

THE PSYCHOLOGICAL BULLETIN

THE PHYSICAL BASIS OF CONDUCT.

BY E. G. SPAULDING,

Princeton University.

My purpose in this paper is to consider the question as to what is the character of those physiological processes and structures, which, found within the living organism, form either directly or indirectly the basis of conduct, or, stated more generally, it is to determine the relation which these organic things and events bear to inorganic. Now I am quite aware that there are positions which at least seem to differ very much from the one herein developed, and that which I find to be their common characteristic is the insistence on the point that there is a very considerable group of organic phenomena, found, for example, in the processes of secretion and absorption, of development and regeneration, that can neither be 'reduced to' nor 'built up from,' at least step by step, the physical and chemical phenomena of which we have such an exact knowledge elsewhere. Yet it is clear, that, before such a position or any conclusions based upon it can be admitted, it is necessary not only to determine just what is meant by 'reduction' and by 'building up,' but also to consider if it is not possible, upon the experimental basis on which we now stand, and by means of certain methodological principles, to say just how different the organic is from the inorganic realm, and whether it is determined teleologically, etc. It is this program, then, that I purpose to carry out in this paper.

Accordingly, although at the risk of offering the trite, but yet because it is necessitated by the character of my argument, I begin with the consideration of some points concerning those laws which are uniformly accepted as valid for inorganic phenomena.

These laws, I find, can be divided into two classes, namely, those, on the one hand, which are *general* or *fundamental* in that their

'essential characteristics' are just those which are common to, on the other hand, a group of *more specific* laws, which can accordingly be called *empirical*. Concerning both kinds of laws four questions can be asked: (1) What are they? (2) What is their relation to each other and to concrete phenomena? (3) Are all, or only some of them valid for the organic realm? and (4) Are there, *besides* these, also special organic laws?

To answer question (1). First, there are *four general and fundamental laws* which, as stated in one form or another, are accepted for all physical or at least all inorganic events. That they are also valid for all organic events and qualities I purpose showing. I shall present here only those details which are required for the construction of my argument.

There is the First Law, that of the *conservative* of energy, which may be stated: In an isolated system in which events are occurring the energy-quantum remains constant.

A *system* consists of a number of energy-quanta of different forms coexisting within certain spatial limits; this may be regarded as a *mechanism*, which is not the same as saying that it is explainable by, or reducible to, *mechanical* principles.

The *process* taking place in a system will consist in the change of a definite quantum of one energy-form into that of one or more others. This constitutes *transformation*, the conditions for which are stated only by the generalized second law, but which itself here leads to the second statement of conservation, namely, that

In all energy-transformations the quantum of one form disappearing is equal quantitatively to the total quantum of the other forms which appear.

This gives the *first constituent of determinism*, the demonstration of which is the first point in my argument; it demands that there can not more happen than there is sufficient cause for; there is a *singularity* of effect.

The criterion of that which shall be regarded as a new energy-form is that it is such a quantity as will produce the same effect quantitatively as that which is already accepted as energy, namely, heat and motion. Accordingly, let the claim for a vital energy be advanced; then this must stand the test of this equivalence-transformation criterion, so that, with positive results, such a new energy would be subject to the same general principles of 'mechanism' as are the other energy-forms.

The Second Law states the *condition for transformation*. According to it, in its generalized form, each energy-form is the product of

two factors, an extensity or capacity and an *intensity* or *potential*, these of course, being different in different species. Secondly, and most important, it is in virtue of intensities that events take place; here there is *another deterministic element, the second*: Two intensities may be opposed and meet, as it were, at a common point; they must, too, be either equal or unequal. With the latter the case, *i. e.* with a difference of intensities existing, and with no third intensity present to supplement the lesser one, *i. e.* to *compensate* the difference, an energy-transfer, *an event*, must take place in the *direction* of higher-to-lower-potential until equilibrium is reached. Thus the principle of efficient causation receives exact formulation, constituting the 'law of events.'

The Third Law, entropy. Since most, if not all events, are exothermic, since, too, because temperature (heat intensity) can not be compensated, heat spreads out or is dispersed, and since, as it does this, the condition of a uniformly equal temperature is approached to, there results a *third constituent of determinism*; natural events have an *irreversibility*, a *definiteness of direction*; the entropy of the universe increases.

