The Bio-Chemical Characteristics of Species*

Efforts to Discover a Specific Differentiating Substance

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EVERY living species whether plant or animal is distinguished primarily by the form of the individuals which compose it. The study of these forms of organisms and of their tissues is the subject of the morphological sciences: Zoology, botany, anatomy and histology. But while the knowledge of the phenomena of life is conditioned by the view, microscopic or macroscopic, of living bodies, it is rapidly limited by the difficulties involved in interpreting the details which are perceived as we approach the molecular structure of plasmas; and the study of the ultimate elements of living bodies is outside the scope of the morphologic sciences.

But another science, that of organic chemistry, which has undergone a prodigious development during the last half century, is engaged in the analytical and synthetic study of the products of life; however, these products are no longer living; they are the scattered fragments of a ruined structure which the more or less chimerical efforts and hopes of a few great minds have endeavored to reconstruct; during the last hundred years, in fact, the most eminent chemists have succeeded in rebuilding from such fragments, if not a compact and symmetrical structure, at least a solid foundation following the discoveries of Chevreul upon the constitution of organic substances, and those of various other scientists down to the quite recent syntheses of the sugars and of the polypeptides.

But as yet no one has solved the great problem: How are these little fragments of living substance associated in the natural state so as to form living plasmas? What are their qualitative and quantitative proportions in the plasmas of each species? It is true that this idea has already engaged many eminent chemists, physiologists, and biologists, including Spencer, E. B. Wilson, Charles Richet, Dastre, Hallion, Leduc, M. F. Guyer, LeDantec, J. Loeb, Huppert, Benedikt, Fick, etc.—this idea that the morphology of each species depends upon its chemical structure, just as each crystal of a salt, to use Spencer's comparison, owes its form to the molecular composition of the said salt.

It appeared as if the finding of the specific substance was only an affair of reagents and skill in analysis, and for more than a quarter of a century precision of analysis has seemed so perfect as to be able to detect not merely the species but even the varieties: thus, A. Gautier made the discovery of very definite chemical differences between various kinds of grape vines, and the hope was excited that the process might be extended among the various living types.

Numerous analyses have been attempted in fact, in various quarters, with this object of discrimination between species, and the present article is intended to demonstrate that this idea of distinct plasmas which has been in the air for some little time, is soundly based upon facts discovered by observation and experiment. It may even be possible later to deduce certain ideas regarding the probable constitution of living tissues with respect to the unit and the apparent immutability of the species. But no one has as yet been able to state the formula of the protoplasm of a single species. . . . And perhaps biological chemistry will never have other material than dead tissues as material for study. Hence the following lines must consist in the fragmentary enumeration of certain physico-chemical facts, which appear to be the ones most applicable among those capable of throwing light on the existences of zoological chemical specificity.

It is evident, for example, that we can readily make a complete or fractional analysis of every living species if we extract and weigh separately each substance or compound contained in the cadaver of the individual; thus Mayer and Schaeffer were able to calculate the percentage of water in the same organs of certain types of Vertebrates and found it to be remarkably constant for the same species—approximately 2%. Zaleski, and later Lapicque, made a study of a simple body which is rarer though universally found in this division, namely, iron; they discovered the following percentages of iron in the liver of animals systematically approximate: in the liver of a rabbit .40%, of the hedgehog 9.8%, of the squirrel 0.5%. In certain cephalopods the corresponding metal is copper, which in the form of the albuminate with 0.38% of the metal forms the hemocyanine. This metal was detected by

Henze in the liver of the cephalopods with a content likewise specifically variable, but ten times as great as that of iron among Molluscs, the percentages being 5.00 to 0.76% for the octopus, 0.32% for the *Sepia officinalis*, and 0.19% for the *Eledone*. Furthermore the bloods or cavitory liquids containing hemocyanine furnish a scale of oxygen absorption which differs in each species (Cuénot). Thus one hundred cubic centimetres of liquids will absorb the following amounts of oxygen: *Helix pomatia* 1 to 2 cubic centimetres, *Limulus polyphemus* 2 7/10, *Astacus fluviatilis* 2 to 3, *Homarus vulgaris* 3 to 4 8/10, sea-urchin 0.5/10, *Carcinus moenas* 3, *Porpurus puber* 3 to 4, *Cancer Pagurus*, 2 4/10 to 4 4/10, *Maia Squinado* 4 to 4 6/10. Even the metal zinc has been found in the *Fulgur Carica* and in the hepato-pancreas of a large carnivorous Gastropod, the *Sycotypus canaliculatus*, in which it constitutes 11% of the ash.

