CONTENTS

WARREN PLIMPTON LOMBARD

1855 - 1939

Doctor Lombard was born at West Newton, Mass., on May 29, 1855. He took his A. B. at Harvard in 1878 and his M. D. in 1881. After graduation in medicine he went to Germany to continue his medical studies with the intention of specializing in obstetrics, but became interested in physiology and entered Ludwig's laboratory as a research worker. Here he remained until 1885. The object of his research in Germany was to determine the method of spread of reflex processes in the spinal cord of the frog. For this purpose he designed a most ingenious piece of apparatus, the "reflex harp," by means of which the reflex contractions of 11 to 15 muscles of the hind leg of the frog could be recorded simultaneously on a kymograph. On his return to the United States in 1885 no position was available and he worked in Curtis' laboratory at New York where he was later made assistant, the salary, he states, being paid by Dr. Curtis himself. Of this experience he made the following remarks at the time of the 50th Anniversary of the American Physiological Society:

"I reached New York; heard that the College of Physicians and Surgeons was the best school."I said, "Then I'll go there!" I saw John Curtis who was then Professor of physiology and asked him, having told my aspirations, if he could have any use for an assistant. He said, "Why, I don't know what I'd do with an assistant. I never had an assistant." I said, "Could I work in your laboratory?" "Well, er, ah, I haven't got a laboratory. I haven't got any place you could work unless you could, by some chance, use the room that I use for my carpenter shop," and he threw open the door. It was a room about ten by twenty. It had a window which one could scarcely see through although it was a good, nice window. It had a sink, and it had gas and there was a fine carpenter's bench. The rest was shavings, dust and spiders! I said, "This will be fine." "Oh," he said, "if you can use that I will be delighted to have you use it." And my first piece of physiological work was to try to find a broom and dustpan and a pail, and some rags and try to clean that room. It was in that room I did some research work upon the time relations of the knee-jerk, and it was because of that that Weir Mitchell who was working on reinforcements of the knee-jerk came to see me. You don't know what it meant to me to have this distinguished man come to see me and talk about his researches and encourage me in mine. He was a great man.

"I can't go on, except to say that it was only a short time after that that Commodore Vanderbilt gave the College of Physicians and Surgeons the money to build its new buildings on 59th Street, and so Curtis had a laboratory. But Curtis, although the most learned, perhaps, of the American physiologists, had never had an opportunity to use any physiological apparatus. And so he made use of this young medic who had just come back from Europe; paid me a couple of hundred dollars, so as to say that I was his assistant. This is why I was at work in the laboratory where the Physiological Society was founded in 1887. And now, one word - I have had more pleasure in research and the associations which were given me with the American Physiological Society. than perhaps anything else in my life, - except my wife. I hope you will go on with your research. You will be proud of yourself if you can find that you have got the gift."

Dr. Lombard took part in the organization meeting of the American Physiological Society and thereafter for many years was one of the most constant attendants at the annual and special meetings. At the first meeting of the Society in Washington, September 1888, he gave a paper on the nature of the knee-jerk and in subsequent meetings he was a frequent contributor to the scientific program. He served as Secretary-Treasurer in 1893 and 1894 and as President in 1919 and 1920 and was a member of the Council at various times, his total service in this capacity amounting to 13 years. It is evident from these data that he took a prominent part in the activities of the Society well on beyond the first quarter of a century of its existence and was instrumental in shaping many of its precedents and policies. Lombard was ingenious in devising physiological apparatus and a number of his communications to the Society referred to improvements and conveniences in methods of research. He made contributions of importance to many different subjects in physiology, but the one with which his name is perhaps most generally associated is his extensive and interesting study of the conditions influencing the character of the knee-jerk response the main results of which are summarized in his paper in the American Journal of Psychology, 1887.

In 1889 he was appointed Professor of physiology at the newly founded Clark University and in 1892 was called to the University of Michigan as Professor of physiology in the medical faculty. He filled this position until his retirement in 1923. He held the position of Professor Emeritus until his death on July 13, 1939.

WALLACE FENN HONORED

Doctor Wallace O. Fenn was awarded the Daniel and Florence Guggenheim International Astronautics Award for 1964 at Warsaw, Poland in September of 1964. The award carries with it a prize of $1,000 and it is the first time it has been given to a scientist in the field of physiological research.

On November 14, 1964 Dr. Fenn received from the President of Italy the Feltrinelli Prize which is given by the Academia del Lincei of Rome, for his contributions in experimental medicine. This award carries with it a prize of $40,000.

Dr. Fenn has been appointed President of the International Physiological Congress to be held in Washington, D. C. in 1968.

GROWTH OF FEDERATION MEETINGS IN LAST TEN YEARS

The attendance at the Federation meetings has quadrupled in the last ten years and the number of 10-minute papers and sessions have doubled thus doubling the number of simultaneous sessions. The percentages of the total memberships of the various societies attending the Federation meetings have not increased during this ten year period. The actual number of members attending has about doubled, which is about equal to the increase in membership of the combined societies. The number of non-members attending has more than quadrupled in the last ten years and in 1964 accounted for 73% of the attendance.

The number of "sponsored" (all non-member authors) papers has gradually increased until by 1963, 36% of the 935 papers received by APS were "sponsored" papers. Some of these "sponsored" papers were very good but members complained of the poor quality of many of them. Several non-members have found member sponsors year after year. This had reached such a commonplace procedure that in 1963 a few non-member papers were submitted without the member "sponsor" ever having seen the paper.

Many members feel that one of the privileges of membership is the right to give a paper but several individuals (many qualified for membership) feel that it is very easy to give a "sponsored" paper thus having the same privileges as a member but not having to pay membership dues to a society. Most of the complaints about the Federation meetings come from non-members. Are they now, or will they soon, control the size and the caliber of the meetings? Are regular members being driven away by the large numbers of both people and papers?

If the Federation meetings are to be kept from becoming too big to handle some curtailment must be put into effect. The APS, in 1964, did tighten its rules, allowing papers to be presented only if a member was a co-author. This produced a reduction of 20% in the number of papers received by APS. Some members felt that this placed a hardship on graduate students who in the past could be "sponsored." Only 2% of the non-members attending in 1964 were students. Students can be the principle author with a member as co-author and in addition the Fall meeting of the APS has no such restrictions.

If stricter rules are not put into effect by the Federation as a whole. or if some revised plan for meetings is not adopted, the Federation may find itself collapsing from the size and complexness of its meetings within the next ten years.

The accompanying graphs show the growth in the various categories in the past ten years.

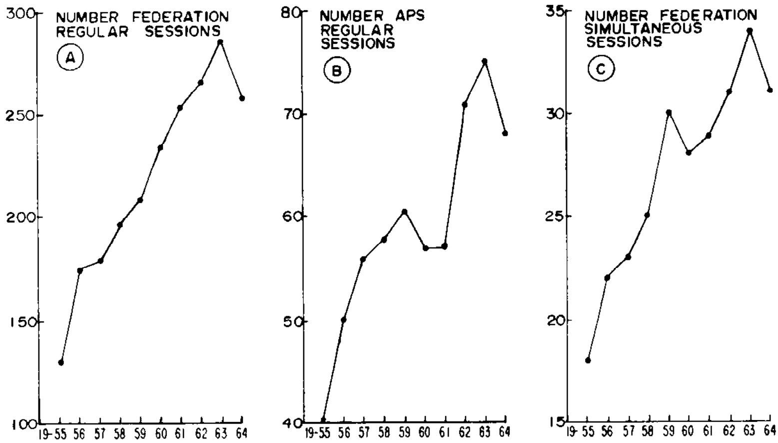
NUMBER FEDERATION REGULAR SESSIONS
A
NUMBER APS REGULAR SESSIONS
B
NUMBER FEDERATION SIMULTANEOUS SESSIONS
C
300
250
200
150
100
80
70
60
50
40
35
30
25
20
15
19-55 56 57 58 59 60 61 62 63 64

Fig. 1

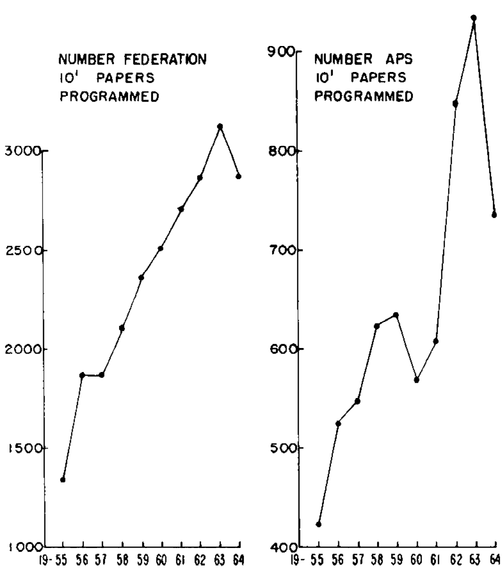
NUMBER FEDERATION 10' PAPERS PROGRAMMED
NUMBER APS 10' PAPERS PROGRAMMED
3000
2500
2000
1500
1000
900
800
700
600
500
400
19-55 56 57 58 59 60 61 62 63 64

Fig. 2

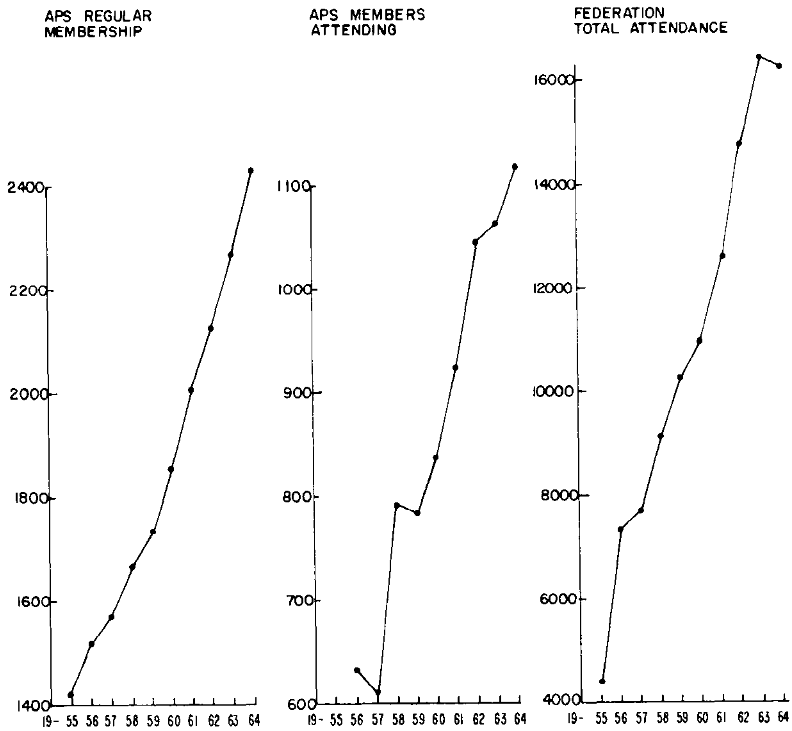
APS REGULAR MEMBERSHIP
APS MEMBERS ATTENDING
FEDERATION TOTAL ATTENDANCE
2400
2200
2000
1800
1600
1400
1100
1000
900
800
700
600
16000
14000
12000
10000
8000
6000
4000
19- 55 56 57 58 59 60 61 62 63 64

Fig. 3

SPECIAL APS PROGRAMS AT THE SPRING MEETING

April 9 - 14, 1965

SYMPOSIA

"Excitation-Contraction Coupling in Striated Muscle" - R. J. Podolsky, Chairman

"Physiological Functions of Histamine" - G. Ungar, Chairman

"Fibrinogen and Fibrin, Their Roles in Health and Disease" - J. H. Lewis, Chairman. (An Intersociety Symposium)

"Role of Insulin in Membrane Transport" - M. E. Krahl, Chairman

"Blood Flow and Exchange at Microcirculatory Level" - B. W. Zweifach, Chairman

"Current Problems in Cardiac Muscle Physiology" - B. F. Hoffman, Chairman. (In association with the Cardiac Muscle Society)

"Gastric Secretion" - C. A. M. Hogben, Chairman

TEACHING SESSION

"Graduate Teaching in Physiology" - C. G. Wilber, Chairman

THIRTY-MINUTE INTRODUCTORY TALKS

"Distribution of Synaptic Inputs in Spinal Motoneurons" - C. A. Terzuolo

"Absorption by Intestinal Mucosa in vitro" - N. Lifson

"Steroidal Regulation of Active Sodium Transport" - I. S. Edelman

"Neuroendocrine Mechanisms Controlling Anterior Pituitary Secretion" - W. F. Ganong

"Cardiovascular Control Mechanisms: Validation by non-destructive testing in animals and man" - R. F. Rushmer

"Heat Adaptation" - K. Schmidt-Nielsen

FEDERATION PLACEMENT SERVICE

OBJECTIVE - Serves as a clearinghouse of information between employers and individuals desiring positions in the fields of the Federated Societies: physiology, biochemistry, pharmacology, pathology, nutrition and immunology.