It is important, also, that this law, in some of its features, is derived from the Second.

That which may be regarded as the Fourth Law, determinism, is, as has been indicated, derivable from the three preceding: Conservation gives singularity, uniqueness of determination; by a cause one and only one effect, namely, that which is equal to it quantitatively, can be brought about. Likewise the Second Law; according to it there is only one effect, namely, that which, as the total rise of one or more intensities, is quantitatively equal to the fall in that intensity which is cause. And it has been seen that the Second and the Third Laws mean a definiteness of direction, an irreversibility in events. These and singularity together constitute *invariability* or *determinism* in the events taking place in any system or mechanism.

The First and Second Laws, and, accordingly, the Third and Fourth by virtue of their derivation from them, can all be expressed in their generic form by an epitomizing formula¹

¹ The derivation of this formula I have shown in my paper, *The Energy of Segmentation, Jour. of Exper. Zoölogy*, June, 1907. In it, W signifies the external work produced by any reversible change taking place in any system at a constant intensity, I ; $U_2 - U_1$ is the accompanying change in the internal energy of the system; dW is the increase in the quantity of work produced when the same change in the system takes place at the intensity $I + dI$; dW/dI is the potential coefficient, I the intensity; the resultant change in the energy of the system is the product of the two.

$$W + (U_2 - U_1) = I \frac{dW}{dT},$$

which can be demonstrated to stand in the relation of genus to a certain class of empirical laws, namely, specific energy-laws, as species. This fact is of great importance for our subsequent considerations.

According to the above principles then, *every event in the physical world is really identical with an energy-transfer under the conditions stated*; and each energy-form is the product of an intensity and an extensity, *i. e.*,

$$E = ic.$$

However, since usually only the changes in, and not the absolute quantity of, the energy of a system can be measured, the differential form of this equation,

$$dE = d(ic) = idc + cdi$$

is more generally applicable.

Then $dE = idc$ when i is constant, and cdi with c constant.

Attention is drawn to this point to make clear what the ultimate purpose of empirical investigation *may be*. In general this can be said to be that of determining dE in any way possible, but as the change, always, of some specific energy-form.

In some cases, now, this end can be attained *directly*; the energy-change can itself be measured. With this done, and with it at the same time also possible to measure the absolute value of one of the factors, it is evident that, should this also be desired, the value of the change in the other factor can be computed; or, conversely, with the *change* in one known, the absolute value of the other factor can be found. In other cases, however, the energy-change can be determined only *indirectly* by measuring both the absolute value of one factor and the change in the other.

Indeed the fact of these possibilities makes it evident that the purpose of empirical investigation may be twofold, namely, to get directly or indirectly, as the case may be, *laws*, which will express either (1) the *transformation* of an energy-quantum of one kind into that of another, or (2) the *functional relation* (*a*) between the two factors of the same energy form, or (*b*) between the intensity factors of different forms, or, finally, (*c*) of constituents of such factors.¹

¹ Examples: (1) $U_2 - U_1 = Q - W$; (2) (*a*) $p_1 v_1 = p_2 v_2$; (*b*) $dp/p = dT/T$; (*c*) where, for surface energy, $dE_s = \gamma ds$, and $\gamma = \frac{1}{2}grhD$, these last are constituents.

Whatever now the term may be that would best characterize and distinguish these last three from the distinctly energy-laws, I for that purpose shall call them functional, descriptive or empirical; and furthermore I wish to insist on that which is perhaps quite clear, but yet important, namely, that they can usually be made constituents of energy-laws, and accordingly must in this sense be in thorough accordance with these.

These facts have been presented in order to make evident what is the character of the relation which the Four Laws bear to empirical laws and to concrete phenomena. However, with regard to this, two positions, *each conditioning a typical and a distinctive view as to the nature of organic phenomena*, can be found and must here be stated.

One which I designate *a* is, that, while admitting the Four Laws to be at least predominantly quantitative, they nevertheless express the common characteristics of the series of specific energy-laws and thus ultimately also of concrete phenomena — for these are energy-changes — so that there results a natural classification, with the Four Laws, or the equation epitomizing them, as highest genus, with concrete events as *infima species*, and with specific energy-laws as intermediate concepts. Accordingly, the characteristics formulated by the Four Laws extend, in all their aspects, both logical and alogical, down and through the empirical laws and become *incorporate* in the concrete phenomena so that these are simultaneously and cospatially both quantitative and qualitative. It is this view which is indicated, I believe, by practically all the considerations which bear on the question, to be correct one, and this it is accordingly that I purpose to support.