In these cases we are concerned with metals which have a catalytic and respiratory function and with special forms of apparatus: these are analyses of so-called "functional" bodies. When simple bodies of this sort (iron, for example) having a catalytic function unite with living matter they enter into the constitution of those giant molecules whose molecular weight has been determined in figures which are themselves strictly specific: thus the oxyhemoglobin of the dog (molecular weight 16,077), differs from that of the horse (16,218), and both of these from that of the ox (16,321), (Hueffner & Ganser). In the same way each plant species manufactures not merely one but several chlorophylls peculiar to itself (Gautier and Etard).

All authorities are agreed that the eggs and the spermatozooids, either one or the other, or both, act as vehicles of specific substances; but the question has been raised whether this constitution, which is evident in their case, forms an exception among the cells of the organism, or whether these special cells are distinguished merely by a superabundance of these special products. However this may be, the isolation of these products has often attracted chemists, at least so far as concerns those species whose eggs are hatched externally, and there have been discovered various organic bases of a moderate degree of complexity, sometimes strictly specific as the name indicates, although chemically very similar.

From the ovary of the *Perch*, Moerner extracted a "percaglobuline," while Kossel obtained from the ovary of the *Cyclopterus lampus* a "cycloptetine" (a protamine of the aromatic group). The "ichtuline" from the eggs of the codfish differs from that of the eggs of the carp by the fact that it decomposes into a special paraneuric acid called ichtulic acid. Hugouenq extracted from the ovaries of the herring a "clupovine" which differs markedly from the "ichtuline" of the eggs of the cod. This clupovine, taken as a type of these organic bases, yields upon hydrolysis less than 5% of the hexonic bases, histidine, arginine, lysine, but 20% of leucine and 50% of other acid amides. From the eggs of the green frog, Galimard extracted a "ranovine" containing a larger proportion of histidine than does clupovine, which otherwise it closely resembles. Kuradjeff discovered the specific protamine, silurine, in the spermatozooids of the *Silurus Glanis*; and in the testicle of the *Acipenser Stellatus* he found an "acipenserine" which differs from the protamines of the salmon group and is similar to sturine. Kossel isolated the following bases: nucleinate of salmine from the milt of the salmon, nucleinate of sturine from that of the sturgeon, and nucleate of scombrine from that of the herring.

An observation made by Phisalix indicates a connection between the "soma" and the "germen," in other words between the organism as a whole and the ovary. I refer to the fact that the glands in the skin of the female toad empty themselves of the poison they contain in order to provide the ovary with materials for the elaboration of the eggs, and in the latter there are found the two poisons which are characteristic of the species, namely, bufotaline and bufotenine. The same author likewise pointed out other peculiar kinds of venom in the blood of serpents and of other batrachians whose utilization by the ovary is quite certain. We may recall here also the observation made long ago by Miescher regarding the production of eggs by the salmon, to the effect that these fish, which take no food at the time of spawning, draw upon the muscular

masses in their sides to furnish material through histolysis for the growth of their genital glands.

A great many of the lower animals, and likewise many plants, are remarkable for their ability to manufacture definite chemical substances which are elsewhere in the world of living creatures either very rare or entirely unknown. Thus the *Alnus incana* often has upon its young branches a deposit of a waxy varnish produced by a cockroach, *Psylla Alni*, and this wax is the ether of a peculiar acid called psyllostearic acid. The juice of the fig tree contains a peculiar rennet known as sycomycase, but it also contains an antiferment like that found in cow's milk. From the variety of bean called the *phasolus lunatus* there can be extracted a cyanogenetic glucoside called phaseolunatine. Mirande has discovered a special glucoside called rhi-nanthine in the ligneous conducting apparatus of the broomrape. Again we may have a well known protein which is almost specific, such as zein from the endosperm of maize and the gliadine of wheat.

