<td>0.7</td>
<td>0.7</td>
<td>10</td>
</tr>
<tr>
<td>Total Cholesterol mg. percent</td>
<td>157-311</td>
<td>214</td>
<td>219</td>
<td>42</td>
</tr>
</tbody>
</table>

* The range given includes 90 percent of the data. Five percent were excluded from the extremes of the ranges.

** Bodansky Units.
<table>
<thead>
<tr>
<th>Component</th>
<th>Range Spectro (Ref. 28)</th>
<th>Range Hawk, Oser, Summerson (Ref. 29)</th>
<th>Range Nelson (Ref. 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic P. mg. percent</td>
<td>5.1 (mean)</td>
<td>3.7 adult (mean)</td>
<td>4.5-5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0 child (mean)</td>
<td></td>
</tr>
<tr>
<td>Urea N. mg. percent</td>
<td>8.7-12.4</td>
<td>10-15 (whole blood)*</td>
<td>10-17 (plasma)*</td>
</tr>
<tr>
<td>Uric Acid mg. percent</td>
<td>4.0-4.8</td>
<td>3-5 (plasma)*</td>
<td>2.5-3.5 (whole blood)*</td>
</tr>
<tr>
<td>Creatinine mg. percent</td>
<td>0.7-1.1</td>
<td>1-2</td>
<td>0.6-1.2 (plasma)*</td>
</tr>
<tr>
<td>Total Protein mg. percent</td>
<td>5.9-7.2</td>
<td>6.5-8.2</td>
<td>6.5-7.5</td>
</tr>
<tr>
<td>Glucose mg. percent</td>
<td>61-130 (97 mean)</td>
<td>65-110</td>
<td>85-120 (fasting whole blood)*</td>
</tr>
<tr>
<td>Bilirubin mg. percent</td>
<td>0.1-0.25</td>
<td>0.1-0.25</td>
<td>0.2-0.8</td>
</tr>
<tr>
<td>Alk. Phosphatase BU**</td>
<td>1.5-4.0 (adult)</td>
<td>5.0-12.0 (child)</td>
<td>3-13 (child)</td>
</tr>
<tr>
<td>Acid Phosphatase BU**</td>
<td></td>
<td></td>
<td>0.0-1.1 (adult)</td>
</tr>
<tr>
<td>Total Cholesterol BU**</td>
<td>130-255</td>
<td>110-390</td>
<td>170-259</td>
</tr>
</tbody>
</table>

* Values are for serum unless otherwise noted.
** Bodansky Units
Mature chimpanzees and human adults exhibit lower alkaline phosphatase levels than do immature chimpanzees and children. This affords an explanation of the generally higher values observed in our chimpanzees because most of the animals were immature.

The carbon dioxide combining power of chimpanzee serum exhibits lower values than those quoted in the literature for man. Nelson (Ref. 30) and Albritton (Ref. 33) indicate lower values for children; the over-all lower values reported here are likely because of the immaturity of our subjects.

V. SUMMARY AND CONCLUSIONS

In excess of 2000 determinations were made on various components of the sera of 52 adult and immature chimpanzees. The normal concentration ranges of 20 serum components are presented and discussed. The various techniques for the individual determinations are outlined.

These base-line studies have not revealed significant quantitative differences in the concentrations of these serum components as compared with those of man. Those differences which were found can be ascribed to a proportionately greater density of immature individuals in our subject population. However, there are indications that the protein composition of chimpanzee serum differs qualitatively from that of man.

The base-line data presented in this report have proven useful in following the course of disease in members of our animal colony, including the biochemical responses to therapy. This information has also served for the detection and diagnosis of sub-clinical disease in chimpanzees.
REFERENCES


5. *Beckman Application Data DU-12-B*, Beckman Instruments, Inc., Fullerton, California, 1957.


