held at Philadelphia, and that a summer meeting be held at San Francisco in 1915.

The following officers were elected for the coming year:

President: E. B. Wilson, Columbia University, New York.

Vice-Presidents:

Section A—Frank Schlesinger, Allegheny Observatory.

Section B—A. D. Cole, Ohio State University.

Section C—A. A. Noyes, Massachusetts Institute of Technology.

Section D—O. P. Hood, U. S. Bureau of Mines, Washington, D. C.

Section E—J. S. Diller, U. S. Geological Survey.

Section F—A. G. Mayer, Carnegie Institution of Washington.

Section G—H. C. Cowles, University of Chicago.

Section H—W. B. Pillsbury, University of Michigan.

Section L—P. P. Claxton, U. S. Commissioner of Education.

General Secretary: H. W. Springsteen, Western Reserve University.

Secretary of the Council: W. A. Worsham, Jr., University of Georgia.

Secretaries of Sections:

Section A—F. R. Moulton, University of Chicago.

Section D—A. H. Blanchard, Columbia University.

Section F—H. V. Neale, Knox College.

Section G—W. J. V. Osterhout, Harvard University.

Section H—George G. MacCurdy, Yale University.

Section L—S. A. Courtis, Detroit, Michigan.

Place of next meeting: Atlanta, Georgia.

Date of next meeting: Convocation Week, 1913–14.

At the general session, held Friday morning at Western Reserve University, the following resolutions were adopted:

Resolved: that the American Association for the Advancement of Science extend to the authorities of Western Reserve University and to those of the Case School of Applied Science, to the Board of Education and the Director of Public Schools, to the Mayor of Cleveland, to the local committee in charge of the arrangements for the third Cleveland meeting of the association, now about to close, and especially to the ladies' reception committee and to the authorities of the different industrial plants which have been opened to the inspection of members, the hearty thanks of the association for the admirable arrangements made, the excellent facilities offered, and the delightful courtesy and hospitality which have been extended by all and which have been highly instrumental in making this third Cleveland meeting one of the most successful which the association has held in recent years.

H. E. Summers,
General Secretary

Heredity and Responsibility[1]

One of the greatest and most far-reaching themes which has ever occupied the minds of men is the problem of development. Whether it be the development of a chicken from an egg, of a race or species from a preexisting one, or of the body, mind and institutions of man, this problem is everywhere much the same in fundamental principles, and knowledge gained in one of these fields must be of value in each of the others. Familiarity with development does not remove the real mystery which lies back of it, though it may make plain many of the processes concerned. The development of a human being, of a personality, from a germ cell seems to me the climax of all wonders, greater even than that involved in the evolution of a species or the making of a world.

We are all familiar with the historic attempts which have been made to solve this problem. The old doctrine of evolution, or preformation, solved it by practically denying development; the doctrine of epigenesis recognized development but did not explain it. The one found all organs and parts present in the germ, which needed merely to grow and unfold to bring them

[1] Presidential address before the American Society of Naturalists, Cleveland, O., January 2, 1913.

to maturity; the other found the germ simple and homogeneous, but required some unknown force, some *spiritus rector* or *vis essentialis,* to cause the homogeneous to become heterogeneous. The one placed all emphasis upon the germ, the other upon outside forces or conditions.

Modern students of development recognize that neither of these extreme views is true—adult parts are not present in the germ, nor is the latter homogeneous—but for more than a hundred years opinions have been vibrating in the field between these two extremes.

Students of development, whether it be that of the individual or of the race, are like those ancient mariners who sailed that dreaded strait on the one side of which frowned Scylla and on the other roared Charybdis—in shunning the Scylla of preformation they run into the Charybdis of epigenesis, in avoiding the rocks of predetermination they fall into the whirlpools of no-determination, in avoiding the perils of fatalism they encounter the dangers of chaotic freedom—while the narrow channel of truth runs somewhere between these two extremes. They tack from one side to the other, ever advancing, ever leaving old dangers behind, ever meeting new ones—and so the science of development zig-zags on.