Moreover, it is very suggestive to observe the relative proportion of certain compounds in the living plasmas of closely related species: thus Schultze and Winterstein found a much higher proportion of arginine in the *Lupinus luteus* than in the *Lupinus angustifolius* or the *Lupinus albus*; hence the specificity is connected with the mode in which these diverse substances are associated. For example, we may cite the distribution of the "generic" glucosides in the closely related trees, the willows and the poplars: the *salix purpurea*, *salix helix* and *Populus alba* contain both salicine and populine; the *salix alba* contains only salicine; the *populus monilifera* only populine; and finally, the *salix babylonica* neither salicine nor populine (T. Weevers).

Another proof, somewhat indirect, of the reality of the specific chemical nature of organisms is provided by the different use which different creatures make of certain substances, for example, the human organism takes from the drug caffeine one methyl group, while the dog abstracts two, and the rabbit three groups. Albanese, who observed this fact, has noted similar modifications in case of theobromine, the active principle in chocolate. Schittehelm has pointed out that the extracts from the spleen of the ox and the horse transform adenine and guanine into uric acid, while those similarly derived from the pig and the dog are not fitted to accomplish this chemical degradation.

It may be noted here also that the vital excreta of the cultures of Protozoa, microbes, or yeasts in definite mediums are so individual as to furnish a valuable basis of specific determination; the two acetic ferments can be distinguished in this manner—the *Bacterium cylindricum*, or mother of vinegar, yielding diacetyl with glycerin while this substance is entirely absent from the cultures of the *Mycoderma aceti* of Pasteur.

We here pass from pure chemistry to biologic reactions, which in certain respects are more precise and which have attracted many investigators. Among the protozoa specificity can generally be readily shown by the appearance of one product or another; for example, Abderhalden and Fringsheim have isolated separate peptolytic ferments from the juices of the *Mucor*, *monilia*, *Phizopus*, *Aspergillus*, and *Saccharomyces*. It is a well known fact that the soluble products resulting from the life of Infusoria in limited cultures cause the death of these creatures at the end of a certain time merely through the presence of an excess of these products. In other words, these organisms may be said to be poisoned by their own excretions. The necessity which farmers are under of having a rotation of crops on a given piece of land has been explained in the same manner, namely, that each species of plants produces a toxic substance peculiar to itself (not yet isolated) which emanates from the roots and remains in the soil where it exerts an inhibiting action only upon plants of the same species.

Among the higher animals the same thing is shown in the humoral reactions of the blood or serum, which of late years have played so large a part in the diagnosis and treatment of human maladies. For example, the coagulines extracted from the red blood corpuscles have a distinctly specific but quantitative action, for they will cause blood of the same species (the cat) to coagulate more quickly than that of another species not very different (dog, rabbit), as demonstrated by Loeb and Fleischner. In general it may be said the

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lipoids of the red corpuscles are poisonous for a different species but inoffensive for individuals of the same species.

The success of seric precipitation is an admirable means of verifying zoologic relationships. The serum of the rabbit treated with the blood of the anthropoid ape gives a precipitate with human serum (Wassermann and Schultze), and the serum of the rabbit prepared with the blood of the *Rana viridis* precipitates that of the *Rana fusca* but not of the tree frog (*Hyla arborea*) or of the toad. The serums of different vertebrates have enabled Jacques Loeb to obtain a beginning of parthenogenetic development in the eggs of the sea-urchin, and since then Jacoby has been able to increase this unexpected aptitude of foreign serum (of the rabbit, for example) by previously injecting intraperitoneally the sperm or the eggs of the same species which it is desired to develop through parthenogenesis, and this is likewise an indirect but still specific sensitization. Achard and Flandin established by experiment the fact that in active anaphylaxis the antigen is endowed with a definite zoologic specificity and it even seems very probable that the complex formed by the anaphylactizing poison with the lipoids of the nervous substance, differs according to the species.

Among the mammals made use of in the laboratory it is known that the cell toxins are composed of two separable portions, one of which, the fixator, is identical in all, while the other is peculiar to the zoologic type; but to each cellular group there corresponds in the organisms a single antibody or fixator, whatever the animal which manufactures it, and this throws light upon the intimate structure of living plasmas in which the zoologic chemical specificity is paralleled by and involved with a functional cellular chemical specificity. Thus Bordet and Gengou demonstrated that by preparing an animal of the species A through injection of the plasma or serum of the species B there can be obtained from A serum which neutralizes the fibrin ferment of the blood or serum of the species B, and this anticoagulant action on the fibrin ferment always retains a strict specificity.