REFERENCES (continued)


REFERENCES (continued)


<table>
<thead>
<tr>
<th>DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFSC (SCMTI-1)</td>
</tr>
<tr>
<td>Andrews AFB</td>
</tr>
<tr>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>AFSC (SCMTI-2)</td>
</tr>
<tr>
<td>Andrews AFB</td>
</tr>
<tr>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>HQ USAF (AFCIN-3T)</td>
</tr>
<tr>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>HQ USAF (AFIRD-HF)</td>
</tr>
<tr>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>AFMTC (Tech Library MU-135)</td>
</tr>
<tr>
<td>Patrick AFB, Fla</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>APGC (PGTRIL)</td>
</tr>
<tr>
<td>Eglin AFB, Fla</td>
</tr>
<tr>
<td>ESD (CCSTN)</td>
</tr>
<tr>
<td>L.G, Hanscom Field</td>
</tr>
<tr>
<td>Bedford, Mass</td>
</tr>
<tr>
<td>AFFTC (FTOTL)</td>
</tr>
<tr>
<td>Edwards AFB, Calif</td>
</tr>
<tr>
<td>AF Office of Scientific Research</td>
</tr>
<tr>
<td>(SRRI)</td>
</tr>
<tr>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>AFSWC (SWOI)</td>
</tr>
<tr>
<td>Kirtland AFB, NMex</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>AFSWC (SWRB)</td>
</tr>
<tr>
<td>Kirtland AFB, NMex</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>


U.S. Naval Inspector of Ordnance
Lockheed Missile Division
P.O. Box 504
Sunnyvale, Calif.

USAFA (Director of the Library)
USAF Academy, Colo

Analytic Services, Inc
1101 North Royal Street
Alexandria, Va

HQ USAF
AFCIN-M
Wash 25, DC

Boeing Airplane Company
Aero-Space Division
Library 13-84
Seattle 24, Wash

Commander
Army Rocket and Guided
Msl Agcy
ATTN: Tech Library
Redstone Arsenal, Ala

WSMR (ORDBS-OM-TL 312)
NMex

Lt Col K. B. Dobson
Ordnance Mission
British Liaison Office
White Sands Missile Range
NMex

National Library of Medicine
ATTN: Library Acquisition
Samuel Lazerow
Wash 25, DC

Defense Research Member
Canadian Joint Staff
ATTN: Dr. M.G. Whillans
Director of Biosciences Research
Wash 8, DC

Cornell Aeronautical Labs, Inc
4455 Genesee Street
Buffalo 21, NY

Director
Armed Forces Institute of
Pathology
Walter Reed Army Medical
Center
ATTN: Deputy Director for
the Air Force
Wash 25, DC

NASA
ATTN: Biology and Life Support
System Program
1520 H Street NW
Wash 25, DC

NASA
ATTN: Chief, Division of
Research Information
1520 H Street NW
Wash 25, DC

School of Aviation Medicine
USAF
Brooks AFB, Tex

Commander
U.S. Naval Missile Center
Point Mugu, Calif
<table>
<thead>
<tr>
<th>Address</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commander</td>
<td>Naval Air Development Center</td>
<td>Johnsville, Pa.</td>
</tr>
<tr>
<td>ATTN: Director, AMAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headquarters</td>
<td>U.S. Army R&amp;D Command</td>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>Main Navy Building</td>
<td>ATTN: NP and PP Research Br</td>
<td></td>
</tr>
<tr>
<td>Commanding Officer</td>
<td>U.S. Naval School of Aviation Medicine</td>
<td>Pensacola, Fla</td>
</tr>
<tr>
<td>ATTN: Director, AMAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Technology Laboratories, Inc</td>
<td>ATTN: Technical Information Center Document Procurement</td>
<td>P.O. Box 95001</td>
</tr>
<tr>
<td>Wash 25, DC</td>
<td></td>
<td>Los Angeles, Calif</td>
</tr>
<tr>
<td>Commanding General</td>
<td>Medical Records Section</td>
<td>Room 325</td>
</tr>
<tr>
<td>Research and Development Div</td>
<td>Division of Medical Sciences</td>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>Dept of the Army</td>
<td>National Academy of Sciences</td>
<td></td>
</tr>
<tr>
<td>Wash 25, DC</td>
<td>National Research Council</td>
<td>2101 Constitution Avenue NW</td>
</tr>
<tr>
<td>Director</td>
<td>Wash 25, DC</td>
<td>Langley Field, Va</td>
</tr>
<tr>
<td>Naval Research Laboratory</td>
<td>Aviation Crash Injury Research</td>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>Wash 25, DC</td>
<td>A Div of Fit Safety Foundation</td>
<td>Cherokee 162, Ariz</td>
</tr>
<tr>
<td>Director</td>
<td>Lockheed Missile and Space Biomedical System Development Division</td>
<td>Sunnyvale, Calif.</td>
</tr>
<tr>
<td>Office of Naval Research</td>
<td>Librarian</td>
<td>U.S. Naval Research Center</td>
</tr>
<tr>
<td>Wash 25, DC</td>
<td>Bethesda, Md</td>
<td></td>
</tr>
<tr>
<td>University of California</td>
<td>Director</td>
<td>Langley Research Center</td>
</tr>
<tr>
<td>Medical Center</td>
<td>NASA</td>
<td>Wash 25, DC</td>
</tr>
<tr>
<td>ATTN: Biomedical Library</td>
<td>ATTN: Librarian</td>
<td>Langley Field, Va.</td>
</tr>
<tr>
<td>Los Angeles, Calif</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Librarian
National Institute of Health
Bethesda, Md

