at the time of collection they may contain considerable ingested mud that would interfere somewhat with the microscopic examination—although the nemas can be profitably examined immediately on collecting.

It is very important to the student of nemas that he *study living material.* For examination alive, *M. pristiurus* may be placed in a drop of tap water for from 10 to 60 seconds until it quiets down, and then mounted at once in a droplet of clear sea water under a thin cover-glass with sufficient pressure to keep the nema from moving more than a very little. This pressure can be applied by drawing the extra sea water from under the round cover-glass with a sliver of filter-paper until the nema can barely move, and then sealing in at once on a turntable with a modicum of smoking hot wax (formula, 1 of beeswax plus 3 of 45° paraffin), best applied from the wick of an ignited, narrow 5-millimeter-gauge taper made of the wax, somewhat like a Christmas-tree candle;—but boiling hot wax and a No. 2 water color brush will answer. A small amount of movement of the nema during microscopic examination is very desirable because the various nemic organs reveal their contours more readily when sliding slightly one on another. Mounting direct into 5 per cent. KOH solution displays various cuticularized organs—mouth parts, spicula, etc., more distinctly.

(2) *Advantages.* There are many marine nemas obtainable at seaside stations more suitable for class use than *M. pristiurus,* but none of them is yet known to bear transportation so well. The drawbacks of *Metoncholaimus pristiurus* are: (1) Its amphids (very important characteristic organs, universal in nemas) though well developed, are rather difficult to see; (2) the sensory setae so prevalent on aquatic nemas are here not very well developed; (3) there are no eyespots; (4) the tissues are not quite as transparent, and hence not quite as readily studied, as in some other forms.

Its advantages are: (1) It is relatively large, and is available at any season; (2) it can be shipped long distances alive, and be kept alive for weeks in cool laboratory storage; (3) it presents the demanian system of organs—indicative of the fact that nemas possess whole systems of organs as yet comparatively unexplored; (4) it presents all the numerous advantages which well-developed free-living forms possess over the parasitic forms commonly used as teaching material, such as, among other things, (a) distinctly developed mouth parts, and salivary glands, (b) caudal glands and spinneret, (c) well-developed amphids, (d) sensory setae, (e) readily visible central nervous system, parts of the peripheral system being easily demonstrable by using sea water-methylene blue (over night), (f) a more or less visible renette, (g) well-developed longitudinal cords and associated organs, (h) visibly differentiated intestinal cells (among them the "birefringent" cells), (i) a double gonadic system in the male, *the primitive and normal condition* (although, here, as it happens, single in the female and thus atypical), (j) growth, fertilization, etc., of the living ova can be observed *in situ;*—all these more or less readily observable without dissection.

(3) *Shipping.* It is recommended that in transportation for laboratory use *M. pristiurus* be shipped with half a liter or so of sea water in a separate container, since additional pure sea water is necessary as a mounting medium for the living nema, and permits renewal during lengthy laboratory storage of the sea water containing the nemas; also, that it be put into the mail or express immediately before closing time, that it be packed with ice or solid insulated CO_2 so as to remain cool in transit, and that it be shipped under cool conditions. The nema is so small that hundreds can be packed in the small space suitable to air mail, and this method of shipping is very desirable, especially as air mail temperatures are not likely to be excessively warm. These nemas stand freezing temperatures.

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SPECIAL ARTICLES

A CHART OF RADIOACTIVE ELEMENTS INDICATING THEIR STRUCTURE

THE terminology and some of the data of this chart are based upon the recent report of the International Radium-Standards Commission.[1] The purpose of the chart is to indicate the structure of the nucleus as well as that of the electron shell of all radioactive isotopes.

[1] Curie, Debierne, Eve, Geiger, Hahn, Lind, St. Meyer, Rutherford and Schweidler, *J. Am. Chem. Soc.*, vol. 53, p. 2437, July, 1931.