In general it seems to be a fundamental fact and one demanding explanation that proteins of the same kind coming from different species are very similar to each other as regards their quantitative constitution: thus, the musculins and the hemoglobins from fishes, from Molluscs, and even from the ox and the goat, yield, upon hydrolysis, almost the same quantities of the same acid amines, but are always biologically distinct as shown by the reaction of the precipitins and of anaphylaxis. They are distinguished also by the fact that they are more readily assimilated as food by the same species. Thus Busquet showed that the frog could be supported by a smaller amount of albumin if fed with the flesh of the same batrachian than when given veal or mutton; and in the case of frogs suffering from starvation the weight could be increased by a smaller amount of this specific flesh than by foods of foreign character. This, however, is only a question of degree as is indicated by the effect upon foreign albumens which are taken into the system by some other method than through the alimentary canal; in such cases there is a nephro-toxic action that has been pointed out by many investigators, particularly by Linossier and Lemoine in 1910. It usually happens that these foreign albumens force themselves through the filter of the kidneys, which they injure, and are found in the urine, but in some cases a singular tolerance has been observed to exist: for example, the dog readily supports the serum of the sheep and of the horse, and the rabbit that of the calf. This seems to indicate that the organism into which the foreign albumen was injected has the power of "rectifying" assimilating or "homologating" more or less quickly the foreign circulating plasma. However, if the latter comes from too distant a type (the albumen of the egg) it usually retains its poisonous qualities.

We must not fail to mention at this point the singular adaptation in female mammals of certain sebaceous excretions into the lacteal secretion. While the nutrition and growth of the young animal are doubtless better promoted if it is fed upon the milk of its own species, yet, if need be, it can assimilate foreign milks so long as its digestive enzymes suffice to correct and compensate the differences between the proteins ingested and those of its mother's milk, since the fats and sugars in the various lacteal fluids are almost identical and differ only in their respective proportions.

With respect to biologic reactions there are few experiments more suggestive than that of Jensen in 1892. Operating on certain Foraminifera (*Orbitolites*,

Amphisteginae) he proved that young individuals of the same species could be united by their pseudopods, while in the adults pseudopods separated from the body could not be reincorporated except upon the same individual. This seems to prove that age causes certain acquired chemical differences to appear in each animalcule.

When the tail of the tadpole of the *Rana sylvatica* is grafted on the body of the *Rana sylvestris* the tissues of the two species exert no reciprocal influence; each tissue regenerates a tissue similar to itself with its own specific characters, each cell preserving the type from which it came. The same specificity is exhibited in the tests made by Wetzel of the possibility of an "illegitimate" graft upon the Hydras. The union between individuals of different species (*Hydra grisea* and *Hydra fusca*) is never so successful as between individuals of the same species, and each regenerates only the portions removed from its own body, so that there is never a genuine union. The grafts between *Hydra viridis* and *Hydra fusca*, or between *Hydra viridis* and *Hydra grisea*, usually failed, and the fragments separated after a few days. L. Guignard observed in the course of his experiments with grafts between the *Rosaceae* containing hydrocyanic glucosides that the migration of these products from one individual to another did not take place unless they belonged to two species of the same genus and produced the same glucoside; otherwise there was no transfer from the graft to the host or vice versa.

Furthermore, the results of the heteroplastic graft are well known and always indicate the same thing, namely, the specificity of humors and tissues. This is shown, for example, by the transplantation of the ovaries, which degenerate after being grafted upon a foreign organism (cat, dog, guinea pig, upon rabbit) but which remain capable of living and even of maturing their follicles upon animals of another variety but of the same species (W. Schultz). This law seems to be much the same among the Invertebrates, and Meisenheimer succeeded in grafting the ovaries of the caterpillars of the *Lymantria japonica* (same genus), and the eggs of these ovaries reached maturity, though they disappeared when transplanted upon a remoter butterfly, such as the *Porthesia similis*.