The second position, *β*, diametrically opposed to this first, is that the Four Laws *are not thus incorporate*; they are interpreted as not touching, or, better, as not affecting the qualitative side, but rather as expressing *only* the quantitative aspect; this, therefore, is regarded as existing simply *side by side* with the qualitative, but not as ‘penetrating it.’

However, the reason why this position is held becomes evident by considering the use which is made of it, and is shown clearly to be an ulterior one. In those who maintain it the *conviction* is strong that organic phenomena are very fundamentally different from inorganic, that accordingly they have their own distinctive qualitative laws and may be characterized by the presence of a teleological element. The opportunity is then sought, while holding this position, and interpreting the teleology as contradictory to determinism *formally*, to avoid at the same time any contradiction with it *realiter*; and it is by making

this second interpretation that this opportunity is believed to be found. For, with it a fact that some, perhaps even many, of the phenomena in the organism are different from those in the inorganic realm, it is argued, that, if this qualitative side be not affected by the Four Laws with their determinism, there will be found room in it for the operation, not only of distinctive, qualitative organic laws, but also, without *concrete* contradiction with determinism, of a teleology.

Yet, that this attempt is really successful, is, I think, open to much doubt; but it has the value of indicating rather clearly the point around which our problem turns, namely, *the relation which one law may have to another*. It is to the consideration of this, then, that I now proceed. Of such relations I find that there seem to be three possible cases:

(a) There is first suggested, as an exaggerated analogy of the above second position ' β ,' the case of two laws applying to concrete phenomena which are widely separated in time and space; then these laws might of course be different, very different; in fact it might appear and even be claimed that they could be so different as to have reached that degree of difference which, as stated *formally*, is *contradiction*, and yet that this, in virtue of the remoteness of the things to which they apply, would not carry with it a contradiction *realiter*. However, such a remoteness could, I think, not long be maintained; sooner or later, either through their implications or because ground for their application *within the same complex* might apparently be found, the two laws would be brought into 'contact' at or 'penetration' of that which can theoretically be regarded as the same point. That point, then, would, by assumption, be determined simultaneously in two *divergent* or *opposed* directions, *i. e.*, a *contradiction realiter* would be generated. The supposition then that the two laws could be so different as to be contradictory is shown to be impossible; then we must infer either that they must be contraries and as such have certain characteristics in common so that they will be subordinate to the same general principles, or that they must have the relation to each other of genus and species. In the first case their determinations would be regarded as running *parallel* and in the same direction, and not as opposed or divergent; in the second, they would coincide, *i. e.*, those of the genus would be incorporate in those of the species. The former leads us to

(b) Two laws, coördinate with each other, may be valid within the same system, and apply to different processes. Their determinations of these processes will then run *parallel* and in the same direc-

tion, while that of the system as a whole will be in accordance with those more general principles to which the specific laws are subordinate. The two laws, then, will be valid side by side, parallel to each other; they will be different, but, again, not contradictory.

(c) But, given what are supposed to be two laws or principles, and grant that they actually or seemingly apply to *one and the same process*. What can their relations be? *Three* cases can be distinguished: (1) The two might prove to be contradictory; *i. e.*, the attempt to apply them to the same process might disclose that they respectively assert and deny the same property or character in that process; for it is just this condition of 'penetrating' the same point or process that generates a contradiction *realiter*. Then both can not be true; and the attempted application of one will have failed; or (2) the two might be laws or expressions for incorporate aspects of one and the same process; as such they might prove to be constituents of one and the same law holding for the process as a whole. Then they are perfectly compatible, in no case contradictory; or (3) between the two laws there might be the relation of genus and species, of subordination one to the other; then the determinations of the one would not run parallel to those of the other, but, rather, the genus would be incorporate in the species and both in turn incorporate in the concrete process. Although different, as stated formally, the two are, of course, quite compatible.

The purpose of this analysis has been to prepare the way for the consideration of the question: If a teleological principle were accepted as operating in organisms, under which one of the above cases is the relation which it bears to mechanistic determinism to be placed? However, it is very evident that the answer to this would depend on the interpretation or definition given to these principles, just as conversely, these would depend on the place in the scheme in which they are put. But we may try the placing of them in each of the different cases and draw our conclusions.

