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## Excretion of Inorganic Phosphate by the Aglomerular Kidney.

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The urine of the winter toadfish, *Opsanus tau* (aglomerular kidney), contains only the faintest trace of inorganic phosphate when the fish are kept in an aquarium in the laboratory. The injection of large amounts of either monobasic or dibasic sodium phosphate intramuscularly or intravenously raises the plasma inorganic phosphate to high levels, but does not cause the excretion of any inorganic phosphate in the urine. The excretion of inorganic phosphate has not resulted from various procedures (feeding, injection of glucose, parathyroid extract, insulin). The injection of sodium glycerophosphate results in a marked rise in the inorganic phosphate of the plasma, but in no excretion of inorganic phosphate by the kidney. The above findings are interesting in view of the fact that the goosefish (another aglomerular marine teleost) secretes urine which may contain large amounts of inorganic phosphate.[1] Since we have been unable to obtain freshly caught or summer toadfish, further investigation of phosphate excretion has been carried out upon the goosefish *(Lophius piscatorius)*.

Specimens of urine obtained from the bladders of 10 freshly caught summer goosefish contained from 0.7 to 45.0 millimols of phosphate* per liter. The plasma phosphate in the same fish varied from 4.2 to 7.7 millimols per liter. The high concentrations of phosphate observed initially in the urine of some of these fish decreased markedly when the fish were kept in live cars at the laboratory.

The injection of inorganic phosphate into a goosefish does not increase the phosphate excretion. The following protocol is typical of many experiments.

Goosefish 5. 2.6 kilos.

9:54—11:56 Urine, 10 cc. containing 3.0 mM phosphate per liter (excretion 0.015 mM per hour).

11:58 Plasma phosphate, 7.7 mM per liter.

12:00 Inject intramuscularly 17 mM disodium phosphate (40 cc. of 6%).

1:52 Plasma phosphate, 19.2 mM per liter.

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[1] Marshall and Grafflin, *Johns Hopkins Hosp. Bull.*, 1928, **43**, 205.

* Whenever the word phosphate is used, inorganic phosphate is meant.

3:00 Plasma phosphate, 20.3 mM.
4:00 Plasma phosphate, 20.0 mM.
4:00 Urine, 16 cc. containing 4.0 mM phosphate per liter (excretion 0.016 mM per hour).

The result of the injection of sodium glycerophosphate is illustrated by the following experiment:

Goosefish 10. 10.0 kilos.
9:20—10:30 Urine 5.0 cc. containing 5.7 mM phosphate per liter (excretion 0.024 mM per hour).
10:30 Injection of 20.0 gm. sodium glycerophosphate (104 mM) intramuscularly
1:05 Urine 20.0 cc. containing 7.4 mM phosphate per liter (excretion 0.057 mM per hour)
2:07 Urine 5.5 cc. containing 8.2 mM phosphate per liter (excretion 0.043 mM per hour)
3:45 Urine 6.5 cc. containing 9.0 mM phosphate per liter (excretion 0.035 mM per hour)
4:45 Urine 3.5 cc. containing 8.7 mM phosphate per liter (excretion 0.030 mM per hour)
5:20 Urine 0.4 cc. containing 8.8 mM phosphate per liter (excretion 0.006 mM per hour)
5:21 Plasma phosphate, 10.7 mM per liter.

The above results prove that injected inorganic phosphate is not secreted by the aglomerular kidney and suggest that the inorganic phosphate in the urine of these fish is formed in the kidney from some precursor (which does not appear to be glycerophosphate). It is reasonable to assume that in a glomerular kidney, injected inorganic phosphate should be excreted only by glomerular filtration. If sufficient phosphate is injected to minimize the error due to reabsorption, the phosphate excretion should approximately measure glomerular filtration. This hypothesis has been tested in frogs by comparing the excretion of injected phosphate with that of xylose, which has been shown by Shannon, Jolliffe and Smith[2] to be a measure of glomerular filtration.

Xylose and dibasic sodium phosphate were injected into the lymph sac of frogs *(Rana catesbiana)*, and urine and blood samples

TABLE I

| Frog No. | Xylose mg % Plasma | Xylose mg % Urine | U/P Ratio | Phosphate mM per liter Plasma | Phosphate mM per liter Urine | U/P Ratio |
|---|---|---|---|---|---|---|
| 3 | 162 | 472 | 2.92 | 7.3 | 20.0 | 2.74 |
| 5 | 292 | 876 | 3.00 | 8.5 | 22.4 | 2.64 |
| 9 | 194 | 330 | 1.72 | 9.3 | 21.5 | 2.31 |
| | 194 | 564 | 2.91 | 9.1 | 30.5 | 3.35 |
| 10 | 222 | 538 | 2.43 | 9.1 | 25.3 | 2.78 |

[2] Shannon, Jolliffe and Smith, *Am. J. Physiol.*, 1932, **100**, 301.

taken at appropriate intervals. Table I would appear to indicate that injected inorganic phosphate approximately measures glomerular filtration under these conditions.

*Summary.* Injected inorganic phosphate is not secreted by the aglomerular kidney but the urine of the aglomerular fish may contain large amounts of inorganic phosphate. This suggests that the inorganic phosphate in the urine of these fish is formed in the kidney from some precursor. From the above results it would appear that injected inorganic phosphate should be excreted only by glomerular filtration in the glomerular kidney. In support of this hypothesis it has been found that the clearances of inorganic phosphate and xylose agree fairly closely in frogs.

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## Further Observations on Specific Inhibition of Bacteriophage Action.

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Recently we described[1] specific inhibition of bacteriophage by bacterial extracts *(B. dysenteriae Shiga* and *B. paratyphosus B).* To test further the specificity of the inhibition, experiments were made with phages and extracts of organisms within the salmonella group, namely, *B. paratyphosus B* and *B. suipestifer.* Both phages were derived from chicken stool filtrates and were specific in their reactions on the 2 cultures.

The extracts were dissolved in saline with the aid of weak alkali and heat, neutralized, diluted with saline to make a 1-200 solution, and passed through Seitz filters. Suitable dilutions of the 2 phages in beef extract broth were prepared and mixed with equal quantities of the filtered bacillary extracts. Two tests were made with these mixtures; one after incubation overnight at 37°* and another following an additional interval of 12 hours at the same temperature. One-half cc. was removed from each one of the tubes, diluted with 4.5 cc. of beef extract broth and the homologous test organism was added.

[1] Levine, P., and Frisch, A. W., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 993.

* In other experiments it was demonstrated that the union of bacteriophage and bacterial extract progresses more rapidly at 37° than at icebox temperature.