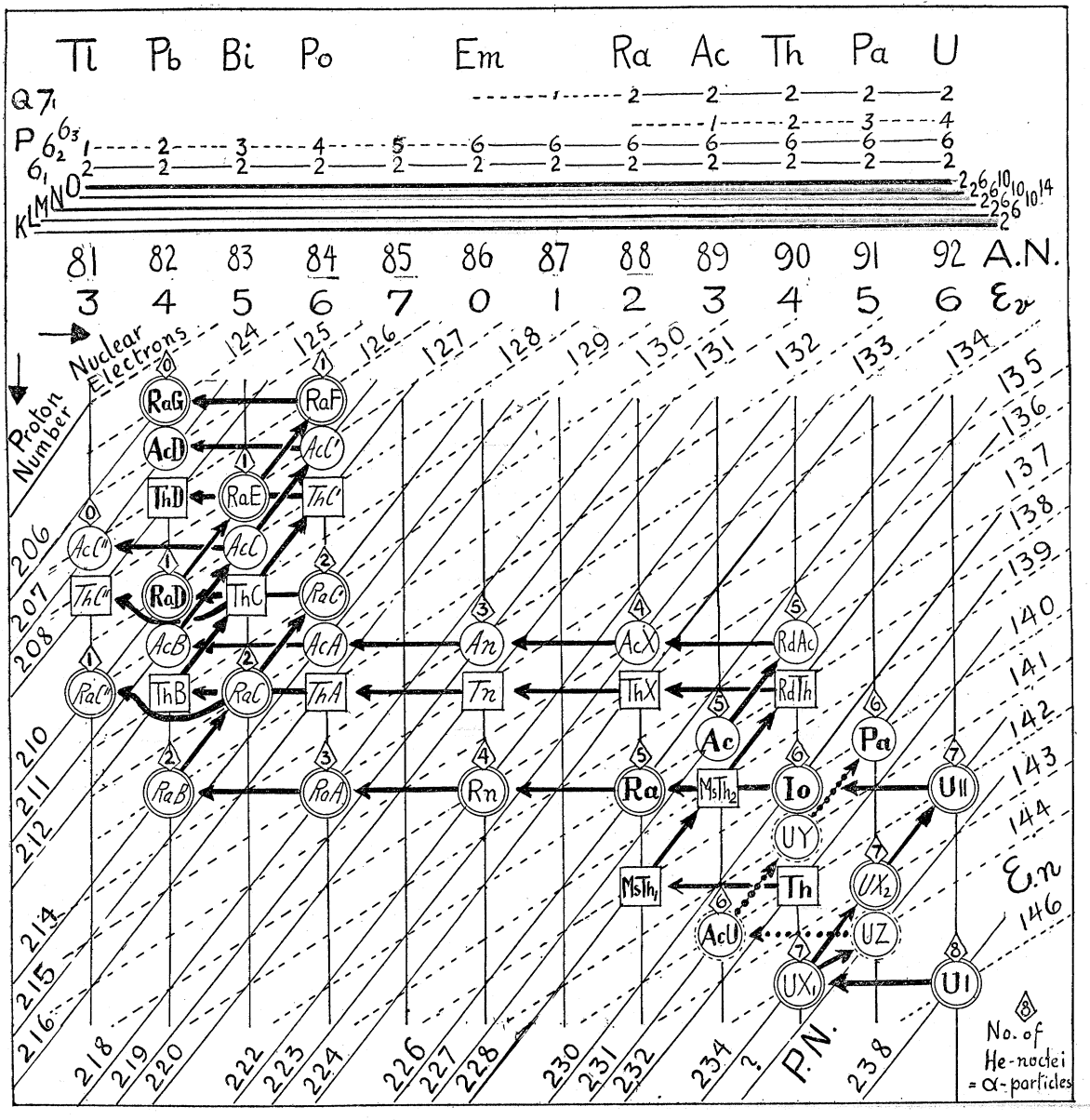
The lower part contains the familiar disintegration series: double circles for the uranium-radium family; single circles for the uranium-actinium family, and squares for the thorium family. The position of AcU and UY is doubtful and indicated by the broken circle. The average life of the atomic species is indicated by bold type—those having a period of over one year; Roman characters—those from one hour to one year, and italics—those existing less than one hour.

Nuclear structure is indicated by the number of

protons and electrons. The proton number, or isotopic weight, is shown on the left and lower edge, they occur in groups of three with some numbers missing. The number of nuclear electrons connects the isotopes at a different angle and it is interesting to note that there are in no instance more than three atomic species for a given number of nuclear electrons and each of these belongs to a different family. Thus 126 nuclear electrons occur in RaF, ThD, and AcC″, while 140 electrons are found in Pa, Io, $MsTh_1$. The table records all atomic species thus far known to exist between P.N. 206 and E_n 124 to P.N. 238 and E_n 146. The small number in the trapezium indicates the number of helium particles which the atomic species can lose. If $Pb^{206} = RaG = x$; $Pb^{207} = AcD = y$ and $Pb^{208} = ThD = z$; then it follows that RaF = $He \cdot x$; AcC = $He \cdot y$ and ThC′ = $He \cdot z$ and Rn = $He_4 \cdot x$; AcX = $He_4 \cdot y$ and ThX = $He_4 \cdot z$ and so on to Ul = $He_8 \cdot x$. Alpha-rays are shown by the arrows pointing to the left, beta-rays by those pointing upwards.