Plasmatic specificity also involves indirectly the existence of parasitic specificity. Parasites sometimes become biologic re-agents of such delicate sensibility that they pass over the species and select one of its varieties: the typical example of this is the famous and so-called providential immunity of plants of the American grape to the *Phylloxera vastatrix*. Highly specialized parasitic insects live upon certain closely related Conifers: the *Chermes Piceae* on the *Abies pectinata*, while the *Abies normannia* is attacked by the *Chermes nusslii*; the *Picea alba* supports the *Mindarus obliquus* and the common fir the *Mindarus albatinus*; in the same way the Rusts of Cereals limit their parasitism to a single species, or at most a small number of related species. But how many butterflies, how many Coleoptera live upon the juices of a single species of plant? The enumeration of these is indefinite, and it would almost seem as if each plant species has its own parasitic insects or special group of them. It may be observed, also, that one of the rare examples known of the sudden appearance of a new animal species coincides with the change in the tree from which it derived its food which was forced upon an insect by migration: we refer to the celebrated cochineal insect of Robinier, the *Lecanium robinianum*, which according to the precise and prolonged observation of P. Marchal is merely a sudden mutation of another species, the *Lecanium corni*, a mutation dating from thirty years before.

The specialization of internal parasites is still more suggestive: among reptiles an endoglobular parasite corresponds to each species (P. L. Simon); there are distinct Sporozoa for each species of Myriapod; each Halcyon has a special Copepod (*Lamippidae*) (A. DeZulueta); each Lamellibranch supports the sporozoans of a Gregarine parasite. Among the various Entozoa, the Taenias or tape worm for example, there is a two-fold specificity, for the worm passes through a complex vital cycle which makes it a necessity for it to find two hosts which are very remote from each other in nature. In their turn these parasites react chemically upon the host on which they feed, giving rise to bio-chemical reactions of the greatest interest, which enabled Weinberg and Parvu to detect the corresponding antibodies in the infected organisms of the *Echinococcus* or intestinal worms.

If we now pass from purely chemical reactions into the domain of physics this other method of attacking the problem furnishes another confirmation of the

existence of a plasma forming a material basis of the species. Such, for example, is the point of congelation of the muscular plasmas, which, according to F. Kryz, have a correspondence in agreement with their zoologic relationship without reference to the temperature and their habitats. This point is the same for the land turtle and the mud turtle, and is nearly the same in the various Batrachians. Furthermore, Portier has observed that the congelation point of the serum of polar animals (Reindeer, Blue Fox) is very near that of the domestic animals of the same group; for the seal it is intermediate between that of the Dog and of the Cetacea; there is an exception to this, however, in the case of the marine Palmipeds, among whom this point differs markedly from that of the terrestrial birds of the same group.

Plant products, the oils for example, exhibit similar properties which are well known and made use of in the laboratory; there are optical differences also between grains of starch: these accompany physical differences such as the aptitude for swelling and forming a paste; thus, potato starch forms a paste at 65°C., that of wheat at 70°C., of maize at 75°C., of rice at 80°C.

Furthermore, the specificity of plasmas is revealed by the form of the crystals in vital excreta. Bartochevitch observed that the phosphate crystals which are formed in microbe cultures on gelatine after desiccation present a different crystallographic type for each species of *Bacillus prodigiosus*, *subtilis*, and *ramosus* *Sarcina lutea*, *Saccharomyces*. According to Ernst Siphonea Algae of the genus *Derbesia* are differentiated by their crystals, the species *D. tenuissima* forming in its protoplasm prismatic or pyramidal crystals of oxalate of lime, while two closely related species *D. Lamourouzi* and *D. neglecta* are lacking in this salt.

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Such are the experiments and observations which speak in favor of the existence, in the two vital kingdoms of substances or plasmas peculiar to a single species: in other words, among all the plasmas of which each individual of the species is composed there is one (which has never been isolated), which merits the name of the specific plasma.

But among the total of living creatures the species is only a mode of classification; for every organism besides its position in the species also represents a variety, a race in the species; and through its species it forms a part of the vaster and more comprehensive groups, the Family, the Order, the Branch.

It is even possible to believe in the probability that within the bloods, the lymphs, the saps and the humors of living creatures there are mingled cellular plasmas characteristic of these various groups. . . .