Thus, first, suppose determinism and teleology to be two distinct and approximately coördinate principles, corresponding to simply two different laws as in case (a) or, since (a) leads to (b) suppose, preferably, as in (b), that the two apply to different processes in the same system. Then this supposition demands that view of the relation of the Four Laws to concrete phenomena which was called ' β ', *i. e.*, that the mechanistic determinism which these laws imply hold only for a quantitative side or process, the teleology for a qualitative. But our

scheme then demands that the two should not be contradictory; that they should have some generic features, that their determinations should be parallel and in the same direction. Accordingly, the teleology could not be interpreted in its usual way, namely, as meaning that variation of means to an end which is contradictory to determinism, so that if the term be still retained, its meaning must be modified.

However, this supposition that mechanism and teleology are two distinct and possibly coördinate principles must be given up, if, instead of accepting position ' β ,' the 'first' interpretation, ' α ,' that the determinism is incorporate in the qualities, be postulated. For then the *determinism must apply to the very same process as does the teleology*, and accordingly we get the following possibilities as given by case (c) :

Either, (c) (1), the determinism and the teleology are contradictory *realiter*; i. e., that formal contradiction which appears from interpreting the teleology as asserting a variation of means to an end, and the determinism as denying this, becomes one *realiter* when it is necessary to apply both to the same process. Then both can not be true, and the establishment of one is invalidation of the other; accordingly, either this must be given up, or, if the term be still used, this can be done only with a modified meaning. Thus, (c) (2), if the determinism shall have been proved for *all* processes within the system and so for the system as a whole in all its aspects, qualitative as well as quantitative, and if it still be insisted that there is a teleological determination for the system, then this can be interpreted as meaning only some such thing as *accumulation* or *progression*, etc., but not as variation of means, and the two principles would express incorporate characteristics of one and the same process or system and might be either constituents of the same law or one be a species to the other as genus. However, this last relation would come under (c) (3) according to which determinism and teleology must be not only quite compatible, but one, say, the latter, must prove to be a special case of the other; thus teleology might, as species, be quite deterministic and yet be genus to a certain group of distinctly empirical yet completely causal organic laws.

Can, now, a thorough-goingly deterministic position, one which will, without exception, apply to *all* phenomena within the organism, be established? I believe that it can, and, accordingly, to do this is now my purpose; for, with this accomplished, our scheme will enable us to decide as to both the existence and character either of a teleology or possibly of other specific organic laws.

The two opposed positions concerning the relation which the Four Laws may bear to the qualities have already been presented. I shall begin my argument for determinism at this point, then, with some considerations as to the *qualities* themselves. That term I use here in perhaps rather a broad sense, equating it with *character* or *property*; but the meaning which I attach to it may be indicated by the statement that it is by the qualities or properties that the bodies and substances which we perceive and know are made up or constituted. For there concern us here, first, the three categories of existence, things, events, and relations, and then, fourthly, that by virtue of or in respect to which any of these may differ or be similar among themselves, namely, qualities.

But 'things' seem to have a precarious existence; they change, either slower or faster. But changes are energy-transfers; so I will let *thing* = *system*, as I have previously defined it.

Now a system, or 'whole,' implies 'parts,' but as to what is regarded as '*whole*' and as '*part*' differs not only with different sciences, but also, within any one science, both with the period in its development and with the immediate purpose in view.

However, whatever be the system which, for the time being, is regarded as the '*whole*,' and however its qualities and properties be perceived, there is one principle which I find to be operating in all cases of 'whole and parts,' the principle, namely, which I call "creative synthesis." Its presence and 'working' can, I think, be demonstrated as follows:

Whatever may be the qualities which a system has as a 'whole,' *i. e.*, whether they be processes, or qualities in the narrow sense of the term, there is always a division which can be made among them. For, on the one hand, there are some of them which are the same as those characters which the 'parts' or 'elements,' whatever for the time being may be selected as such would have or retain if isolated; these accordingly give an *additive* result in the 'whole.' On the other hand there are other properties which are not to be so derived (additively), and it is here that the important principle of '*creative synthesis*' appears. All such *non-additive* characters can and must result only from the coöperation of 'parts' or 'elements' which, when isolated, have characters different from those that are evident when a 'whole' is formed by their coëxistence. The 'parts' *determine, cause*, the appearance of the qualities, and the qualities are new; in some sense they now exist where before they did not. This principle is operating when electrons coöperate to form an atom, atoms molecules, and mole-

cules a particle, etc.; indeed it can be shown to be quite as valid if it be insisted that there are 'secondary' qualities as opposed to so-called 'primary'; to do this it is necessary only to bring the perceiving subject into the 'system.'