ACTIVITIES -
1) register candidates available for positions
2) register positions available
3) publish QUARTERLY, lists of candidates with brief summaries of their qualifications. Candidates are chiefly at the professional level (Ph.D. or equivalent)
4) publish SEMIANNUALLY, lists of positions and fellowships available in academic, industrial and governmental institutions, foundations and societies.
5) provide a PERSONAL INTERVIEW SERVICE during the week of the Annual Meeting.

TO USE THE SERVICE

CANDIDATES are expected:
1) to complete a registration card and two copies of the application form
2) to pay a fee of $3.00 annually for maintaining registration

EMPLOYERS are expected:
1) to complete a registration card for each position available.
ALSO, in order to be eligible to use the interview services at the Annual Meeting an employer must be either an annual subscriber to the PLACEMENT SERVICE BULLETIN or subscribe to the single February List of Candidates.

Both employers and candidates are expected to reply to communications resulting from contacts made through the service.

PLACEMENT SERVICE BULLETIN - issued on a subscription basis:

ANNUAL. $20.00
All lists published during a calendar year (Numbers 1-6)

SINGLE COPIES
Lists of Candidates. . . . . $10.00 each
February, May, August and November
Lists of Positions (Fellowship Supplement) $5.00 each
March and September

It is not expected that under this schedule of fees the Placement Service will be self-supporting; the Federation contributes approximately half the cost of operation. All correspondence should be addressed to: FASEB PLACEMENT SERVICE, 9650 Wisconsin Avenue, Washington, D. C. 20014.

THIRD INTERNATIONAL CONGRESS OF NEPHROLOGY

The Third International Congress of Nephrology will be held in the Washington Hilton Hotel, Washington, D. C., U. S. A., September 25-30, 1966. Dr. Robert W. Berliner of the National Institutes of Health is President of the Congress, and Dr. George E. Schreiner, Professor of Medicine at Georgetown University, is Secretary General.

The Congress is under the general sponsorship of the International Society of Nephrology, and is being sponsored in the United States by the Renal Section of the Council on Circulation of the American Heart Association, together with a number of cooperating societies including, currently, the American Federation for Clinical Research, the American Medical Association, the American Society for Artificial Internal Organs, the American Urological Association, the Scientific Advisory Board of the National Kidney Foundation, and the Washington Heart Association, Inc.

Tentative plans for the program include general sessions devoted to renal physiology, pyelonephritis, uremia, hemodialysis, and homotransplantation. The program will also include sessions on the following topics: renal pathology including biopsy and special microscopy; renal physiology including micropuncture, electrolyte transport, acid base balance, diuretics, renal blood flow, hormones and the kidney, membrane transport; experimental nephritis and pyelonephritis; toxemia of pregnancy; renal tubular defects; nephrotic syndrome; toxic nephropathies; renal hypertension; congenital and hereditary renal disease; epidemiologic studies of renal disease; radiographic and isotopic techniques; peritoneal dialysis and other treatment techniques. Time will be available for the presentation of brief free communications.

Address inquiries to: Secretariat, Third International Congress of Nephrology, 9650 Wisconsin Avenue, Washington, D. C. 20014, U. S. A.

GASTROINTESTINAL SECTION LECTURE

Dr. William Sircus of Edinburgh University and Western General Hospital of Edinburgh, will give the Fourteenth Annual Lecture of the Gastrointestinal Section of the American Physiological Society on Monday, April 12, 1965, during the Spring meeting of the Federation of American Societies of Experimental Biology, in Atlantic City. His topic will be "The Production of Homeostasis in Gastric Secretion."

NINTH BOWDITCH LECTURE

Atmosphere and Oxygen

DANIEL L. GILBERT

This Bowditch lecture will be a departure from the more scholarly presentations previously given at this annual occasion. Indeed, it will dip into the realm of science fiction. I will leave it to you to decide where the science ends and the fiction begins. Anyway, I hope you will enjoy the story which I am about to present.

It is concerned with the effect of the evolution of the earth's atmosphere on the presence of a biosphere on earth. Particular attention will be placed upon the energy used by a biosphere and its relation to the biological effects of oxygen.

Atmospheric Evolution

To begin this story, we must go back in time to the initial stages of the earth's development, about $4.5 \cdot 10^9$ years ago (41). It would be expected that the earth's atmosphere at this time would be composed of the most abundant light elements. As shown in Fig. 1, the most abundant elements in the cosmos in decreasing order are hydrogen, helium, oxygen, carbon, and nitrogen (7). Our cosmos is predominantly composed of hydrogen atoms. The atoms of hydrogen plus helium comprise 99.86% of all the cosmic atoms. The percent atom abundance of oxygen, the third most abundant element in the cosmos, is only 0.09%. Practically, the entire universe is composed of these three elements plus carbon and nitrogen.

ELEMENT	COSMOS	BIOSPHERE	EARTH'S CRUST
H	86.68	62.6	17.70
He	13.18	0.0	0.00
O	0.09	24.9	53.77
C	0.03	10.6	0.13
N	0.01	1.1	0.02
OTHERS	0.01	0.8	28.38

Fig. 1. Percent atom abundance. From (28).

Excluding the chemically stable helium, the most abundant elements in the biosphere (15) are in the same decreasing order as in the cosmos. In contrast, the three most abundant atoms in the earth's crust (28) in decreasing order are oxygen, hydrogen, and silicon. Thus, the atomic composition of living organisms is closely correlated with atomic composition of the cosmos and is not clearly correlated with the present environment of living organisms on earth.

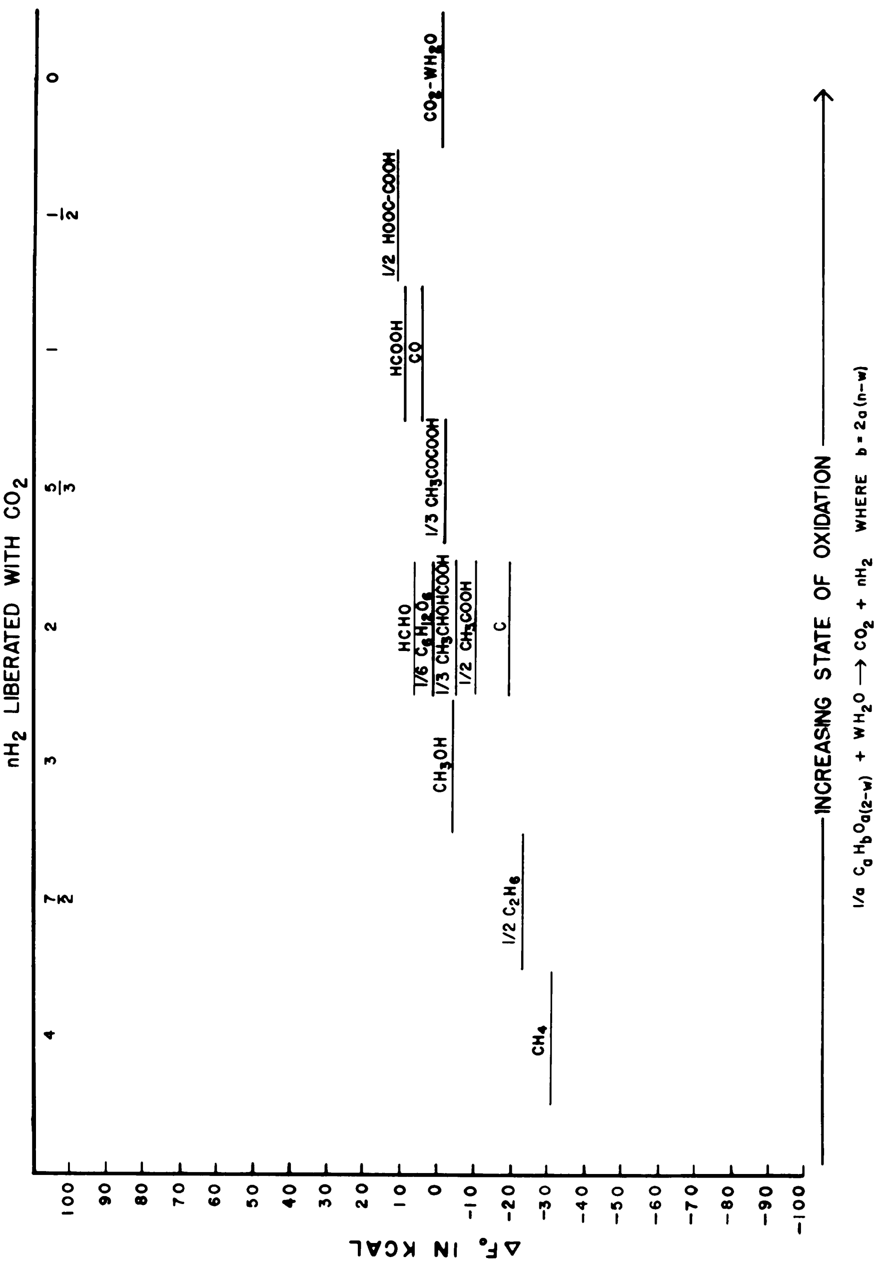
nH$_2$ LIBERATED WITH CO$_2$
4
7/2
3
2
5/3
1
1/2
0
ΔF° IN KCAL
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
CH$_4$
1/2 C$_2$H$_6$
CH$_3$OH
HCHO
1/6 C$_6$H$_{12}$O$_6$
1/3 CH$_3$CHOHCOOH
1/2 CH$_3$COOH
C
1/3 CH$_3$COCOOH
HCOOH
CO
1/2 HOOC-COOH
CO$_2$-WH$_2$O
INCREASING STATE OF OXIDATION
1/a C$_a$H$_b$O$_{a(2-w)}$ + WH$_2$O → CO$_2$ + nH$_2$ WHERE b = 2a(n-w)

Fig. 2. Oxidation states of carbon in presence of hydrogen. From (25). The decrease in free energy for the various compounds according to the given reaction is plotted on the ordinate. Unless otherwise indicated, these values were obtained from Latimer (40) for a temperature of 298°K. Since reactions are thermodynamically possible only when there is a decrease in free energy, the lower the compound is on this free-energy diagram, the more thermodynamically stable it is. Example, illustrating the use of this diagram: The value of ΔF_o for CH_4 is -31.1 Kcal, so the ΔF_o is 31.1 Kcal for the reaction, $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$. Likewise, the value of ΔF_o for 1/6 $C_6H_{12}O_6$ is 1.39 Kcal, so the ΔF_o is -1.39 Kcal for the reaction, $1/6\ C_6H_{12}O_6 + H_2O \rightarrow CO_2 + 2H_2$. The difference between the ΔF_o for these compounds represents the decrease in ΔF_o for the reaction represented by the difference between the above type of reactions. Hence, the difference between the ΔF_o for 1/6 $C_6H_{12}O_6$ and CH_4 is 32.5 Kcal (e.g. 1.39 Kcal minus -31.1 Kcal), and so the ΔF_o is -32.5 Kcal for the reaction, $1/6\ C_6H_{12}O_6 + 2H_2 \rightarrow CH_4 + H_2O$.