We do not insist upon these generalities without noting that the animal and the vegetable kingdom have their special products in great abundance; the chlorophylls, the celluloses, the starches, the tannins, are almost solely of vegetable origin, while glycogen or hemoglobin is of animal origin; but we believe that there is a special chemism among Mammals, which alone excrete their nitrogen in the state of urea, while in the singular Bird-Reptile group united for paleontologic reasons under the name of Sauropsida, this elimination is in the form of uric acid (the Sauropsida also yield special precipitins throughout the group) (Morat and Doyon). We also believe in a special chemism in the Salachil (including the sharks and rays) since Baglioni found in the blood of these fishes a quantity of urea almost as great as that in human urine. Again there are multiple chemical differences among the Invertebrates, some of which eliminate their nitrogen as guanine, while others excrete chitine (worms, insects), and still others conchytoline (molluscs). We need not here enumerate in the vegetable kingdom the gums, mucilages, resins, oils, latex, peculiar to so many families of Phanerogams; some of these, like mannite, are found in many families; while another like sorbite is found almost exclusively in the rose family.

It was by an unexpected application of Wassermann's reaction in preparing the rabbit with human serum that Uhlenhuth obtained a definite precipitate with the serum of the anthropoid apes but not with that of the lower apes or other mammals. Likewise, Friedenthal in preparing the rabbit with the extract from the flesh of a frozen mammoth obtained a precipitate with the serum of the Indian elephant, and Schepotieff, preparing the rabbit with an emulsion of *Cerebratulus Nemertinea*, was able to conclude by a negative reaction with the Annelids and a positive reaction with a Platod that the place of the *Nemertinea* was rather with the flat worms. Similar experiments have defined

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of washing their prints; all these and many other classes of workers who want prints quickly for temporary purposes will find their need met by this bromide-fixing process.

Those who seek new effects might try using a toned paper P.O.P. which could be fixed in potassium iodide. The bright yellow image is stable, and might suit certain subjects.

Many experiments have been tried for converting the silver image into the stable carbonate and sulphate. But the difficulty is that by the time the change is completed the image is destroyed, reminding one of the surgeon who saved the limb but lost the patient's life.

The whole subject of the darkening of silver bromide has been somewhat pushed into the background by the more pressing need of studying the developable image. A certain amount of work has been done concerning the darkening of silver bromide, as this product is needed for actinometers. It might not pay financially, but it would pay intellectually if someone would consult the library of the Royal Photographic Society and give us an epitome of the information available, with bibliographical references. Attention might also be paid to methods of fixing such an image.

Finally, one word of caution. At the present time it is impossible to get I.O.P. that exactly conforms to the usual pre-war standard. Thus a paper bought one month will not always react exactly as a sample bought previously. Neither the Ilford nor Imperial P.O.P. gives such good colors with bromide fixing as they did a year ago.

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the degrees of relation between fishes belonging to the Salmonides. . . .

The group called the Race, which is less comprehensive than the Species, certainly also has its own peculiar plasma. In this connection we may recall the suggestive analyses by which A. Gautier was able to determine the formulas of the coloring matters of various growths upon our vines. . . . similar results have been obtained with the camphors and the cat-echines.

We may mention, too, the innumerable plant or animal parasites which flourish upon one variety to the exclusion of others, as in the case cited above of the Phylloxera. We may mention, too, the racial predispositions to certain affections which exist in the human species, such as that of the Jews to hemophilia, of the blacks to tuberculosis and their comparative immunity to yellow fever, and the gravity of scarlet fever among the Anglo-Saxons.

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Finally, and in very considerable proportion with respect to the total organism, there exist plasmas peculiar to each individual: simple soluble bodies in loose combination, more or less unstable organic compounds resulting from the chemism peculiar to each existence which merit the name of individual plasmas in so far as their proportion in the humors or the cells is compatible with the life and state of health of the individuals under consideration; the physiologic state is their limit of tolerance. They are aggregated and associated throughout life with the specific plasmas and other plasmas, and their harmonious ensemble constitutes a living creature, while their qualitative or quantitative exaggeration enters the domain of intoxication or disease. The various methods of alimentation are primary factors in these peculiarities of plasmas, and in the human species it is easy to understand how some special habit, such as strict vegetarianism, or a steady fish diet, or the habitual taking of arsenic for a long period, would finally constitute a chemism of the body somewhat different from that of the ordinary omnivorous individual: thus, an individual urological formula and an individual blood formula have been observed. Some of these variations exist even at the very beginning of life and before the new creature is able to feed itself; thus, Lapclique discovered in the human embryo that the content of iron in the liver varies from 0.10 to 0.55% (dry extract), and in the foetus of the dog from 0.11% to 0.70%.