Now, it is the recognition of this principle that makes it possible to give a definite statement as to what constitutes 'reduction,' and thus both to answer one of the questions raised at the beginning, and to make the next step in the demonstration of determinism:

Given that which is for the purpose in hand selected as the 'whole,' and letting its 'parts' also be known, say either as atoms, or as ions, or as molecules, or as constituent energies, then the qualities and properties of each of these may be enumerated and laws, of some kind, — what, we shall see, — may be given. For there are three cases:

1. In some instances it will be found that the qualities of the 'whole,' let this be either a body or a substance, result *additively* from those of the 'parts';¹ the former may then be said to be 'reduced' to the latter. This additive method constitutes 'reduction' of the *first kind*. Concerning it two statements must be made; first, if *all* qualities were additive results, then all the physical sciences could adopt a simple computative, perhaps purely deductive method, and secondly, with determinism valid for the 'parts' it would also be for the 'wholes,' and conversely.

However, in a great many cases additive derivation is not possible; and the evidence shows that this is *due, not to our ignorance*, but to the peculiar way in which the 'parts' work together. It is here then that 'creative synthesis' is operative.

Again, such cases fall into two classes. Common to both of them are the facts, first, that, some body or substance having been selected as the 'whole' or complex to be investigated, descriptive laws, coefficients, etc., of the properties of this as a 'whole' can be found and second, that it will be known that such a 'whole' is made up of certain 'parts,' *e. g.*, ions, atoms, specific energy-forms, etc., the laws of

¹ Examples of such additive results could be given almost *ad infinitum*; I content myself with giving some typical ones from the strictly scientific field; thus, 'specific refractive power,' 'specific absorptive power,' 'specific rotary power' of a salt-solution are the additive result of those of the ions; likewise 'specific volumes,' 'molecular heats,' and the pressures of gases or of substances in solution are additive. In all such cases an empirical law, descriptive of some property of the 'whole', can be found, independent of any similar law for the part; yet when this latter is also obtained, the two are found to be related additively.

whose properties and behavior are also known, but yet that such properties are not the same as those of the 'whole.'

2. But at this point the division begins; for, with so much known, it is possible in *some* cases to discover, although only empirically, an exact functional relation, constant within certain limits, between certain laws of properties of the 'whole,' and those of the 'parts.' Such a 'connecting law' is really a law of the synthesis; its importance here is that it gives a second meaning to the term 'reduction.'¹

(3) In other cases *no such functional relation* is discernible; at present we must content ourselves with laws of the 'whole,' and of the 'part,' but without connecting them empirically. 'Reduction,' even of the second type, is not possible.² Shall there be inferred, then, from this lack of 'reduction,' either a permanent irreducibility, or an indeterminism of the qualities of the whole? The question is especially pertinent, since most of our present knowledge of the organism, as found in physiology, histology, and embryology, etc., is of this third type.

For, on the one hand, it must be granted that there are present in the organism as a 'whole' certain qualities and processes which are found nowhere else; it must be admitted, then, that these distinguish the organic realm from the inorganic and may be regarded, in some of their phases at least, as specifically organic characters. But, on the other hand, that just this should be the case, our principle of 'creative synthesis' makes quite intelligible, quite probable. For the organism is a complex, a 'whole,' made up of 'parts'—let them be the atoms or certain ions or the colloidal particles,—which, taken singly, *are found* elsewhere, but which *taken together* are found only in this

¹ Examples of this are: (1) Kinetic theory of gases, according to which the temperature of the whole is functionally connected with the motion of the parts; here *the fact is* that temperature and motion are not the same thing. (2) The *color* of bodies can *likewise* be closely connected with the absorption of light and this in turn with certain atomic phenomena. (3) Increased pressure of 'dilute solutions' as a function of *number* of ions. (4) Optical activity (rotation of planes of polarized light) as a function of spatial position of atoms in the molecule. Finally, I think, all so-called 'reduction' of other qualities and properties to those of the attraction and repulsion and resultant motion of mass particles is of this kind.