At present there can be no doubt that we are sailing nearer the preformation coast than at any time since the modern study of development began under von Baer. In the study of heredity great emphasis is placed, and necessarily so, upon the complexity of the germ and the intrinsic factors of development. There can be no doubt that the main characteristics of every living thing are unalterably fixed by heredity. Men differ from horses or turnips because of their inheritance. Our anatomical, physiological and psychological possibilities are predetermined in the germ cells. Whatever the ultimate relations of mind and body may be, there can be no reasonable doubt that both have developed together from the germ and that the laws of inheritance apply to one as certainly as to the other. The main characteristics of our personalities are born with us and can not be changed except within relatively narrow limits. "The leopard can not change his spots nor the Ethiopian his skin," and "though thou shouldst bray a fool in a mortar with a pestle yet will not his foolishness depart from him." Race, sex, character are predetermined in the germ cells, perhaps in the chromosomes, and all the possibilities of our lives are there fixed, for who by taking thought can add one chromosome, or even one determiner, to his organization?

These modern theories of heredity are profoundly influencing human thought in many fields. We formerly heard that all men were created free and equal; we now learn that all men are created bound and unequal. We were once taught that voluntary acts, if oft repeated, become habits, and that habits determine character; we now learn that acts, habits and character were foreordained from the foundation of the family. We once thought that men were free to do right or wrong, and that they were responsible for their deeds; now we learn that our reactions are predetermined by heredity and that we can no more control them than we can control our heart beats. For ages men have believed in the influence of example, in the uplift of high ideals, in the power of an absorbing purpose; for ages men have lived and died for what they believed to be duty and truth, and have received the homage of mankind; or they have lived malevolent and criminal lives and have been despised

by men and punished by society. But if our reactions, habits, characters are predetermined in the germ plasm such men have deserved neither praise nor blame. If personality is determined by heredity alone, all teaching, preaching, government, is useless; freedom, responsibility, duty are delusions; whether men are useful or useless members of society depends upon their inheritance, and the only hope for the race is in eugenics—always supposing that enough freedom is left to men or to society to control the important function of choosing a mate.

Already a few enthusiastic persons have begun to apply these doctrines to practical affairs. We are told that children should never be admonished or punished, for they do only what their natures lead them to do; the nature of the child must be respected and must be allowed to manifest itself in its own way. Lying and stealing will cure themselves like the mumps, or they will remain incurable, in which case the germ plasm is to blame and nothing could have been done, anyway. Laziness is due to inheritance or to parasites; the latter kind may be cured, but not the former. Thriftlessness, alcoholism and uncleanness run in families and can be cured only by extermination. Men who prey upon society were born with wolfish instincts, and can not help but eat the lambs. Villains, lawbreakers, murderers should be pitied but not punished; if blame attaches to their deeds it falls upon the marriage bureau and the parents. The world needs hospitals and sanatoria and sterilization institutes for the criminals and vicious, but not courts and prisons, and all punishments should be visited only upon the parents to the third and fourth generations.

Do our studies of heredity lead us to any such radical conclusions? If they do we must accept them like brave men. "Truth is truth if it sears our eyeballs." But when theories lead to such revolutionary results it behooves us to examine carefully those theories to see if there is not somewhere a fundamental flaw in them. Have we not sailed a little too close to the preformation coast and grounded our ship on the rocks of predetermination?

One of the most difficult things in the world is to recognize a great truth, to feel its significance, and yet not be carried away by it. Great scientific errors are frequently due not so much to faulty observations as to sweeping conclusions. In biology the search for universal laws is a peculiarly dangerous pursuit. In philosophy great errors are often due not so much to false premises as to supposed logical necessities. A logical chain has led many a man into the bondage of error. Truth is not usually found in extremes, in "carrying out a process to its logical conclusions," but rather in some middle course which is less striking but more judicious.

Having observed that the main characteristics of our minds as well as of our bodies are inherited, it is easy and natural to go further and to conclude that not only all the possibilities of our lives are marked out in the germ, but that all that will actually develop from the germ is there determined and can not be altered. There are many similarities between such an extreme view and the old doctrine of preformation, and it contains a like absurdity. It practically denies development altogether. If the germ is a closed system and receives nothing from without, and if adult characteristics are predetermined in the germ, they are as irrevocably fixed as if they were predelineated.