When diseases proceeding from microbes have been cured certain intoxications confer upon the organism a special chemical condition: vaccination, for example, or, on the contrary, anaphylaxis. Specific sensitizers of the parasitic microbes have been detected after typhoid fever, bacterial dysentery, etc., and very sensitive antibodies recognized in the echinococcus; but we are here infringing upon pathology, which is outside the domain of the proper physiologic plasmas.

The following experiments incline Ch. Todd and R. G. White to believe that the red corpuscles of each individual have a distinct biochemical constitution: the

blood of an ox immunized with the red corpuscles of other cattle undergoes a reaction by which it produces hemolysine; but a polyvalent serum resulting from mixing the serum of several immunized animals, when extracted with the corpuscles of any kind of cattle remains very hemolytic for all the individuals not closely related to the one which provided the corpuscles—even though it has lost its hemolytic power over the corpuscles of that individual. This strongly indicates the existence of family or parental plasmas, which the phenomena of the transfusion of blood have long led us to suspect. And while Carrel has shown that grafted organs do not usually survive unless the organ is replaced upon the same individual (an autoplasmic graft) the success of the grafts of ovaries between sister sheep made by Voronoff, shows clearly enough that the closest family relationship likewise has a biochemical basis. . . .

In the course of individual life plasmatic alteration becomes accentuated, and represents one of the elements concerned in growing old: there is in general a loss of water on the part of the tissues and an encrusting with mineral substances. M. Maurice has observed a regular curve of diminution in the hydration of the tissues with increasing age in experiments upon the dog (15% for the hemispheres of the brain, 25% for the spinal cord, 55% for the nerves). The content of lipoids and phosphorus increase with age, and in the adult the proportion of phosphorus is greatest in the blood and the liver and still more for the nerves. In man a well studied type of these progressive alterations of individual chemism is represented, for example, by the pigmento-fatty bodies which amass themselves at a fixed place in certain nerve cells, beginning with the third year of life, then invade them progressively and in numbers until in the old man there remains only a thin protoplasmic border constricted by the fatty pigments. Can we not consider that we have in this fact the mechanism of the slow substitution of one plasma for another? This second plasma, the fatty body, is particularly easy to follow, to localize, and to characterize, since it is insoluble and pigmented. The comparison with the ordinary evolution of plant life is very obvious: the polymerization of the celluloses, lignification, suberization, and the various incrustations of plant tissues caused by age, are within certain limits a process of the same order.

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We have no intention of asserting that any of the products defined and enumerated above is a specific plasma. It is, on the contrary, quite improbable that any specific plasma whatever will ever be isolated by the devices employed in the laboratory. It is the consensus, the co-existence, the collaboration, of these various plasmatic types which constitutes life, and their physical, chemical and mechanical interpenetration is constant and fundamental. . . .

Beneath the multi-colored weft of membranes, tissues, granules and cellular details of all sorts, which, considered separately, are but dead matter, there flow and circulate substances, different in nature, but of equal value, as concerns life: these are the plasmas in the biologic sense of the word; but the definite chemical substance weighed and delimited molecularly which might be called a specific plasma, or a racial plasma, or individual plasma, does not exist so long as life lasts.

Resilient Wheels for Motor Vehicles

THE *Zeitschrift des Vereines Deutscher Ingenieure*, of October, 1917, discusses a variety of resilient wheels introduced, which, while recognized as not fully equivalent to pneumatic tires for passenger cars, fulfil a useful purpose. The wheels are classed under two groups. Group 1.—(a) The spring wheel uses spiral springs wound from square steel and mounted radially in one or two rows between cups secured to the inner and outer wheels. There is risk of the springs being displaced when running over obstacles or round corners, particularly at more than moderate speed. (b) The Moll wheel is of similar construction, except that side plates are used to protect the springs from dirt, and telescopic tubes are used inside the springs to prevent lateral displacement. These tubes are extended as spherical end caps, which give the requisite degree of transverse flexibility. (c) The Fruth wheel uses a series of oval springs placed on their sides in troughs attached to the outer and inner rims. Bolts through the troughs pass through the overlapping loops of consecutive springs. The wheel is rather less flexible radially, since the springs are compressed in the plane of their winding instead of axially. One of the troughs slides in the others, and so takes up transverse forces. The construction provides circumferential flexibility against accelerating and braking forces. The whole can be mounted as a unit in place of a rubber tire. (d) The Sievert wheel retains rubber or similar material for

