mineralization with time of the more labile biochemical constituents heavier in ^{13}C (see below).

Recent determinations[2] of $\delta\,^{13}C$ in eighteen phyto and zooplankton samples collected off Peru and Ecuador are in the range $-17\cdot4$ to $-21\cdot2\,^o/_{oo}$ with a mean value of $-19\cdot3\,^o/_{oo}$. Six of these samples were chemically separated into the lipid, amino-acid, sugar, hemicellulose, pectin, cellulose and lignin fractions[2]. The mean $\delta\,^{13}C$ values of these fractions were: $-29\cdot8$, $-17\cdot5$, $-19\cdot2$, $-18\cdot7$, $-16\cdot7$, $-22\cdot4$ and $-23\cdot1$ respectively. Thus the isotopic ratios found in the dissolved organic matter most closely approximate those of the cellulose and lignin fractions. This similarity assumes that the $\delta\,^{13}C$ values for these fractions are valid for plankters collected off San Diego.

The dissolved organic matter in the deeper waters of the ocean, < 300 m, has a relatively uniform concentration and does not vary markedly in space, in time or with depth (refs. 11, 12, and unpublished reports from this institute). This situation implies that deep-water organic matter is stable with respect to chemical and biochemical oxidation. The uniform distribution of $\delta\,^{13}C$ in the dissolved organic carbon with depth supports this hypothesis and suggests that the dissolved organic matter is derived from the cellulose and lignin fractions of the plankters, and that the more labile proteins and carbohydrates are biochemically oxidized and utilized in the upper several hundred metres of the ocean.

Carbon isotopic data may be a useful means of understanding the chemical nature, origin and stability of dissolved organic matter in the sea.

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Benzidine Rearrangement

THE mechanism of benzidine formation from hydrazobenzene has been the subject of incessant consideration[1]. Kinetic study[2] has shown the reaction to be bimolecular in respect of acid participation, but the idea[3] that this involves initial formation of a doubly charged cation from such a weak base as hydrazobenzene is totally unacceptable. The singly charged cation, like other ammonium ions, would be in equilibrium with aniline and the nitrogenous anion, associated with it by a π bond[4], were it not that para-substitution ensues. Finally, the quinonoid substituent is rendered aromatic by action of the second molecule of acid, or, alternatively[5] to a subordinate extent, by a suitably constituted hydrazocompound if such be present.

The following scheme shows the continuous series of changes thus postulated.
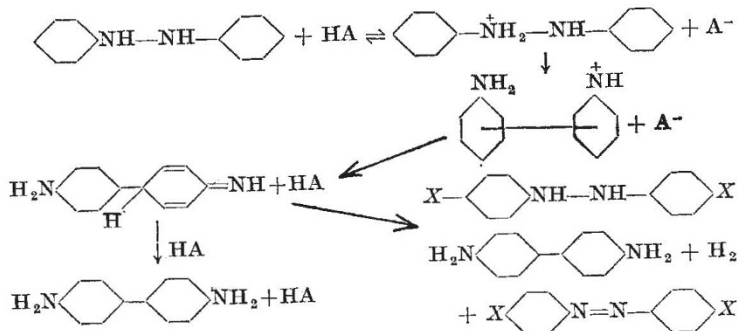
It must be emphasized that this scheme represents phases of the continuous transition from hydrazobenzene to benzidine rather than a series of separate reactions.

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Effect of X-rays on the Electrical Conductance of Phospholipid Bilayer Membranes

A LONG-STANDING hypothesis suggests that a significant contribution to the radiobiological effects of ionizing radiations comes from the damage they cause to cell membranes[1]. The production in this way of massive damage to the membranes—allowing the movement of macromolecules across them—would be of considerable importance, but a smaller change affecting only their permeability to simple electrolytes could also have noticeable biological effects. We have studied the possibility of the latter phenomenon using a system recently introduced as a partial model of the cell membrane. The model membranes are optically black structures formed of phospholipid dissolved in a hydrocarbon; they can be made 1 mm² or more in area, are probably two molecules thick[2], are stable for several hours and have readily measurable electrical characteristics[2,3].

Using pure lecithin prepared in the laboratory from hens' eggs, dissolved in n-heptane, we formed membranes of about 1 mm² area in various electrolyte solutions and measured the electrical conductance (σ) before, during and after X-irradiation. The X-rays were 220 kVp from a therapy machine and the dose rate (which was up to 600 rads/min) was measured at the position of the membrane in subsidiary experiments.

The ratio to the initial conductance (σ_0) of the change of conductance ($\sigma-\sigma_0$) on application of the X-rays is shown in Fig. 1. In all cases the conductance returned to its initial value ($\sim 5\times10^{-9}\,\Omega^{-1}$) when the X-rays were switched off. With our present apparatus it was not possible to measure the time constant for the appearance of these conductance changes; we were able to conclude only that the time constant had a value less than 2 min. To probe the nature of the charge-transfer process manifested as membrane conductance, we formed membranes and