At the opposite extreme is the view with which we are all familiar, viz., the will is absolutely free; no taint of heredity rests

on the mind or soul; character is a *tabula rasa* on which the self writes its own record as it pleases and is responsible for the result. This view, like the old epigenesis, virtually postulates a new creation for each individual. So far as the mind and soul are concerned there is no hereditary continuity with past generations and none with future ones. But while such a view may be logically complete and theologically satisfying, it is not scientific, for it contradicts the evidence.

The truth then seems to lie somewhere between these two extremes. Our personalities were not absolutely predetermined in the germ cells from which we came, and yet they have arisen from those germ cells and have been conditioned by them. When it is said that any characteristic is predetermined in the germ cell, what does this mean? What but that the development of that characteristic is made possible? Adult characteristics are potential and not actual in the germ, and their actual appearance depends upon many complicated reactions of the germinal units with one another and with the environment. In short, our actual personalities are not predetermined in the germ cells, but our possible personalities are.

In all organisms the potentialities of development are much greater than the actualities. In many animals a small part of the body is capable, when separated from the remainder, of producing a whole body, though this potency would never have become an actuality except under the stimulus of separation. In like manner a part of an egg may, when separated from the remainder, give rise to an entire animal. By modifying the conditions of development animals may be produced which have one eye, many eyes, or no eyes; animals in which the bodies are turned inside out or side for side; animals in which all sorts of dislocation of organs have taken place; and the earlier the environmental forces act the more profound are the modifications produced. But leaving out of account all forms which are so monstrous that they are incapable of reaching maturity. we find that there are left many variations in the size and vigor of the body as a whole, as well as of its parts; many variations in the more or less perfect correlation of these parts with one another, which were determined by the conditions of development rather than by heredity. In a given germ cell there is the potency of any kind of organism that could develop from that cell under any kind of conditions. The potencies of development are much greater than the actualities. Anything which could possibly appear in the course of development is potential in heredity, and under given conditions of environment is predetermined. Since the environment can not be all things at once, many hereditary possibilities must remain latent or undeveloped. Consequently the results of development are not determined by heredity alone, but also by extrinsic causes. Things can not be predetermined in heredity which are not also predetermined in environment.

Functional activity, or use, is one of the most important factors of development. Functional activity is response to stimuli, which may be external or internal in origin. The entire process of development may be regarded as an almost endless series of such responses on the part of the organism, whether germ cell, embryo, or adult, to external and internal stimuli. It is a truism that use strengthens a part and disuse weakens it; it is likewise a truism that responses which are oft repeated become more rapid and more perfect, and in this way habits are formed. Practically all education, whether of man or of lower ani-

mals, consists in habit formation, in establishing constant relations between certain external or internal stimuli and certain responses of the organism. At first these stimuli are largely of external origin; later the external stimuli may be replaced more and more by internal ones; but whatever the source of the stimulus, the response of the organism to these stimuli is one of the most important factors of development, whether of the body or of the mind.

Among organisms a given cause does not always produce the same effect; this does not necessarily involve any violation of the law of causality, since it is highly probable that in responding to a stimulus the organism itself undergoes some change, and in subsequent repetitions of the stimulus, responses may differ because the organism is itself different. This is what is meant by "summation of stimuli," "physiological states," etc. Even in some of the simplest organisms one can observe inhibitions of responses and modifications of behavior, which seem to be due to conflicting stimuli, or to changes in the physiological state. In higher organisms such inhibitions or modifications proceed particularly from internal stimuli, which in turn are probably conditioned by hereditary constitution and past experience. The factors which determine behavior are not merely the present stimulus and the hereditary constitution, but also the experiences through which the organism has passed and the habits which it has formed.