elasticity, and uses a wooden road rim. A rubber ring is held on each side of the fellys by through-bolts, which also secure steel side rings carrying the outer wooden rim clear of the inner wheel. All wear comes on the wooden rim, and the only connection between this and the inner wheel is through the rubber side rings. These are rather flexible and liable to slide-slip. Group 2.—(a) The Siemens and Halske wheel uses radially mounted spiral springs (imperfectly protected against dirt and transverse forces) and a flexible outer rim. The outer rim is built up from strip steel wound to form a hoop, which is secured by clips and protected by renewable sections of leather or similar material held by rivets. (b) The Flohr wheel is similar, save that the outer rim has steel links (resembling link belting), the pins of which serve also to carry cups for the radial spiral springs. The rim pins are exposed to dirt and moisture.

Cork Slabs from Cork Waste

SLABS of considerable strength may be made by compressing ground cork waste and heating it at 160 to 180 degrees C., while under compression. No binding agent is required, and it has been suggested that the natural resin of the cork serves as a binder. Various samples of ground cork were extracted several times for 24 hours with alcohol and with chloroform in the cold. The maximum amount of the united extracts, in the case of cork dust, was 9.35 per cent of the air-dry weight. Higher results were obtained when water was also used, e. g., up to 10.3 per cent, since the tannins are also extracted, but water has an injurious action on the cork substance. The extract was resinous and began to melt at 150 degrees C. Equivalent weights of comparative samples of natural and extracted granulated cork were compressed to form plates of various thickness, then heated in the moulds for about 3 hours at 180 degrees C. or for 15 to 20 hours at 160 degrees C. At the higher temperature a slight browning of the cork substance was observed, but at 160 degrees C., in spite of the longer time, there was no perceptible decomposition. Tensile tests were made in a cement-testing machine; the strength depended on the degrees of compression and the heating. The more favorable results with plates compressed under 7 atmos. varied from 6 to 8 kilos, per sq. cm.; some very heavily compressed plates showed 14 kilos. per sq. cm. The plates from the extracted cork were only slightly inferior to those from the natural cork. The resistance to water and steaming was almost entirely a function of the temperature of heating while under compression; plates heated at 50 to 100 degrees C. readily disintegrated, while those heated at 180 degrees C. were the most resistant. Heating before compression was useless. The compressed plates adhered firmly to the walls of the mould, but pieces of tissue paper placed between prevented this adhesion and showed no oily or resinous stain. The author concludes that resinous extractive matters play no part in binding the compressed plates, but that their solidity depends on an interlocking or felting of the cork cells. Without heating, the elasticity of the cork is restored by steaming and the plates fall to pieces, but at 160 to 180 degrees C. incipient decomposition destroys the elasticity and the felting of the cells is permanent and rigid.—*Note in J. Soc. Chem. Ind. on an article by H. Ost in Z. angew. Chem.*

Stellite

THE name "stellite" is derived from the Latin word *stella*, a star, because when the alloy is polished it takes a beautiful silvery color and luster. The first experiments in the development of stellite were made for the purpose of combining metals to make an alloy that would be sufficiently hard and that would have the strength to stand up under heavy cuts. Although, at first, there was some difficulty in obtaining the strength and getting a hard cutting edge, these experiments showed that chromium, cobalt and tungsten of which stellite is made could be alloyed in such a way as to give the desired results. In 1912 these experiments culminated in the perfected laboratory production of stellite.

Stellite is an alloy of these semi-rare metals, but contains no iron and therefore cannot properly be termed steel. The binary alloy, consisting essentially of cobalt and chromium, can be forged with difficulty at a bright red heat, but when it becomes cool its hardness remains as great as before the first heating. Stellite does not get harder as it gets hotter, but it gets tougher and holds the cutting edge longer. Cobalt is not affected by heat up to about 1,900 degrees Fahr., and the tungsten and chromium are not affected by any heat up to 2,600 or 2,800 degrees Fahr. It is clear, therefore, that the cobalt becomes tougher up to the degree of softening, but at the same time the other two metals are not changed. This makes a closer and tougher bond, allays all chance of crumbling and makes the tool last longer because it has the necessary strength to take off a heavy cut without breaking.—*The Iron Age.*