Taken from reference 25 (Gilbert, D. L.) "Speculation on the Relationship Between Organic and Atmosphere." Perspect. Biol. Med., 4: 58, 1960. Published by the University of Chicago Press, The hydrogen of the initial atmosphere would be expected to be in its free form and bound to oxygen, carbon, and nitrogen. Thus, oxygen would be in the form of water, which is much more stable thermodynamically than molecular oxygen in a hydrogen atmosphere. The most stable compounds of carbon and nitrogen in such an atmosphere would be methane and ammonia (40) as shown in Figs. 2, 3, and 4. The amino acid, glycine (31), would also tend to form methane and ammonia in such a reducing atmosphere. Hence, the initial atmosphere would be composed of molecular hydrogen, helium, water, methane, and ammonia (67, 68).

Some hydrogen particles, due to their light mass, would be able to overcome the gravitational field of the earth and continually escape. This dehydrogenation process has made the earth a pinpoint of oxidation in a reducing universe. An energy source, such as from the sun, could dissociate hydrogen from the water, methane, and ammonia, as shown in Fig. 5. However, there would be a great tendency for a back reaction to occur, in which the hydrogen again becomes bound. As the hydrogen concentration in the atmosphere is decreased, there would be less probability for a back reaction to occur. The result would be the net liberation of bound hydrogen from the methane, ammonia, and water. Fig. 5 also illustrates that the energy required for the release of hydrogen from methane and ammonia is not very much (40). The liberated hydrogen from these bound forms would continually tend to escape from the earth's atmosphere. The liberated nitrogen would remain in the form of molecular nitrogen. The liberated oxygen would combine with the liberated carbon and other substances, such as silicon and iron, to form oxides. Since molecular oxygen has a high thermodynamic potential, it would not be expected to remain in its free form. The most stable compounds of carbon and nitrogen in an oxygen atmosphere would be carbon dioxide and molecular nitrogen as illustrated in Figs. 6, 7, and 8.

Hence, the net result of this release of free and bound hydrogen from the atmosphere would be the formation of carbon dioxide and molecular nitrogen and the absence of all water. Production of intermediate metastable substances such as sugars and amino acids which comprise the biosphere can be expected during this transition. These metastable substances could possibly interact with each other to form increasingly complex metastable systems, which could eventually give origin to life itself.

Thus, it is speculated, the "life" atmosphere stage represents just the transition phase of the evolution of the earth's atmosphere between a "pre-life" reducing atmosphere stage and a future "post-life" oxidizing atmosphere stage. The kinetics of this process may be altered by organisms, but not the net results (Fig. 9), (25, 27, 28).

One would expect that the generalizations for what has been discussed for the earth would also hold for the other planets. Large cold planets would tend to retain the "pre-life" reducing atmosphere. Indeed, the atmospheres of Jupiter and Saturn do contain hydrogen, methane, and ammonia (27). Our planet, Earth, is in the transition "life" atmosphere stage and it has been estimated that the earth is losing about $1 \cdot 10^{-8}$ Emoles of molecular hydrogen per year (27). The symbol E is the

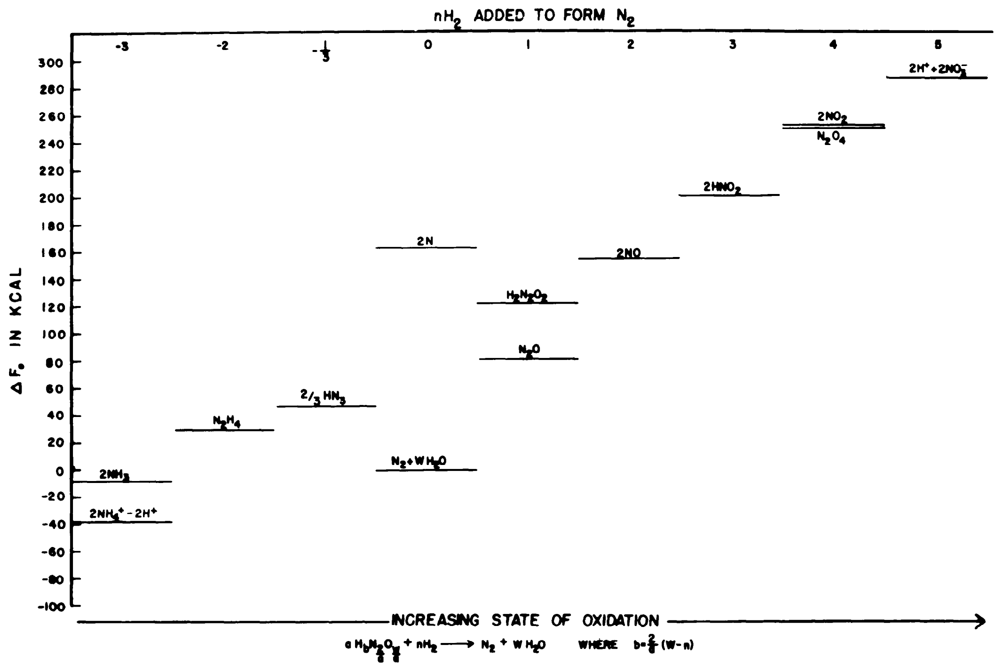

Fig. 3. Oxidation states of nitrogen in presence of hydrogen. See explanation for Fig. 2. From (25), Gilbert, D. L., "Speculation on the Relationship between Organic and Atmosphere." Perspect. Biol. Med. 4: 58, 1960. Published by the University of Chicago Press. Copyright 1960 by the University of Chicago.

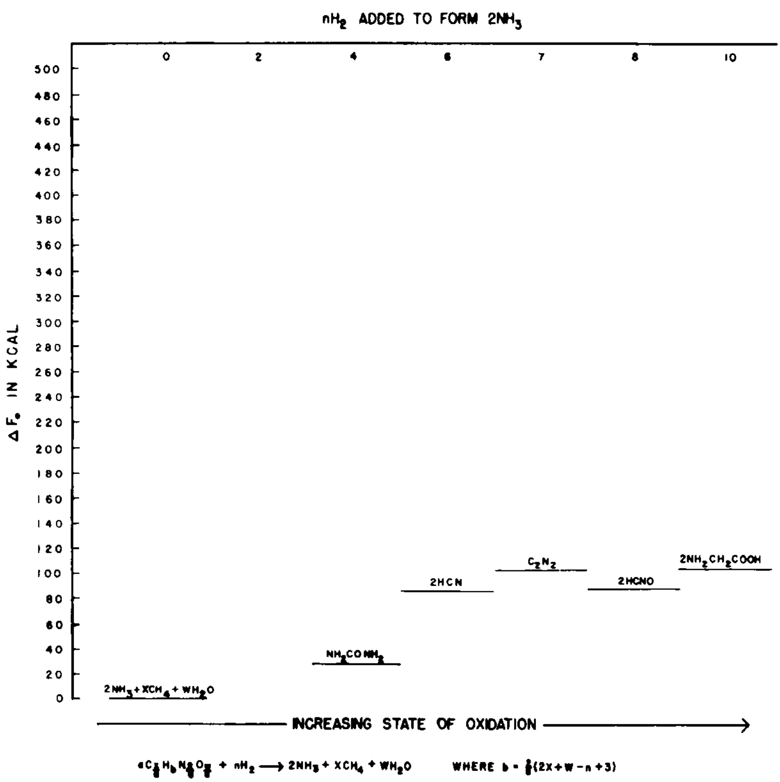

Fig. 4. Oxidation states of nitrogen-carbon compounds in presence of hydrogen. From (25). The ΔF_0 for NH_2CH_2COOH was obtained from Gucker et al. (31). Otherwise, see explanation for Fig. 2. Gilbert, D. L., "Speculation on the Relationship between Organic and Atmosphere." Perspect. Biol. Med. 4: 58, 1960. Published by the University of Chicago Press. Copyright 1960 by the University of Chicago.

	ΔFo (K cal)
$CH_4 \rightsquigarrow C + 2H_2$	12
$2NH_3 \rightsquigarrow N_2 + 3H_2$	8
$2H_2O \rightsquigarrow O_2 + 2H_2$	113
REDUCTION OF O_2	
$C + O_2 \longrightarrow CO_2$	−94
$X + O_2 \longrightarrow XO_2$	

X represents other substances, which can be oxidized by O_2

Fig. 5. Atmospheric evolution. From (25). Calculated from Latimer (40) at a temperature of 298oK. Gilbert, D.L., Perspect. Biol. Med. 4: 58, 1960. Publ. by Univ. of Chicago Press.

abbreviation for the prefix, Erda, and represents the multiple 10^{-18} (28).

The atmosphere of the earth also possesses a belt of helium below an outermost envelope of hydrogen. At the surface of the earth, the hydrogen accounts for about $1 \cdot 10^{-6}$ atm (45). It seems most likely that the "life" atmosphere stage is ending on Mars, since its atmosphere contains carbon dioxide, very little water (64) and hardly any molecular oxygen, if any at all (61). There is some evidence for the existence of a biosphere on Mars (61), but it is not too strong (60).

Small hot planets, on the other hand, would tend to be in the "post-life" stage due to the loss of the atmospheric constituents. Since Venus, a very hot planet (8), contains carbon dioxide and perhaps, molecular nitrogen, it would seem that this planet possesses a "post-life" atmosphere. Mercury, relatively close to the sun, has practically no atmosphere. It has been speculated that our moon, itself, possibly previously possessed a biosphere (29). There is evidence for organized structures (9) and organic compounds (5, 50) in meteorites which possibly suggests a biotic or prebiotic activity on meteors (49).

