otherwise morphologically intact for several days. We believe that the phagocytes degenerated rapidly when suspended in the media employed and became permeable to the surrounding medium, thus providing the intracellular bacteria with a favorable environment for growth.

It is suggested that the method outlined may be more useful generally in evaluating the effectiveness of phagocytosis against pathogenic bacteria than conventional techniques since, in our hands, the use of mechanical, immunological, osmotic, and electrical methods for releasing ingested *P. pestis* often indicated falsely that these bacteria had been killed by the phagocytes, as was the case with other workers using antibiotics to control extracellular organisms.

These data add further evidence that the ability of *P. pestis* to resist phagocytosis in the host is not important in determining its virulence since virulent, and even some avirulent strains, are able to survive within free phagocytes. We believe that a major determinant of the virulence of the plague bacillus may be its ability to multiply within the fixed macrophages of the host's reticuloendothelial system, and this possibility is under investigation.

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Direct Pathway to the Brain

Abstract. *Whole-body autoradiographic studies demonstrated that, when isotopically labeled glucose is placed in the ligated oropharynx, there is a rapid movement of the isotope directly to the intracranial cavity. This passage involves nonspecific diffusion, bypassing all recognized routes to the brain.*

It has been reported (*1*) that the introduction of isotopically labeled glucose and sodium chloride into the ligated oropharyngeal cavity of the rat produced a greater concentration of radioactivity in the brain than did direct gastric or intestinal administration of these substances. These results raise questions concerning the pathway for the movement of these compounds into the intracranial cavity. Whole-body autoradiography was utilized to investigate this phenomenon.

Twelve adult male rats (200 ± 20 g) were anesthetized with chloral hydrate (400 mg/kg intraperitoneally); ten of these rats were in the experimental group (group 1) and two were used as controls (group 2). In the experimental animals, the esophagus and trachea

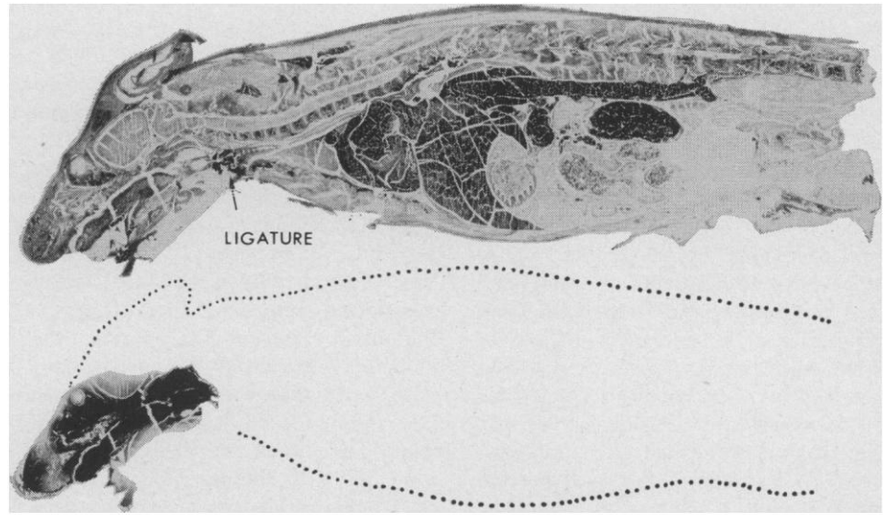

Fig. 1. The massive activity in the head region after labeled glucose was placed in the mouth. Above the autoradiograph is a photograph of the actual section from which it was made. There is no activity beyond the ligature, but it is present throughout the face region and is evident in the brain.

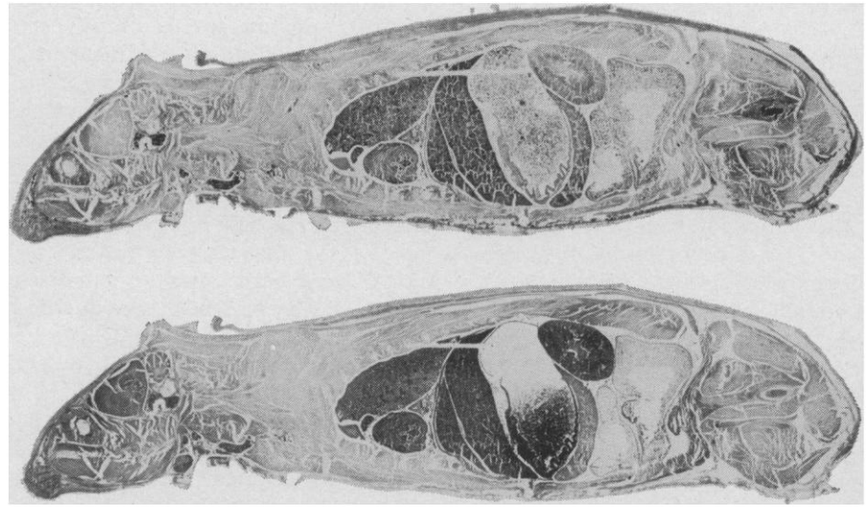

Fig. 2. Autoradiogram of a control animal after duodenal administration of the isotope. A photograph of the same tissue section is above it. The distribution of activity throughout the body is apparent.

were securely ligated proximal to the submaxillary gland. A longitudinal slit, placed in the trachea below the ligature, permitted the animal to breathe freely. The animals were then placed on their feet in an upright position—that is, normal stance with the head slightly raised—and held by means of a head-holder.