By responsibility in the higher sense I understand the ability on the part of the individual to respond to rational, social and ethical stimuli, or impulses, and to inhibit responses to stimuli of an opposite nature; and the corresponding expectation on the part of others that the individual will so respond. The higher the type of organization the larger is the range of stimuli to which it will respond and the larger the number and kind of responses which may be called forth; and at the same time the larger becomes the power of inhibition of responses, whether through the balancing of one stimulus against another or from whatever cause. Human responsibility varies with the complexity of the stimuli involved, as well as with the capacity of individuals to respond to those stimuli. A man might be quite responsible in savage society, who would be quite irresponsible in civilized communities. In an infant there is no capacity to respond to rational, social or ethical stimuli, but with increasing capacity in this respect comes increasing responsibility. Mental and ethical imbeciles, insane and mentally defective persons, have a low capacity for such responses and inhibitions, and consequently less is expected of them. There are in different men all degrees of responsibility, as there are all degrees of capacity. In one and the same individual responsibility varies at different times and under different circumstances; it rises and falls, like the tides, in every life. Varying capacity to respond to rational, social and ethical stimuli, and to inhibit responses of an opposite nature depends not merely upon inheritance, but also upon training, habits, physiological states. The common opinion that all normal men are equally responsible is not correct; in the eyes of the law this may be true, but legal obligations are so far below the capacities of normal men that all may be held equally responsible before the law, though in reality their responsibilities are as varied as their inheritance or their training.

Conversely the responsibility of society to the individual is universally recognized. Irresponsible persons must be cared for by older or wiser persons who become responsible for them; and in general the responsi-

bility rests upon society to provide as favorable environment as possible for all its members. Experienced persons can to a certain extent choose their own environment and thus indirectly control their responses and habits, but young children are almost, if not quite, as incapable of choosing their environment as of choosing their heredity, and it becomes the duty of society to see to it that the environmental stimuli are such as to develop rational, social and ethical habits rather than the reverse.

Of all animals I suppose that man enjoys the most extensive and most varied environment, and its effect upon his personality is correspondingly great. Of all animals man has the longest period of immaturity and it is during this period that the play of environmental stimuli on the organism is effective in modifying development. In addition to the material environment he lives in the midst of intellectual, social and moral stimuli which are potent factors in his development. By means of his power to look before and after he lives in the future and past as well as in the present; through tradition and history he becomes an heir of all the ages. The modifying influences of all these environmental conditions on personality is very great. Each of us may say with Ulysses: "I am a part of all that I have met." So great is the power of environment on the development of personality that it may outweigh inheritance; a relatively poor inheritance with excellent environmental conditions often produces better results than a good inheritance with poor conditions. Of course no sort of environment can do more than to bring out the hereditary possibilities, but, on the other hand, those possibilities must remain latent and undeveloped unless they are stimulated into activity by the environment.

Not only the possibilities of development, but also the actual, developed capacities of men, are much greater than the habitual demands which are made upon them. How often have we surprised ourselves by doing some unusual or prodigious task! What we have once done we feel that we can do again. We realize more or less clearly, depending upon our experience, that what we habitually do is far less than we could do. It is this reserve, upon which we can draw on special occasions, that gives us the sense of freedom. I well remember a conversation which I once had with the late Dr. William Pepper. He had asked me to undertake a task which I felt incapable of performing, and I had pleaded inability, lack of time, anything to escape the responsibility. But with a confidence born of experience he said to me, "You know we *can* do what we *have* to do." In his inspiring address on "The Energies of Men," William James showed that we have reservoirs of power which we rarely tap, great energies upon which we seldom draw, and that we habitually live upon a level which is far below that which we might occupy. Darwin held the opinion, as the result of a lifetime of observation, that men differ less in capacity than in zeal and determination to utilize the powers which they have. In playful comment on the variety and extent of his own life work he said, in modest and homely phrase, "It is dogged as does it." It may be objected that the zeal and determination were inherited, but here also the hereditary possibilities become actualities only as a result of use, training, habit.