² Examples of this class could also be given in almost indefinite number, but a few chosen at random suffice:—crystal-melting-points, coefficients of elasticity, of surface tension, of expansion of metals, condensation point, etc. These can be found both for compounds and for constituents. Now, we are not able to make use of the 'conceptual model' constructed by the aid of elementary corpuscles with ideal motions. Much of the behavior of the lower organisms, as described by Jennings, for example, falls in this class.

special complex. And since the qualities of such a 'whole' result, some few of them additively, others by 'creative synthesis' from those of the 'parts,' then, so far as the last is the case, the qualities of this complex must be those which will be found in no other complex (inorganic). And so far as these qualities or some of them can not *now* be 'reduced,' in either sense of the term, all that can be done, though even this forms the first step in 'reduction,' is to study the qualities of the 'whole' directly and by themselves, and, if possible, get empirical, descriptive laws for them. In this respect, the position—sometimes taken—that the organism itself is the only useful unit for biological study is justified.

But this admission does not warrant or allow an evasion of the question as to whether physical laws, all or only some of them, are valid for the organism. To this the first answer that can be made is quite evident from the principle of 'creative synthesis': Those physical laws which are descriptive laws of inorganic 'wholes' or complexes are limited to these unless such 'wholes' are themselves found in organisms and give additive results; however, in general, such laws are no more valid for 'organic wholes' than, conversely, the peculiar laws of the latter are for the former. And, secondly, so far as certain parts, certain chemical elements, etc., are not among the constituents of the organism, it is evident that their specific laws have no application to it.

But, on the other hand, it is a matter of well authenticated knowledge that the organism, or its unit, the cell, is made up of the atoms of certain elements, these atoms constituting an energy-form of a very specific character; and the presence of other specific energy-forms is also established. Furthermore, these constituents, when isolated, are known to follow definite specific laws, either themselves 'energy-laws,' or constituents of these. But these have been demonstrated to be subsumable under the Four Laws, so that, conversely, the determinism which they imply is incorporate both in the specific laws and, finally, in the concrete phenomena to which they apply; for concrete phenomena, at the same time that they are qualities, are also quantities. The qualities are, therefore, completely *determined*.

Accordingly, it must be granted, in agreement with general methodological principles as to the 'extension' of a law and as a matter of consistent procedure, that, when the atoms of certain elements and a number of specific energy-forms coexist in a certain complex, all the laws for these, generic (like the four) as well as specific, are still obeyed. Indeed, there would be no question as to this were all the qualities of such a complex or 'whole' derivable additively; then, the

laws of the 'whole' would be derivable in like manner from those of the 'parts.' But no more should there be a question as to this validity when it is found that this additive derivation is limited, and that 'creative synthesis' must be brought in that an account may be given of *the appearance of new and distinctive qualities*. For, whether these can be 'reduced,' in the second sense of the term, to the properties of the parts, or not, in neither case can any reason at all be given why the fact of this 'synthesis' should invalidate the continuance of the 'concrete operation' of either the special or the general laws. In fact, for inorganic complexes it is accepted that there is no such invalidation. Then, I hold, — and this is perhaps one of the most essential points in my argument — *consistency* demands that the same position should be taken for organic complexes; *here* there are quite the same reasons — no more, but certainly no fewer — for it as *there*; the only difference is one of constituents and the arrangement, etc., of these within the complex. Consistency demands, then, that, in the view which we take of the results of the investigation of organic phenomena, we should adopt simply the same principles of procedure and of interpretation as are accepted for inorganic. For then, and then only, can the character of the relation between the two realms be equitably stated.

This brings the result, in both cases, that, just as the relation of the Four Laws to the specific laws and to concrete phenomena implies a determinism for them when taken singly, or together additively, so will that same determinism be quite as valid for them and the distinctive and new qualities which they produce when working 'synthetically.' For these qualities, as qualities of the 'whole,' there may be discoverable — as I have pointed out — laws, descriptive and even specifically organic.