Organic Evolution

Now that the overall process of going from a "pre-life" to a "post-life" atmospheric stage has been presented, let us examine the evolution of the earth's biosphere. To begin this story, it is to be pointed out that important steps for the development of the earth's biosphere may have actually preceded the origin of the earth itself (35, 54). Thus, the beginning of this phase may conceivably take us back to the estimated age of our galaxy about $15 \cdot 10^9$ years ago (10). However, the oldest

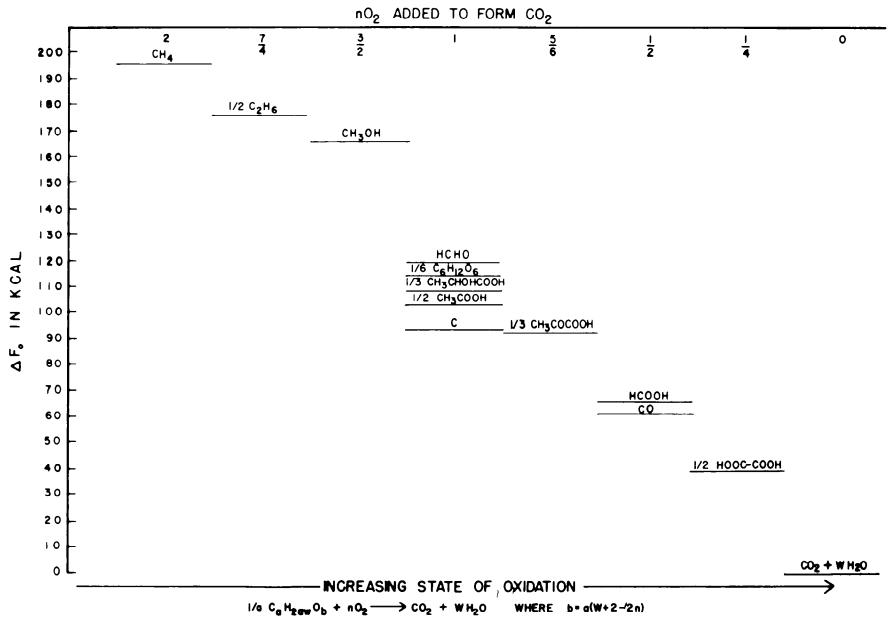

Fig. 6. Oxidation states of carbon in presence of oxygen. From (25). See explanation for Fig. 2. Gilbert, D. L., Perspect. Biol. Med., 4:58, 1960. Publ. by the University of Chicago Press. Copyright 1960 by the University of Chicago.

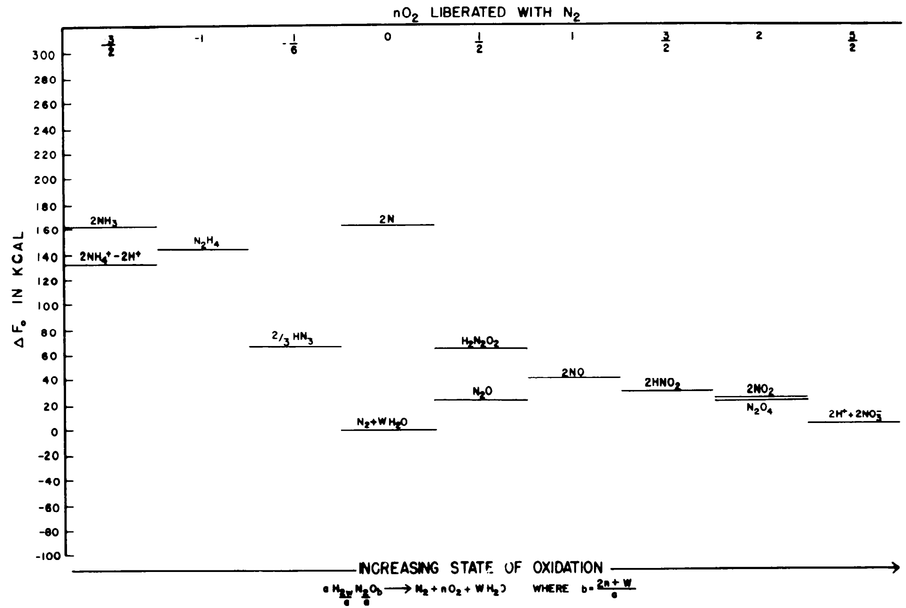

Fig. 7. Oxidation states of nitrogen in presence of oxygen. From (25). See explanation for Fig. 2. Gilbert, D. L., Perspect. Biol. Med. 4: 58, 1960. Publ. by the University of Chicago Press. Copyright 1960 by the University of Chicago.

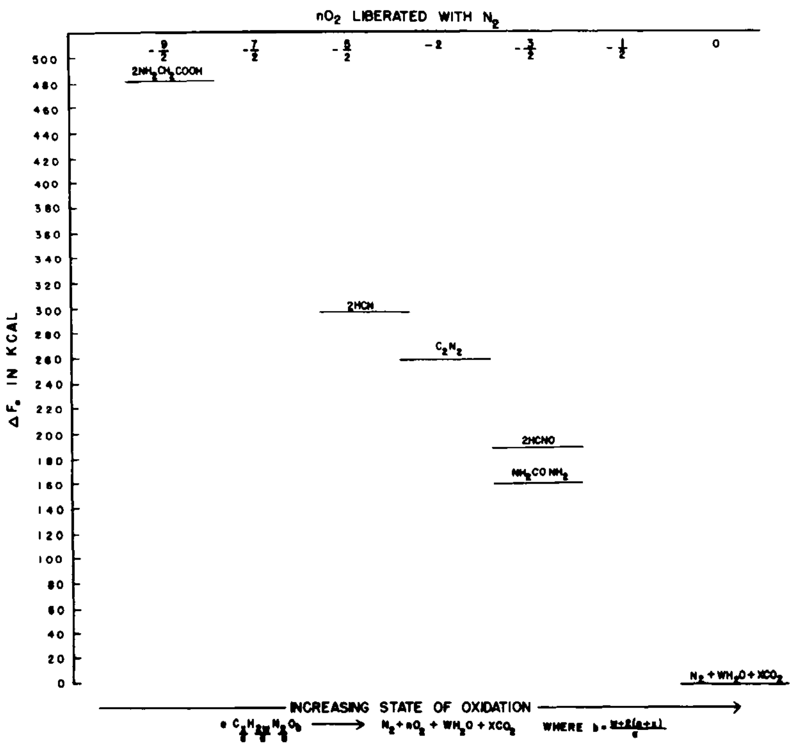

Fig. 8. Oxidation states of nitrogen-carbon compounds in presence of oxygen. From (25). The ΔF_0 for NH_2CH_2COOH was obtained from Gucker et al. (31). Otherwise, see explanation for Fig. 2. Gilbert, D. L., Perspect. Biol. Med. 4: 58, 1960. Publ. by the University of Chicago Press.

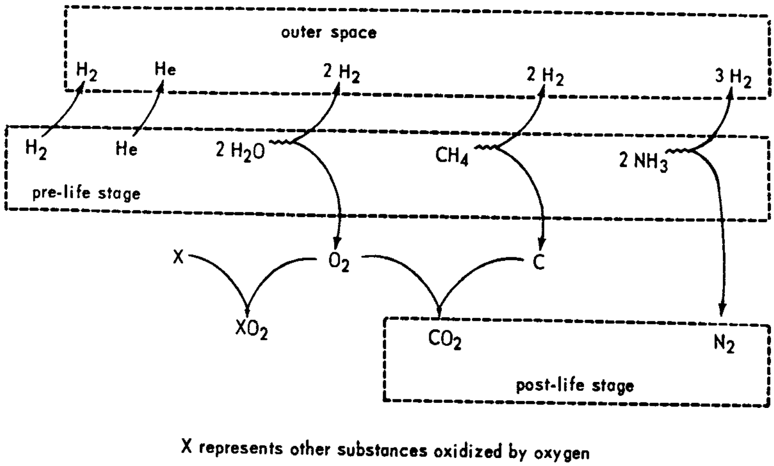

Fig. 9. Evolution of atmospheres. From (28).

observed components of the primitive biosphere have been estimated to be 10^9 years old (13, 43).

Several authors have discussed various aspects of how the development of a biosphere was derived from the supposed primitive reducing atmosphere into the present oxidizing one (5, 6, 18, 32, 45, 52, 57, 67, 68, 72). Provided that the hydrogen concentration in the primitive atmosphere was already sufficiently decreased, an energy source such as from the sun, could release hydrogen from methane and thereby produce a substance, such as sugar, which represents an intermediate metastable oxidation state of carbon between reduced methane and oxidized carbon dioxide (Fig. 2). Not much energy is required for this production. Other characteristic metastable compounds of the biosphere could similarly be produced (45, 52). Indeed, experimental syntheses of organic compounds under such conditions have been performed (45, 58). There would be less chance of a back reaction reverting the metastable compounds back to methane and ammonia as the hydrogen concentration decreased; the life time of these metastable compounds would be progressively increased, which could permit development of more complicated metastable compounds. Adenine synthesis in an electron irradiated atmosphere composed of methane, ammonia, water, and hydrogen is increased when the hydrogen is decreased (58). As these metastable compounds dissolved in the liquid phase of water, metastable systems were evolved which resulted in the formation of the primitive biosphere. Only the constituents of the biosphere dissolved in the liquid phase of water would be retained, since practically the entire primitive atmosphere has been lost (2). This conclusion seems necessary since the percent atom abundance of neon in the cosmos is 0.003 (7), which is a sizeable percent in comparison to the cosmic nitrogen abundance (Fig. 1). However, the fact that the earth contains hardly any neon at the present time implies that neon must have escaped from the earth's atmosphere. Since methane, ammonia, and water have lower molecular weights and consequently larger relative gas velocities (Fig. 10) than neon, these constituents of the primitive atmosphere must have escaped. The initial impact of the primitive atmosphere has not yet been forgotten and is responsible for the presence of the minute biosphere, which represents just the infinitesmal skin of the earth. The crust of the earth contains much less hydrogen, helium, carbon, and nitrogen than in the cosmos (Fig. 1), due to the loss of the primitive atmosphere. Oxygen was retained because it reacted with other elements such as silicon and iron in the earth's crust.

GAS	RELATIVE VELOCITY	GAS	RELATIVE VELOCITY
H	1.00	CO	0.19
H_2	0.77	N_2	0.19
He	0.50	NO	0.18
N	0.27	O_2	0.18
O	0.25	$HO_2^{\cdot}$	0.17
CH_4	0.25	Ar	0.16
$OH^{\cdot}$	0.24	CO_2	0.15
NH_3	0.24	N_2O	0.15
H_2O	0.24	NO_2	0.15
Ne	0.22	O_3	0.14

Fig. 10. Relative gas velocities. (From 28).

The primitive biosphere probably utilized the very small energy released by the reduction of metastable compounds, such as the carbohydrates, by molecular hydrogen into methane and water. The chance of finding primitive organisms which existed at the dawn of life seems remote. Instead, it seems much more likely to find remnants of biochemical systems which did exist in the primitive organisms. Such a system might be present in the anaerobic methane bacteria which are able to take up hydrogen and release methane (74). This energy utilization by the biosphere would tend to deplete the metastable constituents of the biosphere. Perhaps later, the biosphere catalyzed the already existing photochemical reverse reaction; hence, increasing the energy reserve for the biosphere in the forms of molecular hydrogen and carbohydrate. Photoproduction of hydrogen occurs in organisms, such as the purple bacteria (53). The presence of molecular hydrogen would tend to destroy the constituents of the biosphere by reducing them to methane and ammonia, so that the primitive organisms probably had to cope with the problem of "hydrogen toxicity." An example of hydrogen toxicity is the deleterious effect of hydrogen on nitrogen fixation by Azotobacter (48).