It is generally admitted that no constant distinction can be recognized between the brain of a philosopher and that of many a peasant. Neither size nor weight of brain, nor complexity of convolutions, bears any constant relation to ignorance or intelli-

gence, though doubtless an "unlimited microscopist" could find differences between the trained and the untrained brain. The brains of Beethoven, Gauss and Cuvier, although unusually large, have been matched in size and visible complexity by the brains of unknown and unlearned persons—persons who were richly endowed by nature, but who had never learned to use their talents. In all men the capacity for intellectual development is probably much greater than the actuality. The parable of the talents expresses a profound biological truth: men differ in hereditary endowments, one receives ten talents and another receives but one; but the used talent increases many fold, the unused remains unchanged and undeveloped. Happy is he who is compelled to use his talents; thrice happy he who has learned how to compel himself! We shall not live to see the day when human inheritance is greatly improved, though that time will doubtless come, but in the meantime we may console ourselves by the thought that we have many half-used talents, many latent capacities, and although we may not be able to add to our inheritance new territory, we may greatly improve that which we have.

I have once or twice in this address referred to eugenics in a way which was intended to be facetious, but I would not wish to be understood as attempting to disparage that infant industry. Undoubtedly it represents an important application of biological discoveries to human welfare; but it seems to me that it can not wisely go farther at this time than to attempt to eliminate from reproduction the most unfit members of society. Giving advice regarding matrimony is proverbially a hazardous performance, and it is not much safer for the biologist than for others. With a more complete knowledge with regard to the inheritance of human defects than we now possess, at least in many instances, it will probably be possible to give such advice wisely; but apart from certain bodily peculiarities, he would be a bold prophet who would undertake to predict the type of personality which might be expected in the children of a given union. Some very unpromising stocks have brought forth wonderful products. Could any one have predicted Abraham Lincoln from a study of his ancestry? Observe I say *predict,* and not explain after his appearance. Can any one now predict from what kind of ancestral combinations the great scholars, statesmen, men of affairs of the next generation will come? Could the capacities and careers of the members of this society—those who were born outside of Boston or Philadelphia—have been predicted? The time may come when it will be possible to predict what the chances are that the children of given parents will inherit more or less than average intellectual capacity, but since germinal potentiality is transformed into intellectual ability only as the result of development, such a prediction could not be extended to the latter unless the environment as well as the heredity were known. Society can safely eliminate its worst elements from reproduction, but it can not wisely go farther than that at present.

My distinguished predecessor in this office, in his striking address before this society one year ago, pointed out as one of the great tragedies of life the almost infinite slaughter of potential personalities in the form of germ cells which never develop. A more dreadful, though less universal, tragedy is the loss of real personalities who have all the native endowments of genius and leadership, but who for lack of proper environmental stimuli have remained undeveloped and unknown; the "mute, inglorious Miltons" of the world; the Cæsars,

Napoleons, Washingtons who might have been; the Newtons, Darwins, Pasteurs who were ready formed by nature, but who never discovered themselves. One shudders to think how narrowly Newton escaped being an unknown farmer, or Faraday an obscure bookbinder, or Pasteur a provincial tanner. In the history of the world there must have been many men of equal native endowments who missed the slender chance which came to these. We form the habit of thinking of great men as having appeared only at long intervals, and yet we know that great crises always discover great men. What does this mean but that the men are ready formed and that it requires only this extra stimulus to call them forth? To most of us heredity has been kind—kinder than we know. The possibilities within us are great but they rarely come to full epiphany.