Librarian
Quarterly Cumulative Index Medicus
American Medical Association
535 North Dearborn Street
Chicago, Ill

The Rockefeller Institute
Medical Electronics Center
66th Street and New York
New York 21, NY

NORAIR Div of Northrop Corp
ATTN: Bioastronautics Branch
1001 East Broadway
Hawthorne, Calif

New Mexico State University of
Agriculture, Engineering, and Science
ATTN: Librarian
University Park, NMex

5010th Air Base Squadron
5010th Air Base Wing
USAF
APO 937, Seattle, Wash

Princeton University
The James Forrestal Research Center Library
Princeton, NJ

Government Publications Div
University of New Mexico Library
Albuquerque, NMex

Life Sciences Group
Northrop Corporation
1001 Broadway
Hawthorne, Calif

School of Aviation Medicine
USAF Aerospace Medical Center (ATC)
ATTN: SAMDYN A
Capt Bruce H. Warren
Brooks AFB, Texas

ASD (WWB)
Wright-Patterson AFB
Ohio

Life Sciences Department
Code 5700
U.S. Naval Missile Center
Point Mugu, Calif

ASD (WWRDMP-2, T. McGuire)
Wright-Patterson AFB, Ohio

ASD (WWRDMA)
Wright-Patterson AFB, Ohio

ASD (ASBAT Library)
Wright-Patterson AFB, Ohio

Aerospace Medicine
The Editor
394 So. Kenilworth Ave
Elmhurst, Ill

Chief, Pathology Dept
Presbyterian- St Lukes Hospital
ATTN: Dr. George M. Hass
1753 W. Congress St
Chicago 12, Ill

Chief, Dept of Pediatrics
University of Oregon Medical School
ATTN: Dr. Donald Pickering
3171 S.W, Sam Jackson Park Road
Portland 1, Ore
Chief, Pathology Dept
Evanston Hospital
ATTN: Dr. C. Bruce Taylor
Evanston, Ill

LOCAL

Air Force Missile Development Center

ATTN: MDR
   NLO   1
   MDNH  1
   MDRB  15
   SRLTL 3
   MDRAR 25

Holloman AFB, NMex
| Air Force Missile Development Center | Air Force Missile Development Center | UNCLASSIFIED |
| Holloman AFB, New Mexico | Holloman AFB, New Mexico | UNCLASSIFIED |

**PHYSIOLOGICAL BASE-LINE STUDIES OF ZOOLOGICAL SPECIMENS" SERUM BIOCHEMICAL VALUES OF CHIMPANZES, BY F.W. Staten, R.H. Edwards, P. Fahlstrom, E. Goins, Z. Cooper and V. Schwandt, August 1961. 20 pp incl. tables.**

(APMDC-TR-61-25) unclassified report

Biochemical titres of various components in the sera of 52 chimpanzees are presented. The findings are compared with man and the Macaca mulatta monkey. The method employed for each specific analysis is briefly discussed. The concentrations of the factors in the serum of the chimpanzee herein reported are similar for the most part to those in human serum.

---


(APMDC-TR-61-25) unclassified report

Biochemical titres of various components in the sera of 52 chimpanzees are presented. The findings are compared with man and the Macaca mulatta monkey. The method employed for each specific analysis is briefly discussed. The concentrations of the factors in the serum of the chimpanzee herein reported are similar for the most part to those in human serum.