As the hydrogen pressure in the atmosphere decreased, the photodissociation of water into hydrogen and oxygen became more probable. The energy involved in this reaction is quite large (Fig. 5) and accounts for the large amount of energy released in the oxidation of sugar. The sugar, which represents a hydrogen pool, is oxidized by molecular oxygen into carbon dioxide and water (Fig. 6). Organisms were then possibly developed which could utilize the energy released from the oxidation of carbohydrates by molecular oxygen in the biochemical process of respiration (Fig. 11). In this process, the energy released by the formation of water is responsible for practically all the energy stored as adenosinetriphosphate.

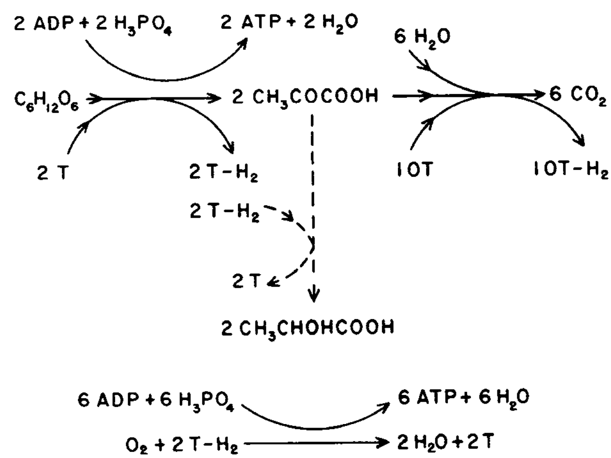

Fig. 11. Respiration. From (25). This figure simplifies the over-all general reactions of respiration. T refers to the hydrogen carriers in the hydrogen transport scheme (e.g., flavo-enzymes, cytochromes). The oxidation of $C_6H_{12}O_6$ to CO_2 produces 12 T-H_2, which results in formation of 36 ATP. The total ATP production from this oxidation is 38 ATP. However, the breakdown of $C_6H_{12}O_6$ into 2 $CH_3CHOHCOOH$ only results in the net formation of 2 ATP. (ADP refers to adenosinediphosphate, and ATP to adenosinetriphosphate). Gilbert, D. L., Perspect. Biol. Med., 4: 58, 1960. Publ. by the University of Chicago Press. Copyright 1960 by the University of Chicago.

Next, it might be expected that the biosphere evolved the catalytic photochemical process of photosynthesis, as present in green plants, which transforms solar energy into a large chemical energy reserve in the forms of molecular oxygen and carbohydrate, the bound form of hydrogen (Fig. 12). Essentially, photosynthesis, as it occurs in green plants, photodissociates water; the carbon dioxide merely acts as a sponge in absorbing the hydrogen. The quantasome, which is the fundamental particle involved in photosynthesis, is closely related to the electron-transport particle of mitochondria, which is the fundamental unit of respiration (56).

	ΔF_o (Kcal)
$12\,H_2O \rightarrow 6\,O_2 + 12\,H_2$	680
$12\,H_2 + 6\,CO_2 \rightarrow 6\,H_2O + C_6H_{12}O_6$	8
$6\,H_2O + 6\,CO_2 \rightarrow 6\,O_2 + C_6H_{12}O_6$	688

Fig. 12. Photosynthesis. From (25). Calculated from Latimer (40) at a temperature of 298°K. Gilbert, D. L., Perspect. Biol. Med. 4: 58, 1960. Publ. by University of Chicago Press. Copyright 1960 by the University of Chicago.

At the present time, molecular oxygen serves as the principal biological energy source for oxidizing a source of hydrogen. In some organisms, the source of hydrogen may even be molecular hydrogen (24) or methane (39).

The appearance of molecular oxygen in the atmosphere would alter the synthesis of cellular constituents (1, 73), make available more energy for the biosphere, and confront the biosphere with the problem of "oxygen toxicity": (20, 21, 22).

Due to the increased energy made available to most of the biosphere, the activity of the biosphere could be increased. For this reason, it has been speculated that molecular oxygen was required for the origin of the metazoa (51). Gaffron points out that there are no known multicellular differentiated organisms which are anaerobes (19).

To combat "oxygen toxicity", it was necessary for the biosphere to develop antioxidant mechanisms of a varied nature (20, 21, 22, 26). The mechanism by which this natural selection process occurs will not be discussed here (11). As the partial pressure of the oxygen in the atmosphere gradually increased, there developed as a consequence further antioxidant mechanisms. However, just as pH buffers can resist, but not completely prevent pH changes, antioxidant mechanisms will resist the toxic effects of oxygen, but not completely prevent them. Consequently the toxic action of oxygen is present at even the lowest oxygen pressure. Oxygen toxicity becomes increasingly apparent with an increased oxygen pressure and a decreased antioxidant defense.

One example of an antioxidant defense is the development of the iron enzyme, catalase, which decomposes hydrogen peroxide. Iron, itself, acts as a catalyst in decomposing hydrogen peroxide, but the catalytic action of catalase is 10^{10} times greater than that of iron (4). The development of this enzyme required oxidizing conditions (4).

Another example is the development of antioxidant mechanisms within the photosynthetic apparatus. The photochemical mechanisms responsible for the biological formation of molecular hydrogen and oxygen would be greatly affected by the presence of oxygen. Photoproduction of molecular hydrogen would be inhibited since molecular oxygen inactivates the enzyme, hydrogenase (17), which catalyzes the production of molecular hydrogen (24). Under the appropriate conditions, the photosynthetic apparatus of green plants in the presence of added hydrogenase can photoproduce molecular hydrogen (55). The presence of oxygen would also tend to produce photo-oxidative damage by chlorophyll (65). It appears that the carotenoids intimately associated with the photosynthetic apparatus inhibit this photo-oxidative damage (19, 65) and, therefore, permit the continuance of the photosynthetic production of molecular oxygen. Plants also contain phenolic compounds (33), which are very effective antioxidants (69).

Since oxygen is removed in the chemical reaction responsible for bioluminescence, it has been suggested that bioluminescence was used as an effective antioxidant defense when the atmospheric oxygen was produced (42).

Also, since oxygen has been shown to destroy artificial lipid bilayer membranes (36) it would seem that development of antioxidant mechanisms was necessary for the maintenance of biological membranes in the presence of an oxygen atmosphere.

An increase of oxygen in the tissue of dinosaurs has been suggested to account for the extinction of dinosaurs (62), but this does not seem probable since the oxygen concentration probably only increased gradually during atmospheric evolution.

It has been pointed out that air breathing organisms have a much smaller ventilation than do aquatic organisms. If the ventilation was not decreased when aquatic organisms became air breathing organisms, then the partial pressure of oxygen in the arterial blood of air breathing organisms would be greater than in the present air breathing organisms. Thus, this decreased ventilation effect can be considered as another "antioxidant defense" (59).

The biosphere has had to maintain itself against both "hydrogen toxicity" and "oxygen toxicity" in order to survive. Hence, it is not too surprising that the redox potential must be properly regulated so that cyclic photophosphorylation, an important aspect of photosynthesis, can occur (66).

Oxygen and the Biosphere

Since oxygen is reactive, the existence of molecular oxygen in a planet's atmosphere can be taken as circumstantial evidence for the presence of a biosphere. Actually, only 0.01 percent of all the oxygen in the earth's crust is molecular oxygen in the atmosphere (Fig. 13) (28). The lithosphere contains 90 percent of the oxygen in the earth's crust, and has been appropriately referred to as the "oxysphere" (41). However, the lithosphere is still not saturated with oxygen. The oxygen pressure in the bulk of the earth's crust is from 10^{-10} to 10^{-30} atmospheres (47). Only 30 percent of the iron in the lithosphere is in the oxidized form. To oxidize all the iron requires 4800 Emoles of molecular oxygen (28).

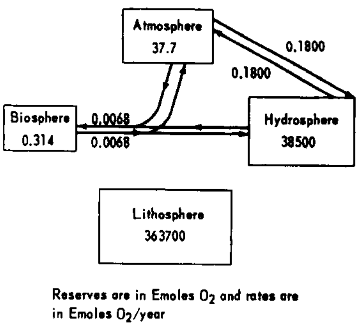

Fig. 13. Major oxygen turnover routes. From (28). E. is the abbreviation for the prefix, erda, and represents the multiple, 10^{18} (28). The atmospheric reserves of oxygen as Emoles of molecular oxygen consist of 37.0, 0.0548, and 0.6 in the forms of O_2, CO_2, and H_2O respectively.

There is a large exchange of oxygen between the hydrosphere and the atmosphere, due to the exchange of gaseous oxygen in the atmosphere with the dissolved oxygen in the ocean (Fig. 13). Photosynthesis produces 0.0068 Emoles of molecular oxygen per year, which results in an atmospheric turnover of oxygen from the biosphere about every 5400 years: (28) a very short period of time from a geological point of view. All other productions of molecular oxygen are negligible in comparison (28). Hence, the oxygen present in the atmosphere today is due to photosynthetic activity.

It appears that there are several other planets in the cosmos besides Earth which could equally well support a biosphere (12, 63). It must be kept in mind that life can possibly exist in ways that cannot even be imagined at this time. Even on earth, organisms have been found in the bottom of the ocean at 10900 meters (37) where the pressure is in excess of 1000 atmospheres (16). A significant percentage of micro organism spores have even survived exposure to 10^{-8} mm Hg pressure for ten days, although none survived after exposure for thirty days (3). Bacteria and algae exist in hot springs at a temperature range from 80°C to 88°C (34, 70). A culture of thermophilic sulfate reducing bacteria produced H_2S at 104°C exposed to 1000 atmospheres (70). Some organisms can grow at temperatures down to -18°C (70) and it has been speculated that a lower temperature limit for living organisms might be -80°C (46).

Nevertheless, the relative abundance and peculiar properties of the atoms are undoubtedly important in relation to any living process. For any type of biosphere there must be the ability to store and utilize energy. Let us consider the qualifications of storage energy forms of a biosphere which would be expected to be composed of a substantial quantity of hydrogen, since it is the predominant cosmic element. If one considers for such a biosphere the qualifications of storage energy forms in the environment (Fig. 14), then oxygen appears to be the best qualified (25).

1. Great Abundance
2. Easily Accessible
3. High Thermodynamic Potential
4. Slow Reaction Rate

Fig. 14. Qualifications of storage energy forms.

One qualification is that the storage energy form should be abundant. Oxygen is very abundant, being the third most abundant element in the cosmos (Fig. 1).

The second qualification is that the storage energy form should be easily accessible. Since oxygen is ordinarily in the gaseous state, unless the temperature is exceedingly low, it is easily available all over the surface of a planet.

The third qualification is that the storage energy form should have a high thermodynamic potential. Oxygen possesses a relatively high potential, being surpassed only by the rapidly acting flourine and chlorine and by other forms of oxygen.

The last qualification is that the storage energy form should have a slow reaction rate. Oxygen is slow to react. However, in spite of this inherent sluggish behavior, oxygen does react with the metastable substance comprising the biosphere, which results in "oxygen toxicity". It is still an intriguing problem of how the biosphere is able to survive at all in an oxygen atmosphere. Thus, Gerschman has stated (20):

"A better understanding of the fundamental mechanism involved inclines us to marvel at the continuous and powerful cellular defenses against oxygen rather than to be surprised at its potential destructive action." This same problem of metastable states being able to exist in an oxygen atmosphere is not unique for the biosphere. For example, Evans, in discussing the oxidative corrosion of metals back to their natural oxidized state, wrote (14): "Until a few years ago, the difficulty confronting Students of Corrosion was not to find an explanation of the attack, but rather to account for the fact that metals survived at all." The antioxidant mechanism responsible for the metal survival is the development of a metal oxide film upon the metal surface; hence, impeding oxygen access to the metal below and resulting in a decreased oxidation rate (14).