What is needed in education more than anything else is some means or system which will train the powers of self discovery and self control. Easy lives and so-called "good environment" will not arouse the dormant powers. It usually takes the stress and strain of hard necessity to make us acquainted with our hidden selves, to rouse the sleeping giant within us. How often is it said that the worthless sons of worthy parents are mysteries; with the best of heredity and environment they amount to nothing; whereas the sons of poor and ignorant farmers, blacksmiths, tanners and backwoodsmen, with few opportunities and with many hardships and disadvantages become world figures. Probably the inheritance in these last-named cases was no better than in the former, but the environment was better. "Good environment" usually means easy, pleasant, refined surroundings, "all the opportunities that money can buy," but little responsibility and none of that self discipline which reveals the hidden powers, and which alone should be counted good environment. Many schools and colleges are making the same mistake as the fond parents; luxury, soft living, irresponsibility are not only allowed, but are encouraged and endowed —and by such means it is hoped to bring out that in men which can only be born in travail. College athletics has this much at least in its favor, that it trains men who take part in the contests to do their best, to subordinate pleasure, appetite, the desire for a good time, to one controlling purpose, it trains them to attempt what may often seem to them impossible, to crash into the line though it may seem a stone wall, to get out of their bodies every ounce of strength and endurance which they possess. Such training makes men acquainted with their powers and teaches courage, confidence and responsibility. If only we could make young persons acquainted in some similar way with their hidden mental and moral powers, what a race of men and women might we not have without waiting for that uncertain day when the inheritance of the race will be improved! Whatever the stimulus required, whether pride or shame, fear or favor, ambition or loyalty, responsibility or necessity, education should utilize each and all of these to teach men self knowledge and self control.

But it will be said that self control depends upon inheritance, that strong wills and weak wills are such because of heredity. It is true that one man may be born with a potentiality for self control which another man lacks, but in all men this potentiality becomes actuality only through development, one of the principal factors of which is use, or functional activity. An amazing number of persons have but little self control. Is this always due to defective inheritance, or is it not frequently the result of bad habits, of arrested develop-

ment? To charge defects at once to heredity removes them from any possible control, helps to make men irresponsible, excuses them for making the least of their endowments. To hold that everything has been predetermined, that nothing is self determined, that all our traits and acts are fixed beyond the possibility of change is an enervating philosophy and is not good science, for it does not accord with the evidence. It is amazing that men whose daily lives contradict this paralyzing philosophy still hold it, as it were, in some water-tight compartment of the brain, while in all the other parts of their being their acts proclaim that they believe in their powers of self control: they set themselves hard tasks, they overcome great difficulties, they work until it hurts, until they can say with Johannes Müller, "Es klebt blut an der Arbeit," and yet in the philosophical compartment of their minds they can say that it was all predetermined in heredity and from the foundations of the world. Whether all the phenomena of life and of mind can be explained on the basis of a purely mechanistic hypothesis or not, that hypothesis must square with the facts and not the facts with the hypothesis. It has always been true of those who "sat apart and reasoned high of fate, free will, foreknowledge absolute" that they have "found no end in wandering mazes lost." Whatever the way out of these mazes may be—whether it be found in the varied responses of an organism to the same stimulus, in the immense complexity of the mechanism involved, or in some form of idealism which finds necessity not in nature but in the spectator, and freedom not in the spectator but in the agent—it is true that for those who do not "sit apart and reason high," but who deal merely with evident phenomena, the way out of these mazes is not to be found in denying the actuality of inhibition, attention, and control. Because we can find no place in our philosophy and logic for self determination shall we cease to be scientists and close our eyes to the evidences? The first duty of science is to appeal to fact, and to settle later with logic and philosophy. Is it not a fact that the possibilities of our inheritance depend for their realization upon development, one of the most important factors of which is use, functional activity, in response to stimuli? Is it not a fact that our capacities are very much greater than our habitual demands upon them? Is it not a fact that belief in our responsibility energizes our lives and gives vigor to our mental and moral fiber? Is it not a fact that shifting all responsibility from men to their heredity or to that part of their environment which is beyond their control helps to make them irresponsible?

This debilitating philosophy in which everything is predetermined, in which there is no possibility of change or control, in which there is hypertrophy of intellect and atrophy of will, is a symptom of senility, whether in men or nations. We need to return to the joys of a childhood age in which men believed themselves free to do, to think, to strive, in which life was full of high endeavor and the world was crowded with great emprise. We need to think of the possibilities of development as well as of the limitations of heredity. Chance, heredity, environment have settled many things for us; we are hedged about by bounds which we can not pass; but those bounds are not so narrow as we are sometimes taught, and within them we have a considerable degree of freedom and responsibility.

> That which we are we are,
> One equal temper of heroic hearts
> Made weak by time and fate, but strong in will
> To strive, to seek, to find, and not to yield.

EDWIN G. CONKLIN
PRINCETON, N. J.