numbers, it appeared advisable to make further experiments before finally accepting a conclusion of such general physiological importance.

Numerous experiments were made, in which large numbers of individual mealworms were subjected to various humidities at temperatures ranging from 8° to 37° C.[3] Analyses after intervals of from 14 to 35 days showed that the rate at which the reserves were utilized was governed by temperature alone. For example, batches of these insects consumed reserves equal to 19 per cent of their dry weight in 35 days, when exposed to humidities of either 0 or 60 per cent at 24° C. I also made daily estimations of the amount of carbon dioxide produced by mealworms at different temperatures and humidities, and found that the rate of respiration appeared to be governed by temperature alone, and unaffected by changing humidity.

Experiments with other insects, including bed-bugs[4], clothes-moths[5] and adult[6] and pupal[2] tsetse flies all show that with them the rate of metabolism is governed by temperature, and unaffected by changes in humidity.

In the light of present knowledge, it is difficult to see how an increase in the rate of metabolism *could* help an insect to withstand desiccating conditions. True, it would produce more water of metabolism, but this would mean an increase in the rate of respiration (to obtain the extra oxygen) and consequently the spiracles would be opened more frequently. This would allow more water to be evaporated[7]. For every molecule of metabolic water produced, at least one molecule of oxygen must be taken in, and under dry conditions more water is lost by the evaporation which accompanies respiration than is gained by metabolism. This has been shown by analyzing insects which have been subjected to low humidities, and by the fact that many insects are more susceptible to desiccation at high temperatures (where metabolism *is* actually increased) than at low temperatures.

With an actively moving insect, an unfavourably low humidity may perhaps cause great activity, and a consequent increase in the metabolic rate; but this will hinder, rather than help in withstanding desiccation. With resting insects such as fasting mealworms, a lowering of the humidity does not increase the rate of metabolism; if the metabolic rate were increased, it would not be of any advantage.

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[1] Buxton, P. A., *Proc. Roy. Soc.*, B, **106**, 560–577 (1930).
[2] Buxton, P. A. and Lewis, D. J., *Phil. Trans. Roy. Soc. Lond.*, B, **224**, 175–240 (1934).
[3] Mellanby, K., *Proc. Roy. Soc.*, B, **111**, 376–390 (1932).
[4] *Parasitology*, **27**, 111–22 (1935).
[5] *Ann. App. Biol.*, **21**, 476–482 (1934).
[6] *Bull. Ent. Res.* (in press) (1936).
[7] *Biol. Rev.*, **10**, 317–333 (1935).

## Organizers in Mammalian Development

EMBRYONIC organizers, discovered in the Amphibia by Spemann[1], have since been found also in birds (Waddington[2]) and fish (Luther, Oppenheimer[3]). It seems probable that embryonic determination is brought about in the same way in all groups of vertebrates, and rather similar conditions have been found in some invertebrates. Previous work on mammalian embryos has, however, produced very little definite evidence in support of this suggestion. The occurrence of identical twins shows that regulation is possible in very early stages (see Nicholas[4]), while several authors have described apparently mosaic development of parts isolated from early somite, or later, stages.

The only available fact concerning the actual process of determination in mammalian embryos is that the ectoderm of the rabbit embryo in the primitive streak stage can be induced, by a chick organizer, to form neural tissue (Waddington[5], working with the tissue culture technique[6]). Attempts to obtain inductions by transplanting pieces of the rabbit primitive streak into other rabbit embryos have so far been unsuccessful, although the grafts differentiate into neural tissue and (probably somitic) mesoderm; small amounts of neural tissue have been found in grafts which did not include the anterior end of the primitive streak, the rabbit behaving in this respect exactly as does the chick.

Grafts may also be made from the rabbit into the chick, and the grafted tissues differentiate (Waddington and Waterman[6]). Until recently, no inductions were observed in these grafts, but this long-expected result has now occurred; in a specimen, No. 36—9ORC, the anterior part of the embryonic axis of a two somite rabbit has induced a small but definite neural plate in the host chick. This shows that the rabbit contains an organization centre, and, taken with the fact mentioned above that the rabbit ectoderm is competent to react to a chick organizer, scarcely leaves room for doubt that the determination of the mammalian embryo during normal development is in fact produced by an organization centre.

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and Department of
Experimental Zoology,
Cambridge. June 30.

[1] H. Spemann, *Arch. Entw-mech.*, **43**, 448 (1918).
[2] C. H. Waddington, NATURE, **125**, 924 (1930); *Phil. Trans. Roy. Soc.*, B, **221**, 179 (1932).
[3] W. Luther, *Biol. CentralBl.*, **55**, 114 (1935). Oppenheimer, *Proc. Nat. Acad. Sci.*, **20**, 536 (1934); *Proc. Soc. Exp. Biol. and Med.*, **31**, 1123 (1934).
[4] J. S. Nicholas, *Anat. Rec.*, **55**, 31 (1933).
[5] C. H. Waddington, *J. Exp. Biol.*, **11**, 224 (1934).
[6] C. H. Waddington and A. J. Waterman, *J. Anat.*, **67**, 356 (1933).

## Metabolism of Cartilage

THE recent letter of Bywaters[1] on this subject prompts us to describe some observations made independently in the course of a study of normal mammalian tissues showing an anærobic type of metabolism. Following our investigation of the metabolism of the medulla of kidney[2], a tissue recognized as having a poor capillary supply, we were led to study cartilage because this is an entirely non-vascularized tissue, and here we found the same association of anærobic type of metabolism and poor oxygen supply as in medulla of kidney.

Our experiments were done with thinly sliced rib cartilage of the rat, suspended in a bicarbonate-saline medium. Concentration of glucose: 0·2 per cent.

| Material | Respiration | Ærobic glycolysis | Anærobic glycolysis |
|---|---|---|---|
| | $Q_{O_2}$ | $Q_G^O$ | $Q_G^N$ |
| Costal cartilage | | | |
| Specimen I | − 0·68 | + 1·22 | + 1·36 |
| Specimen II | − 0·22 | + 1·27 | + 1·85 |
| Xiphisternum | — | — | + 0·90 |

These figures are much higher than those obtained by Bywaters for the rabbit; in particular, the