The quantum numbers for the normal state are in the upper half of the table; the continuous lines indicate that the K, L, M, N, and O shells are filled, while the broken lines indicate the energy layers which are being filled up, that is the P and Q shells. The atomic number, A.N., and normal valence electrons, E_v, complete this portion of the chart.

A study of the chart reveals that in beta decay the nucleus not only loses an electron, but also the valence



shell gains an electron, while in alpha decay, both nucleus and valence shell lose a pair of electrons each.[2]

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THE SUGAR TOLERANCE OF YEASTS EXPRESSED IN ATMOSPHERES

MYCOLOGISTS who study microorganisms on culture media are presented with physiological problems, such as the osmotic relations of microorganisms to their substrata. The plant physiologist considers and observes such relations in single cells and in turn in groups of cells. The microbiologist studying yeasts has a good opportunity to appreciate the interplay of osmotic forces outside and inside cell membranes, because of the advantageous size of these organisms.

In considering the osmotic relations of any cell or group of cells we get a true picture of natural conditions, if we think of each cell, tissue or organism as part of a moist system. We think then of the substratum and the yeast cell, for example, as in a continuous relation through moisture or water. Such continuity of water relations is absolutely essential for all organic life. We are apt, however, to think of a fungous body as merely displacing a volume of the solution in which it occurs. If we regard this displacement as anything but the occurrence of an instant we do not have a true picture. We had best think first of the continuity of the moist environment of the microorganisms as being throughout their cell structure.

The environment in which we culture our microorganisms is generally of the density or water content presented by dextrose broth or agar, which is in turn theoretically influenced by the moisture content of the air in the test-tube. Microorganisms growing on agar slants absorb or give off solutes only and therefore are most intimately related to organic substances which became solutes in a moist environment. There is no exchange between the protoplasm of a cell and its environment except as substances in solution.

For a further realization of this principle, picture yeasts or molds in juxtaposition to grains or particles which are of such a nature as to be unchanged by any reaction. Picture these yeast cells and such inert particles as part of a moist system. The moist environment is continuous throughout the yeast cell. The inert particle is unaffected. There is no interplay of osmosis between the living cell and the inert grain. Replace the particle with a sugar crystal of the purest type. The moist environment is now continuous with the crystal as well as with the living cell. There can no longer be the inert relation which existed between the yeast cell and the inert particle. The living cell, the syrup films of the crystal and the crystal must adjust their osmotic relations, and this continually. Life is not an equilibrium, but is continually trying to approach it. It is always getting there. When we admit these conceptions, we must admit that all microorganisms which carry on metabolic and reproductive activities in concentrated solutions have a higher tolerance of high osmotic pressures than those subsisting only in dextrose broth of the standard methods or in the liquid phase of a solid culture medium.

What specific proofs are there of such a relation pertaining to yeasts tolerant of concentrated sugar solutions? The following instances are illustrative and sufficiently indicative. When we use water blanks instead of a sugar solution for dilution blanks in count work, with sugars the count is lower, because some cells are killed by the dilution water. We may also observe the same relationship when we take a loop of growing yeasts from a sugar solution of 50 per cent. total solids and add to it water or more dilute sugar solution to complete a microscopic mount. Again almost instantaneous plasmolysis occurs, when we mount living yeast cells growing on a sugar agar slant of 50 parts of sugar to 100 parts of agar medium in water or broth containing 35 parts of sugar per hundred. Further, yeasts grown at as high a concentration as 50 parts of sugar to 100 of broth or agar medium are smaller than when grown in 35 parts of sugar to 100 parts of broth or agar medium. Pfeffer[1] claims that as cells become acclimated to concentrated solutions the cell wall develops strength and the radius of the cell decreases as the cell's resistance to osmotic pressure increases. Cells thus accommodating themselves to concentrated nutrient solutions which constitute their environment must be inherently able to increase the amount of osmotic substance they contain. With such accommodation the appearance of the protoplasm changes. We have observed excessive vacuolation in yeasts growing in high sugar solutions.

The density of sugar solutions may be expressed as atmospheres. Considering the usual broth media, we find that from 1½ to 3 per cent. of sugar is their usual concentration. A 1 per cent. dextrose solution would have its osmotic pressure expressed in atmospheres by a value of 1.25. Dextrose broth containing 1 per cent. of sugar would be somewhat higher, due to added nutrient, as beef extract or peptone. The inoculated medium, due to the inclusion of the sam-

[2] Hackh, *Phys. Rev.*, vol. 13, p. 165, 1919; and *Phil. Mag.*, vol. 39, p. 155, 1920.

[1] W. Pfeffer, trans. by A. J. Ewart, "Physiology of Plants," Vol. I, pp. 136, 140. 1906.