Free Radicals and Oxygen Toxicity

The activation of oxygen to a free radical state accounts for part of its sluggish behavior in spite of its high potential (30). The "Gerschman theory" implicates oxidizing free radicals as the cause of oxygen toxicity (23). Usually free radicals are unstable and energy is required to produce them. A free radical is characterized by an unpaired electron in one of its orbitals. A filled orbital contains two electrons which have opposite spins, resulting in a net spin of zero. If an orbital contains only an unpaired electron, then the electron spin results in a magnetic moment, which gives rise to paramagnetism. There is generally a strong tendency to pair electrons in orbitals and eliminate a net electron spin, and it is for this reason that free radicals are unstable. Fig. 15 illustrates the dissociation of water into ions or radicals. The dissociation constant of H_2O into H^+ and OH^- ions is $1 \cdot 10^{-14}$, whereas the dissociation constant of H_2O into H· and OH· radicals is $1 \cdot 10^{-83}$ (40). Hence, the radicals are much more unstable than the ions. It is generally easier to break

REACTION	K
H:Ö:H ⇌ H^+ + ⁻:Ö:H (H_2O) (H^+) (OH^-) ION FORMATION	$1 \cdot 10^{-14}$
H:Ö:H ⇌ H· · ·Ö:H (H_2O) (H·) (OH·) RADICAL FORMATION	$1 \cdot 10^{-83}$

Fig. 15. Formation of ions and radicals. Calculated from Latimer (40) at a temperature of 298°K.

chemical bonds so that there are formed charged species instead of species containing unpaired electrons. Fig. 16 illustrates how a species may possess an electrical charge and also an unpaired electron. If a hydrogen atom is combined with molecular oxygen, the free radical $HO_2\cdot$, which contains one unpaired electron, is produced. The ionized form of $HO_2\cdot$ is O_2^-, which is a charged free radical.

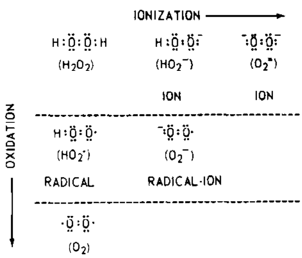

Fig. 16. Radicals and ions of oxygen.

According to the univalent theory of Michaelis (44), molecular oxygen can become reduced by accepting only one electron at a time. The univalent reduction of oxygen by hydrogen is illustrated in Fig. 17 with reference to changes in free energy, which were calculated from Latimer (40). Since the free-radical states ($HO_2\cdot$, $OH\cdot$, and $H\cdot$) are not stable, the energy released by them is of considerable magnitude; but they are difficult to produce, and thus act as energy barriers for both oxygen and hydrogen peroxide.

However, once they are formed, they can give rise to non-specific propagating chain reactions. In a chain reaction the energy required for the free radical production is regenerated by the energy liberated in the free radical reaction. One can use as an analogy a water movement from one level to a lower level by means of a siphon. It requires energy to move the water from the high level to a still higher level in the siphon tube. The higher level in the tube corresponds to a free radical or activated state. Once energy has been added to the system to drive the water from the high level to the activated level in the tube, then water will flow from the activated level to the lower level continuously until all the water has been transferred. The energy released in going from the activated level to the low level is used in part to drive the water from the high level to the activated level.

An example of a chain reaction is shown in Fig. 18 (26). The free radicals $R\cdot$ and $RO_2\cdot$ act as chain centers, and an increase in their concentrations can increase the rate of formation of the organic peroxide RO_2H. Biological damage can be due to the radicals as well as to the peroxide and to the radicals derived from the peroxide. The radicals,

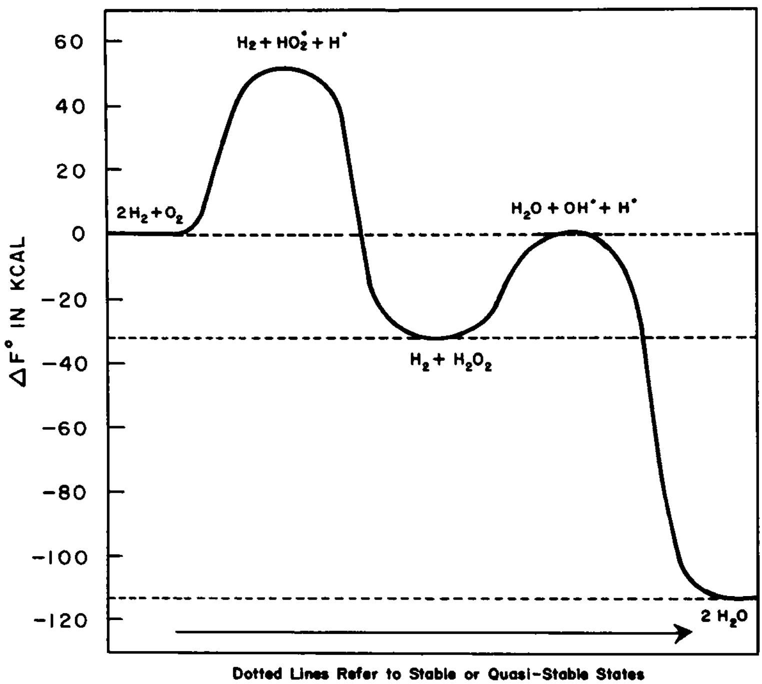

Fig. 17. Univalent reduction of oxygen by hydrogen. From (26). Gilbert, D. L., Radiation Res. Suppl. 3: 44, 1963. Published by Academic Press, Inc.

as well as other similar unstable chemical intermediates, serve as the catalysts for the inherent biological action of oxygen. Increasing the free-radical concentration is a pro-oxidant effect, and decreasing the free-radical concentration is an antioxidant effect. The existence of free radicals in biological systems has been demonstrated by the use of electron spin resonance spectroscopy (38). Some of these biological free radicals may be largely immobile in the cell (71).

Any biological storage form of energy would tend to be dissipated, resulting in tissue destruction and eventual death of the organism. When biological antioxidant defenses are damaged, then the effects of "oxygen toxicity" become more apparent. The "Gerschman theory" of "oxygen toxicity" points out the similarity between the biological deleterious effects of both X-irradiation and oxygen (23). The X-irradiation merely catalyzes the damaging influence of oxygen by injuring the antioxidant defenses through free radical reactions. Thus, an X-irradiation dose

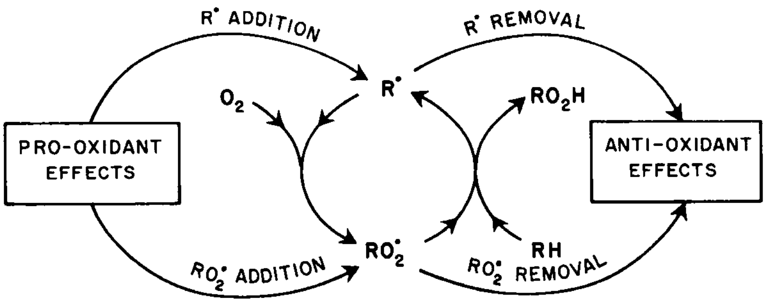

Fig. 18. Chain reaction. From (26). Gilbert, D. L., Radiation Res. Suppl. 3: 44, 1963. Published by Academic Press, Inc.

of 500 rads can kill a man, yet the energy absorbed is only 0.0012 Kcal per kilogram of tissue, which is equivalent to a negligible temperature increase of only 0.0012°C.

An antioxidant may, under the appropriate conditions, exhibit a pro-oxidant effect (26). For example, a hydrogen donor, such as reduced glutathione, might remove free radicals and thus act as an antioxidant as illustrated in Fig. 19. It should be pointed out that breaking a given chain reaction by removing the free-radical chain centers can possibly produce other free radicals for another chain reaction. A hydrogen donor, such as reduced glutathione, might also activate oxygen to a free-radical state ($HO_2^\cdot$ or O_2^-) and thus now act as a pro-oxidant as shown in Fig. 20. Depending on the biological system and on the criterion for judging oxidation, the net prevailing influence of a given condition may be either pro-oxidant or antioxidant.

$$2GSH + 2RO_2^\cdot \longrightarrow 2GS^\cdot + 2RO_2H$$

$$2GS^\cdot \longrightarrow GSSG$$

Fig. 19. Antioxidant effect.

Free Radical Removal

$$GSH + O_2 \longrightarrow HO_2^{\bullet} + GS^{\bullet}$$

$$HO_2^{\bullet} + RH \longrightarrow R^{\bullet} + H_2O_2$$

Free Radical Addition

Fig. 20. Pro-oxidant effect.

Summary

In conclusion, it is speculated that during the time that the atmosphere of a planet changes from one composed of molecular hydrogen, helium, water, methane, and ammonia into one composed of carbon dioxide and molecular nitrogen, a "life-stage" is possible, providing there is available an adequate energy source and providing that the duration of the transition is long enough to give rise to a biosphere. Although a biosphere can obtain energy without using molecular oxygen, a biosphere can obtain more energy by using oxygen. However, there is a price to be paid by this oxygen utilization, since oxygen really represents a double-edged sword. It supplies the energy for life, but it also destroys living material. Thus, the price paid by the biosphere for this convenient source of energy is oxygen toxicity. Antioxidant defense mechanisms were evolved by the biosphere in order to combat the destructive influence of oxygen.

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THE CORONARY'S CODE

Slow me down, Lord! Ease the throbbing of my heart by the quieting of my mind. Steady my hurried pace with a vision of the eternal reach of time. Give me, amidst the confusions of my day, the calmness of the everlasting hills.

Break the tensions of my muscles and nerves with the soothing music of the rippling streams that live in my memory. Teach me the art of taking minute vacations - of stooping down to examine the beauty of a flower, to chat with a friend, to pat a dog, to read a few lines from a good book.

Let me look upward into the sturdy branches of the towering oak and know that it grew great and strong because it grew slowly and well. Slow me down, Lord, and inspire me to sink my roots deeply into the rich soil of life's enduring values.

Anonymous

GUIDELINES FOR THE COMMITTEE ON MEMBERSHIP

The growth and character of our Society are largely determined by the number and quality of candidates proposed for membership by members themselves. Members of the Society therefore play a major role in determining the evolution of the Society. In contrast, the role of the Committee on Membership in appraising nominations will always be relatively uncertain and members of this Committee have frequently turned to Council for advice in delineating their responsibilities. Council has therefore prepared a set of "Guidelines" for use by members of the Committee on Membership in their difficult and time-consuming appraisal of candidates proposed by members of the Society. The principal points in these guidelines are reproduced below for the information of members and as a reminder that the privilege of nominating new candidates is a basic factor determining the development of our Society.

The General Rules

The Advisory Committee on Membership was established in 1960 (Article VII, Standing Rule 5) to assist Council in reviewing applications for membership and to advise on policy matters related to the selection of new members. Nominations to all classes of membership may be made at any time during the year, but the Committee ordinarily reviews applications twice each year in time for appraisal by Council at the Spring and Fall meetings of the Society. In recent years the number of annual nominations has been 150 ± 50, of which about two-thirds are appraised at the Spring meeting for placement on the ballot at the Fall elections (Table I).