But these laws, by virtue of the origin of that of which they are laws, will be subsumable under the same principles of mechanistic determinism as are the qualities which, though *new*, are yet, like those of the 'parts', quantitative as well as qualitative.

The meaning of all this is, of course, a complete and thorough-going determinism for all processes and qualities found within the organism, *i. e.*, for those both of the 'parts' and of the 'whole', and for the 'synthetic creation' of certain of the latter from the former, whether the functional relation between the two be known or not, and it was this position that I set out to establish.

Considering this attempt to have been successful, further results may now be stated as they are demanded by the scheme of the 'possible relations between two laws or principles.'

That analysis shows (c) (1) that, with determinism established for the organism both in 'whole and part', there is absolutely no opportunity for teleology, if this mean 'the variation of means to one end'; for, with the determinism holding good for all qualities and processes, the attempt to apply teleology in the above sense to any one of these makes of the formal contradiction one *realiter*. Consequently, if it still be insisted that the term 'teleology' be retained, its meaning must be modified, (c) (2). And there are, indeed, certain good reasons for so modifying and retaining it; for, on the one hand, the principle of 'creative synthesis' makes it intelligible that the organism, since it is a 'peculiar' complex, should have certain properties and processes not found in the inorganic realm, and yet that all of these should be completely determined. However, among these there might well be some, which, as indeed there are good grounds for maintaining, could best be described *empirically as directly preservative of both the form and life of the organism*. On the other hand, the same principle makes it easy to understand, that in both the ontogenetic and phylogenetic development there should be a *progression* in the appearance of new characters, and, in this sense, as is the case with every *progression*, an *accumulation*. The progression, at the same time that it would be quite determined, would also imply at each stage both some end previously 'made for' and the making for a more distant end in the same series.

At length, then, it is possible to answer one of the principal questions stated at the beginning of this paper, namely, as to the nature of organic events and qualities and their relation to inorganic. For the determinism which I believe to have found means that the Four Laws extend down and through — as the genus does for the species and their constituent characters — the empirical laws, both energy- and functional and descriptive, of the organic as well as of the inorganic realm, and that they finally become *incorporate* in the concrete phenomena. But the development of the position has shown that this leaves ample opportunity for the admission of the claim made by the adherents of *another*, a contrasting, viewpoint, that *some* organic phenomena can not be 'reduced to' or 'built up from' inorganic elements or 'parts,' or the laws of the former be connected functionally with those of the latter. What such a 'reduction' or 'building up' must mean has been analyzed, and the unjustifiableness of inferring the permanent impossibility of 'reduction' of the second type from its present lack has been made evident. On the other hand, that there must be perhaps such a permanent impossibility as concerns additive reduction, the principle of 'creative

synthesis' has made quite clear. At the present time, then, *some* organic phenomena are 'reduced' according to the first method, *others* according to the second, while for still others neither of these is possible, so that, for these last, the only recourse is the descriptive law, and the most expedient unit perhaps the organism, or the cell, or the nucleus, and not the atom, the energy-form, or the colloidal particle. But, at almost any time, it may be found that such descriptive laws are functionally connected with those of the atom, or of the specific energy-form. Accordingly, they *must be held to be* quite compatible with, in fact, theoretically, to be *cases of determinism*, at the same time, that, as descriptive, they may be best stated and worked out from the standpoint of the teleology as defined in (c) (2), that, namely which is conducive to the *preservation* and *progress* either of the individual or of the species. *Such a teleology* is (c) (3), not only compatible with, but a *special case of determinism* itself; it is *objective* and not subjective, *i. e.*, it demands no psychically felt purpose. In fact, the same argument by which determinism has been established, and teleology limited and made acceptable, demands, that, when there are certain events, physical or psychical, identified with *conduct*, they shall conform to these deterministic principles. The psychical teleology becomes, then, a special case of the objective.

Finally, the validity of the Four Laws for organic as well as for inorganic phenomena brings both these realms into the *same classification*, at the same time that in this the presence of *non-additive differentia* as qualities of the 'whole' is both demanded and made intelligible by 'creative synthesis.' Both the organic and the inorganic are, then, species in the same 'natural classification,' that is, the complexes or 'wholes' of the former differ from those of the inorganic realm just as the complexes within this realm differ among themselves. This, then, is the character of the relation which the organic has to the inorganic; they are related as species under the same genus.