sac, and while the male nucleus is in the process of fusing with the polar nuclei to form the endosperm nucleus, there are mitochondria in the vicinity of the endosperm nucleus. These mitochondria originally came from both the male and female parents.

Thus, on a cytological basis, it appears that there are species differences regarding the mechanism and importance of cytoplasmic inheritance. In *Mirabilis,* it is important with respect to leaf variegation, but in other cases, *i. e.,* corn, with odds as low as 3.4 to 1 and 1.7 to 1 for percent total chlorophyll and milligrams chlorophyll per 100 sq cm leaf surface respectively, as measured by "Students" pairing method and tables of Z, it is apparent that cytoplasmic inheritance is not an important factor in inheritance studies of chlorophyll in corn.

Summary. These studies show that maternal inheritance of chlorophylls as measured by a series of crosses made reciprocally between high and low chlorophyll inbred lines of corn is not significant, and that male and female parents each contribute equally to the genotype of the F_1 cross in respect to chlorophyll concentration.

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In vitro Experiments on Exchange of Phosphate by Enamel and Dentin.

W. D. Armstrong. (Introduced by F. H. Scott.)

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Krogh, Holst, and Hevesy,[1] and Manly and Bale[2] demonstrated the presence of radioactive phosphorus in the whole teeth of animals receiving a parenteral administration of compounds of this isotope. Hevesy and Armstrong[3] in an investigation in which the enamel and dentin of cats' teeth were separately studied found, using radioactive phosphorus as an indicator, the rate of exchange of phosphate by the enamel of erupted mature teeth to be about one-tenth that of the dentin. The rate of exchange was such as to make highly improbable an ability of enamel of mature teeth to undergo significant changes of composition as a result of nutritional alterations.

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1 Krogh, A., Holst, J. J., and Hevesy, G., *Det. Kgl. Danske Videns, Selskab. Biol. Med.,* 1937, **13**, 13.

2 Manly, L., and Bale, W. F., *J. Biol. Chem.,* 1939, **129**, 125.

3 Hevesy, G., and Armstrong, W. D., *Proc. Am. Soc. Biol. Chem.,* 1940, XLIV.

The experiments herewith reported were carried out by agitating 0.12-0.15 mg of the finely pulverized specimens in 10 cc volumetric flasks completely filled with the solution of labeled phosphate. The active material was supplied by the Radiation Laboratory of the Department of Physics of this University. The specimens after the stated time of contact with the active solution were recovered and washed ten times with water by centrifugation.

These results obtained *in vitro,* especially in the case of dentin, show a surprisingly rapid rate of exchange of phosphate. However, the relative rates of exchange by enamel and dentin are very similar to those observed *in vivo* by Hevesy and Armstrong.[3]

Since dentin contains[4] 22.2% protein and enamel less than 1% of protein, the larger amount of labeled phosphate acquired by dentin from solutions at pH 7.5 might have been due, if the protein of dentin has an isoelectric point somewhat above pH 7.5, to combination of phosphate anion with dentin protein. The acid combining power of dentin protein in relation to hydrogen ion concentration is not known but it appears very unlikely that this protein could combine with anions in solutions of pH 13. The experiments whose results are tabulated in the second and third columns of Table I indicate almost identical rates of acquisition of labeled phosphate by dentin from a solution of pH 7.5 and 13. It is, therefore, unlikely that the higher rate of uptake of radioactive phosphate by dentin at pH 7.5 was due to chemical combination of phosphate with dentin protein. The 2 experiments with dentin at pH 7.5 and 13 also indicate no effect of the state of ionization of phosphate on its rate of exchange with dentin.

TABLE I.
Exchange of Phosphorus by Enamel and Dentin.

Material	Enamel	Dentin	Dentin	Dentin Protein
pH solution	7.42	7.51	13	7.4
Time in hr at 38°	20	20	22.5	20
Activity (counts/min)	19.6 ±0.33	111.0 ±1.6	218 ±1.9	8.85±0.23
Background (counts/min)	8.62±0.21	8.62±0.21	8.80±0.17	8.80±0.17
Mg P in solution	18.5	18.5	18.5	14.0
Mg P labeled by 1 count*	0.0122	0.0122	0.0114	
Mg P exchanged/g/24 hr	1.42	11.7	11.8	
% P exchanged/24 hr	0.81	9.19	9.26	
Specific activity†	0.0445	0.502	0.505	
Relative specific activity	1	11.2	11.3	

* Calculated from total activity of solution and its content of phosphorus.

† Specific activity: The % of total activity in a tissue per mg of phosphorus.

[4] Armstrong, W. D., Brekhus, P. J., and Cavett, J. W., *J. Dent. Research,* 1936, **15**, 312.

As further evidence that dentin protein does not combine with phosphate at pH 7.5, denatured dentin protein[4] was agitated for 20 hours with a solution of labeled phosphate with the result that no active phosphate was present in the protein after thorough washing with water.

The greater rate of exchange of phosphate by dentin must, therefore, be attributed to the smaller size of the crystallites of the mineral phase of dentin, but more especially to the fact that dentin is permeated by the dentinal tubules which probably have the effect of permitting a more complete contact of the crystals of the mineral phase with the solution containing labeled phosphate than exists in the case of enamel. An alternative hypothesis might be that the higher activity of dentin is due merely to some active solution trapped in the dentinal tubules. Nevertheless, phosphate in solution which is not removed from the tubules by thorough washing would be expected, with time, to reach an exchange equilibrium with the phosphate of the mineral phase.

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Cinnamic Acid Metabolism in Man.

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The fate of cinnamic acid ($C_6H_5CH{:}CHCOOH$) after its administration to the animal organism has been examined repeatedly. The following facts are known. Cinnamic acid given by mouth to humans is oxidized to benzoic acid which is excreted in the urine linked with glycine in the form of hippuric acid.[1,2] In cats and dogs after the administration of phenylpropionic acid not only hippuric acid but also small amounts of cinnamoylglycine are excreted.[3] After administration of cinnamic acid hippuric acid with small traces of cinnamoylglycine are found.[4] After administration of cinnamic

1 Erdmann and Marchand, *Liebig's Annalen der Chemie und Pharmacie*, 1842, **44**, 344.

2 Knoop, F., *Beiträge zur Chemischen Physiologie*, 1905, **6**, 150, and 1908, **11**, 411.

3 Dakin, H. D., *J. Biol. Chem.*, 1906, **5**, 173, 303.

4 Dakin, H. D., *J. Biol. Chem.*, 1907, **6**, 203.