Table I. New Members Elected to Full Membership.

	Spring	Fall	Total
1956	30	58	88
1957	37	71	108
1958	47	52	99
1959	50	75	125
1960	71	104	175
1961	51	96	147
1962	56	106	162
1963	79	116	195
1964	47	105	152
	468	783	1251

Policies relating to selection of new members have been discussed on many occasions in the history of the Society. The most general statement of policy is given in Article I, Section 2, of the By-laws:

"Section 2. Members: Any person who has conducted and published meritorius original research in physiology and/or biophysics and who is a resident of North America shall be eligible for membership in the

Society."

and

"Section 4. Associate Members: Advanced graduate students in physiology at a predoctoral level, teachers of physiology, and investigators who have not yet had the opportunity or time to satisfy the requirements for full membership shall be eligible for associate membership in the Society provided they are residents of North America."

Further rules concerning membership are in Article VII, Standing Rules.

1. Election to Membership: Two members of the Society must join in proposing a person for membership, in writing, and with a statement of his qualifications. The Council may, from the persons so proposed, nominate candidates for election to membership. Nominations shall be presented at Spring and Fall meetings; a two-thirds majority vote of the members present and voting at the next following Fall or Spring meeting shall be necessary for election.

   If a Spring or Fall meeting of the Society is not held, the procedures of nomination and/or election of new members may be effected by mail.

   The names of the candidates nominated by the Council for membership and statements of their qualifications signed by their proposers shall be available for inspection by members during the Society meetings at which their election is considered.

and

3. Election to Associate Membership: Associate Members shall be proposed, nominated and elected in the same manner as full members.

   Associate members shall have the privilege of attending business sessions of the Society but shall have no vote. Associate members may be nominated for full membership.

   Honorary members and Sustaining Associate members are considered by Council.

Many questions naturally arise when members of the Advisory Committee on Membership are faced with interpreting this general policy in the course of evaluating applications. What is meant by "meritorious" and "original?" How many "publications" are required and in what journals? Indeed one is often hard put to give a definition of "Physiology" itself. These and other questions relating to growth and appropriate distribution of interests in the Society have been and will continue to be asked by all those charged with selecting new members. In general, there are no certain answers to these questions. Interpretations will always differ according to the interests, training and prejudices of the individuals on the Committee. Our safeguard and indeed and our strength lie in the fact that the Membership Committee is constantly changing thus supplying a broad range of interests, opinions, geographical representation and personal circle of acquaintances. "Guidelines" for membership are therefore not intended to answer specific problems nor to define rigid policies; rather they are designed to provide information and to state some general principles which may be helpful to members in coming to their individual and collective decisions.

Previous Discussions of Membership Policy

General background information relating to growth of the Society, distribution of interest in the past, relation to growth of other societies, role of Associate Members, arguments for and against enlarging membership and other related questions will be found in:

a. Fenn, W.O. History of the APS, 1937 to 1962, Chap. 3, pp. 56-64.
b. Hardy, J. A report of the Committee on Membership, The Physiologist, Vol. 4, No. 4, pp. 16-19. 1961.
c. Membership Requirements, The Physiologist, Vol. 5, No. 2, p. 51, 1962.

The Growth of the Society

The American Physiological Society has grown from a small "honor" Society to a large professional organization which remains "honorary" but at the same time fulfills many national and international functions for the benefit of biology and medical sciences as well as for physiology. This growth of our Society, in diversity of function as well as in size, has not evolved as a result of a conscious policy; rather, it has taken place by slow natural evolution and selection, driven not only by scientific but also by the social and economic developments of our time. We seek to preserve some of the delights of a small honor Society such as the annual banquet, informal business meetings, and "town meeting" type of voting procedures, but we cannot disregard the obvious responsibilities and disadvantages which come with the flowering of science as a whole. Numerical growth of APS has closely paralleled that of other scientific societies in the United States, including the Federated Societies for Experimental Biology. Annual rate of growth for APS was 4.7% in the decade prior to 1957; it increased to 5.5% in the years 1957-60 and averaged 7.2% from 1960-63. Recent statistics are shown in Table II.

If rate of growth were to remain stable at about 7%, the membership would reach 3,000 by 1967 and 4,000 by 1971. Parallel growth in the Federation as a whole would bring the total membership of FASEB to the 20,000 mark within ten years.

Perhaps a steady-state will eventually be attained, but in the meantime we must look forward to many new problems arising from our growth.

Table II. Recent Growth of APS (Regular Members Only)

Calendar Year	Number Elected	Total Membership	Incremental Growth*	Rate of Growth (%)
1960	175	1878	154	8.9
1961	147	1996	118	6.3
1962	162	2132	126	6.3
1963	195	2291	159	7.5
1964	152	2415	124	5.4

*Difference between number elected and losses through death, retirement or resignation.

Solution of these problems will depend largely on the quality of membership itself during the years to come. At this time it seems wise to emphasize quality and an interesting distribution of talent, with a stable or moderately reduced rate of growth in the expectation of a total membership in the range of 3,200 to 3,500 by 1970. This requires membership by the Advisory Committee on Membership to be more selective than it has been in the recent past.

Role of the Individual Members

Definitions of "physiology" and criteria of "quality" are left to individual members of the Society and eventually to members of the Committee and Council. Specific definitions will change from year to year according to the varied backgrounds and interests of Committee members. As stated above, our strength lies in the constantly changing make-up of the Committee to ensure introduction of new ideas and an ever changing circle of personal acquaintance with candidates and their sponsors. Individual members need feel no hesitation in backing strongly those candidates whom they know personally to be promising candidates. It is the responsibility of Council to maintain a proper balance of interests, experience and geographical distribution on the Committee charged with selecting candidates for membership.

Publications

In general, it is assumed that each candidate will have published original papers of significance to physiology - definition of "significance" being left to the judgment of members and to the Advisory Committee. The number of papers is less important than their quality. Emphasis should properly be placed on original and independent work which provides promise of things to come. Publication in Society journals is not important from this point of view, although ordinarily it is expected that the candidate will have manifested interest in meetings, symposia, or other activities of the Society.

Distribution of Interests

The ratio of "Ph.D.'s to M.D.'s" has been close to unity, ever since our Society was founded in 1888. At the present time about half our members are associated with medical schools (25% in departments of physiology, 10% in other preclinical sciences and 15% in clinical departments). About 25% of the present members are affiliated with research institutes (government or private), 10-15% with zoology or biology departments in colleges and the remaining 10-15% represent diverse branches of industry and medicine, including schools of veterinary medicine and agriculture.

These proportions have occurred by "natural selection" but there have been many discussions of the pros and cons of introducing some form of quota system to prevent dominance by any one group or neglect of minority groups. Arguments have been particularly heated with respect to applications from "clinical physiologists" but in the end, as observed by Fenn (History, p. 59)."The final vote is usually true to tradition and in favor of good physiology wherever it is found."

TRAVEL TO JAPAN

Group flights are being arranged for delegates to the 23rd International Congress of Physiological Sciences in Tokyo, Japan, September 1-9, 1965. Flights leaving the west coast and the east coast are being arranged at various times by the Chevy Chase Travel Agency, 4951 Saint Elmo Avenue, Bethesda, Md. 20014.

The Canadian Federation of Biological Societies is arranging a charter flight for delegates leaving San Francisco August 26 and leaving Tokyo September 18, 1965. Dr. Olivier Heroux, National Research Council, Ottawa 2, Canada, is arranging the flight.

Travel Grants for citizens or residents of the United States are being awarded by the U.S. National Committee for the IUPS, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

UNIVERSITIES OFFERING THE Ph.D. DEGREE IN PHYSIOLOGY

A questionnaire was circulated to all medical schools and graduate schools in order to determine those that offered the Ph.D. degree in physiology. Following is a list of those answering in the positive. Different universities offered the degree for work in a variety of different sub-disciplines of physiology. Details will be published later by the Education Committee.

Medical Schools

Univ. of Alabama Medical College
Albany Medical College
Albert Einstein College of Medicine
Univ. of Arkansas School of Medicine
Baylor Univ. College of Medicine
Boston Univ. School of Medicine
Bowman-Gray School of Medicine
Univ. of California School of Medicine, Los Angeles
Univ. of California School of Medicine, San Francisco
Univ. of Chicago School of Medicine
Univ. of Cincinnati College of Medicine
Univ. of Colorado School of Medicine
Columbia Univ. College of Physicians & Surgeons
Cornell Univ. Medical College
Dartmouth Medical School
Duke Univ. School of Medicine
Emory Univ. School of Medicine
Univ. of Florida College of Medicine
Georgetown Univ. School of Medicine
George Washington Univ. School of Medicine
Medical College of Georgia
Hahnemann Medical College
Harvard Medical School
Howard Univ. School of Medicine
Univ. of Illinois College of Medicine (Chicago)
Univ. of Indiana School of Medicine (Indianapolis)
Johns Hopkins Univ. School of Medicine
Univ. of Kansas School of Medicine
Univ. of Kentucky College of Medicine
Louisiana State Univ. School of Medicine
Univ. of Louisville School of Medicine
Loma Linda Univ. School of Medicine
Loyola Univ. Stritch School of Medicine
Marquette Univ. School of Medicine
Univ. of Maryland School of Medicine
Univ. of Miami School of Medicine
Univ. of Michigan School of Medicine
Univ. of Minnesota Medical School
Univ. of Mississippi School of Medicine
Univ. of Missouri School of Medicine
Univ. of Nebraska College of Medicine

New York Univ. School of Medicine
Univ. of North Carolina School of Medicine
Univ. of North Dakota School of Medicine
Northwestern Univ. Medical School
Ohio State Univ. College of Medicine
Univ. of Oklahoma School of Medicine
Univ. of Oregon Medical School
Univ. of Pennsylvania School of Medicine
Univ. of Pittsburgh School of Medicine
Univ. of Puerto Rico School of Medicine
Univ. of Rochester School of Medicine
St. Louis Univ. School of Medicine
Seton Hall College of Medicine
Medical College of South Carolina
Univ. of South Dakota School of Medical Science
Univ. of Southern California Medical School
Stanford Univ. School of Medicine
State Univ. of Iowa College of Medicine
State Univ. of New York Downstate Medical Center (Brooklyn)
State Univ. of New York at Buffalo School of Medicine
State Univ. of New York Upstate Medical Center (Syracuse)
Temple Univ. School of Medicine
Univ. of Tennessee College of Medicine
Univ. of Texas School of Medicine (Galveston)
Tufts Univ. School of Medicine
Tulane Univ. School of Medicine
Univ. of Utah College of Medicine
Vanderbilt Univ. School of Medicine
Univ. of Vermont College of Medicine
Medical College of Virginia (Richmond)
Univ. of Virginia School of Medicine
Washington Univ. School of Medicine (St. Louis)
Univ. of Washington School of Medicine (Seattle)
Wayne State Univ. College of Medicine
West Virginia Univ. School of Medicine
Western Reserve Univ. School of Medicine
Univ. of Wisconsin Medical School
Woman's Medical College of Pennsylvania
Yale Univ. School of Medicine

Many of the medical schools offer the degree in conjunction with their graduate schools.