A solution of uniformly labeled ^{14}C-glucose (0.0173*M*, 0.2 ml containing 10 μc) was pipetted into the oropharynx of each of the ten rats of group 1. The solution was permitted to remain there 4 minutes; the mouth of the rat was subsequently thoroughly rinsed with distilled water over a 30-second period. Throughout this procedure the animal was held in its normal position, that is, with feet down. Immediately after the rinsing, a sample of blood was obtained from four of the animals by cardiac puncture. Each animal was then frozen by immersion in liquid nitrogen and kept at −9°C. In the two control animals, the ^{14}C-glucose was introduced directly into the first portion of the duodenum by means of a polyethylene tubing inserted by way of gastrostomy through the pylorus.

To ascertain whether the activity in the brain was restricted to the cerebral circulation or appeared in the parenchymal tissue, the brains of two animals in the experimental group were perfused. Four minutes after glucose was placed in the oropharynx, the animal's chest was opened and a sample of cardiac blood was obtained. A metal cannula was then introduced through the left ventricle and tied into the ascending aorta for perfusion. The right atrium was cut, a clamp was placed on the descending aorta, and perfusion of the head region with normal saline at 120 mm-Hg pressure was begun. The perfusion was continued for 2 minutes before the animal was frozen as described.

Autoradiograms of the whole body were prepared from the frozen animals by the tape-sectioning method of Ullberg (*2*), with modifications (*3*). All manipulations were carried out in a cold room at −9°C. At this temperature, smearing of tissue during sectioning did not occur. All sections were cut, beginning at the tail or at the head, with the long axis of the animal perpendicular to the knife. Kodak No-Screen x-ray film was used with exposure times of 7 to 15 weeks.

The massive radioactivity in the head region which was seen after placing labeled glucose into the mouth is shown in Fig. 1. The unstained tissue section from which the autoradiogram was made is shown above the autoradiogram. There is no activity beyond the ligature or any spread in the direction of sectioning. Activity is present throughout the face region and clearly evident in the intracranial cavity. Apparently the glucose or labeled fragments of it can pass directly from the mouth to the brain, bypassing the gut. The autoradiograms of head-perfused animals were indistinguishable from those prepared from animals which were not perfused (Fig. 1). This suggests that the radioactivity is within the tissue of the brain rather than its being a reflection of radioactivity in the blood in transit. In support of this contention, the radioactivity in the cardiac blood samples of the experimental animals of group 1 was not significantly above background.

An autoradiogram from a control rat (group 2) which had received the ^{14}C-glucose by duodenal administration is shown in Fig. 2. In contrast to Fig. 1, where radioactivity was limited to the head region, Fig. 2 illustrates the diffuse distribution of glucose or metabolites when carried by the circulation.

The whole body autoradiogram (Fig. 1) established that the radioactivity moved through all the tissue in the head region up into the intracranial cavity. Inspection of 12 to 60 serial sections from each animal failed to reveal a preferential pathway from the oropharyngeal cavity to the brain. There was no evidence for preferential distribution within the brain parenchyma itself, although those portions of the brain which are closest to the oropharynx generally exhibited greatest uptake of the isotope.

Approximately half of the animals receiving the labeled glucose orally provided autoradiograms similar to Fig. 1. The autoradiograms of the remaining animals showed less activity, including some in which no activity could be detected in the brain. This variability of our results may be related to technique, the character of the saliva, the physiological condition of the animal, or other factors.

In other radiotracer studies (*4*), sodium chloride and the insecticide phosphamidon were used with whole brain assay techniques (*1*). The results suggest that in both rats and blackbirds the isotope may reach the brain as we describe here. The chemical nature of the radioactivity which travels this more anatomically direct pathway from the oropharynx to the intracranial cavity is unknown.

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"Blow" of the Pilot Whale

Abstract. *A captive pilot whale emptied as much as 88 percent of lung gas passively, without the aid of expiratory muscles. Level or decreasing pressures in the esophagus during expiration, and in the blowhole at the onset of expiration, revealed the driving force of expiration to be solely elastic recoil. Active muscular reexpansion of the lungs ensued immediately. Expiration and inspiration were completed in about 1 second.*

Scholander has proposed that, as a special adaptation to the marine environment, whales may more completely deflate their lungs than terrestrial mammals do (*1*). Such is the case for porpoises (*2*). This mechanism would lessen frequency and duration of surfacing and would permit more effective exchange of respiratory gases during recovery after a dive.

A young adult female pilot whale *Globicephala scammoni* (3 m long, 450 kg) was kept in seawater pools of a marine mammal facility at Scripps Institution of Oceanography. The holding facility included a channel through which the animal could swim into an inside laboratory. The whale was trained to enter this channel on command, at which time the channel could be closed off by wooden gates from the adjacent pools.