Graduate Schools and Other
(with departments or schools)

Univ. of Alaska - Zoophysiology
Univ. of Arizona - Zoology
Auburn Univ. - Zoology; Agricultural College
Baylor Dental College (Dallas)
Brown Univ. - Biology

Univ. of California (Berkeley) - Physiology & Anatomy
Univ. of California (Davis) - Zoology
California Institute of Technology - Biology
Catholic Univ. of America - Biology
City College of New York - Biology
Claremont Graduate School - Physiological Psychology
Clark Univ. - Biology
Univ. of Colorado - Biology
Colorado State Univ. - College of Veterinary Medicine
Cornell Univ. (Ithaca) - New York State Veterinary College;
New York State College of Agriculture
Univ. of Connecticut - Zoology
Univ. of Delaware - Biological Sciences
Florida State Univ. - Biological Science
Fordham Univ. - Biology
Univ. of Georgia - Zoology
Univ. of Houston - Biology; Biophysics
Univ. of Illinois (Urbana) - Physiology & Biophysics
Illinois Institute of Technology - Biology
Indiana Univ. (Bloomington) - Anatomy & Physiology
Iowa State Univ. - Zoology & Entomology
Kansas State Univ. - College of Veterinary Medicine
Univ. of Maine - Zoology
Univ. of Maryland (College Park) - Zoology
Univ. of Maryland Dental School (Baltimore)
Univ. of Massachusetts - Zoology
Massachusetts Institute of Technology - Biology
Michigan State Univ. - Physiology
Univ. of New Mexico - Biology
North Dakota State Univ. - Agricultural College
Univ. of Notre Dame - Biology
Oklahoma State Univ. - Veterinary College
Univ. of Oregon - Biology
Purdue Univ. - Biological Sciences; Veterinary College;
Agricultural College
Univ. of Rhode Island - Zoology
Rutgers Univ. - Physiology & Biochemistry
St. Bonaventure Univ. - Biology
St. Johns Univ. - Biology
Univ. of South Carolina - Biology
Univ. of Southern Illinois - Physiology
Syracuse Univ. - Zoology
Temple Univ. - Biology
Univ. of Texas - Zoology
Utah State Univ. - Zoology
Washington State Univ. - Zoophysiology
Univ. of Wyoming - Zoology & Physiology

No attempt was made to list the departments offering degrees in Plant Physiology.

DESERT REUNION

D. B. DILL

Response to stress as modified by age has attracted our attention in recent years. I gave a preliminary account in THE PHYSIOLOGIST, February, 1963, of our study of 1962 in which six physiologists returned to high altitudes for follow-up observations after a time lapse of from 27 to 33 years. Last summer an analogous desert study was carried out at Boulder City, Nevada with the support of PHS Grant CD 00056-02. Five participants had been subjects and observers in a desert study in 1932 or 1937 or in both years: in 1964 F. G. Hall and I were at Boulder City from June 22 to July 31; J. H. Talbott, W. V. Consolazio and C. F. Consolazio were there for about a week in mid-July. Three young men helped Hall and me and also served as subjects: E. Earl Phillips, Jr. of the University of Florida, Gainesville, W. van Beaumont of Indiana University and Don MacGregor of the University of California, Santa Barbara. Others participated for short periods: S. M. Horvath, Environmental Stress Laboratory, University of California, Santa Barbara; Klaus Klausen, University of Copenhagen - he is spending a year at Indiana University, and K. D. Hall, Duke University Medical School. K. Schmidt-Nielsen, Department of Zoology, Duke University spent two days with us as subject and observer. In addition, thanks to the efforts of Phillips, 31 Boulder City boys, ages 10 to 19 volunteered as subjects.

Our major interest was in the rate of sweating and in the concentration of chloride in sweat. We sought to establish the relation, if any, between these measurements and the following: acclimatization, skin temperature, body temperature, metabolic rate, individual inherent characteristics and age.

Our standard walk was for about four miles in the mid-afternoon on the high school track. The rate was 3.75 mph or 100 m/min. One day we walked in the nearby desert and on another day, July 25, we went to Death Valley for the standard walk. The daily maximum temperature at Boulder City varied from 34° to 43°C while during our day in Death Valley it was 47.2°C. To vary the sweat rate and skin temperature some walks were done soon after sunrise or 2 hours or more after sunset. The combination of low metabolic rate, low sweat rate and high skin temperature was obtained by sitting in the sun.

In the time available not all the possible inter-relations could be tested adequately although we learned something about most of them. I gave a preliminary report of some of the findings at a seminar on bioclimatology at Sapporo, Japan in November 1964. Papers presenting our findings are in preparation.

Factors that clearly influenced the concentration of chloride in sweat in these outdoor studies in dry heat were: sweat rate, inherent characteristics and age. The degree of acclimatization was a factor in some but was not evident in others. However, some of us had been exposed to high temperatures prior to reaching Boulder City. Under the conditions of our studies there was no obvious relation between sweat chloride concentration and skin temperature, body temperature or metabolic rate.

I learned from a preliminary inquiry that the Desert Research Institute of the University of Nevada is prepared to embark on ecological desert research. Dr. Wendell A. Mordy, Director of the Institute arranged for an interchange of ideas about such a venture. This was held at Las Vegas, July 20 and 21, and included a visit by USAF helicopter across the Virgin River to the Golden Butte area. President C. J. Armstrong of the University and several members of his faculty at the Southern Regional Division, Las Vegas attended. Among visiting physiologists were Scholander, K. Schmidt-Nielsen, George Bartholomew, F. G. Hall, J. H. Talbott and myself. Two members of the Board of Regents took part, Fred M. Anderson, M.D. of Reno and Juanita White, Ph.D. of Boulder City. Curtis Bowser of the Bureau of Reclamation, and Charles A. Richey of the National Park Service provided information about Lake Mead and contiguous desert areas. Interested observers were George Sprugel, Jr., Chief Scientist of the National Park Service, David B. Tyler and Josephine K. Doherty of the National Science Foundation, David L. Patrick, Director of Research, University of Arizona and Dade D. Parker, ecologist, University of Utah.

In the closing session it became clear that the University should explore the possibility of insuring for future generations of biologists the availability of a large area of Nevada desert adjacent to Lake Mead and reaching to an altitude of 7000 feet. It was further agreed that the University might well add to its faculty a senior biologist qualified to develop the field of desert biology, funds being in hand for such an appointment. I was delighted to learn recently from Dr. Fred M. Anderson that Dr. Frits Went is leaving his professorship at Washington University to accept this appointment, effective February 1, 1965.

Finally a word about the good friends at Boulder City who helped us realize our plans: Wm. McCormick, principal of the Boulder City High School with agreement of the Clark County Board of Education made available to us the air-conditioned biology laboratory and gymnasium in the high school and the high school quarter-mile track. The air-conditioned Boulder City Inn, Mr. and Mrs. Beaugureau, proprietors, provided excellent food and comfortable rooms. We enjoyed the hospitality of Dr. and Mrs. Elmer Lee and Drs. Tom and Juanita White. Thanks to these and many other friends the eleven of us had good fun and a successful summer.

Those who returned: C. F. Consolazio, U.S. Army Medical Research and Nutrition Laboratory, Denver; D. B. Dill; J. H. Talbott, Editor JAMA; W. V. Consolazio, National Science Foundation; and F. G. Hall. The first four were in the Harvard Fatigue Laboratory for many years.

SONNETS SANS BONNETS

(To suggest importance of vasomotor tone as an indispensable adjunct to adequate cardiac activity)

KENNETH A. ARENDT

Ah heart, thou art a wondrous thing;
thy praises all the poets sing.

To thee great powers have been assigned;
for some thou dost supplant the mind.

Yet, lest thou swell thyself unduly,
lest false pride make thy beat unruly,

Consider now how dire the pickle;
thy worth would not exceed a nickel

If, for all thy mitral flapping,
the vasomotor cells were napping.

Go to, mighty heart, change thy pace if thou wilt.
Imbibe till thy ventricles are well gefüllt.

Contract with thy might, from thy depths send a gusher.
May all be impressed with thy skill as a flusher.

We would fain extol thee, thy virtues well marking.
A crown on thine S-A node proudly we're parking.

But now -- for a moment -- pause thou in reflection.
These odious odes may bear closer inspection.

Blush thou red, oh vain heart; the truth now, don't pad it.
Without venous blood rushing in thou hast had it!

Whence cometh this stream; to whom now the praise given?
'Tis vascular tone; without this, there's no livin'!

We've heard, oh heart, how great thou art thine import never doubting.
Mindful indeed that we have need of thine incessant spouting.

Still, though we see that without thee life could not long continue,
There's something more in nature's store than just one mass of sinew.

Rest now thy pride silent inside; hold, thou tricuspid popper!
Were vasomotor tone impaired, thou wouldst be but a flopper.

Hark thou, oh heart, hear what I say!

Dare thou such arrogance display?

Thy chambers swell with pride unmixed
while all about thee stand transfixed.

Vast hordes of tissue cells
which listen to thee while, alas,

Thou dost affront their sensibilities
with such crass gas as,

"Without me thou couldst not sigh,
nor eat a piece of pumpkin pie.

How ever couldst thou hope to swallow?
Thy gut would be, perforce, quite hollow.

Thou couldst not hie thee to the park
nor seek seclusion after dark.

Nor couldst thou ----"
"HOLD!" -- arises now a mighty shout:

"Let's git the varmint! ----
Sieze the lout!"

Come thou, blood vessel; have no fear.
We are thy friends; thy words we'll hear.

"What can I say; how shall I start?
How best rebut yon gasseous heart?"

The truth, we say; the truth will out!
Too long we've heard "old muscles" spout.

"Suffice it then merely to say
that we assembled here today

Would on rock bottom now be bumping,
in spite of cardia's wild thumping.

We should be quite beyond assistance,
but for peripheral resistance!"

IN MEMORIAM

PETER FREDERIC SALISBURY
1913 - 1964

D. M. AVIADO

On November 5, Peter died of an acute coronary heart disease. At that time, he was in the midst of investigating the physiology of the heart in general and of reappraising the physiological principles in the treatment of ischemic heart disease in particular.

The scientific contributions of Peter Frederic Salisbury have one central theme: the conquest of heart disease and its complications. Most of his 87 publications during the last 15 years deal with characterization of the functions of the normal heart, in contrast to those of the abnormal heart, and seeking means of converting the former to the latter. The pulmonary and renal complications of heart disease were systematically studied in terms of the mechanisms for their induction, also culminating in the early application of the artificial heart, lung and kidney. Two weeks before Peter died, he was personally bothered by his lack of time to pursue the practical aspects of his current experiments regarding the determinants of function of the ventricular muscle. He was about to embark on additional experiments that would have offered some leads to the treatment and prevention of heart disease.

Peter was born in Dresden, Germany on April 12, 1913. He became a naturalized American citizen in 1943. He held B. A. and M. A. degrees in biochemistry from the University of Cambridge, England, M.D. from the University of Rome, and Ph.D. in physiology at the University of Minnesota. He served as a research associate at the Institute for Medical Research, Cedars of Lebanon Hospital from 1948 to 1958, and subsequently a principal investigator at St. Joseph Hospital at Burbank, California until the time of his death.

Peter was an active member of the American Physiological Society, serving in the Joint Editorial Board of the Journal of Applied Physiology and American Journal of Physiology from 1958 to 1964. He was a Founder and an elected President of the American Society for Artificial Internal Organs and received the American Medical Association Hektoen Award for his pioneer work with the heart-lung machine. He was a Diplomate of the National Board of Medical Examiners, member of the Los Angeles County Medical Association, Fellow of the American College of Cardiology, and a member of a dozen other scientific organizations.