

7

EXPERIMENT SEVEN

Rabbit Heart

The isolated perfused rabbit heart (Langendorff preparation) provides a way of studying drug effects on ventricular muscle.

Because of their thick walls, the ventricles in the rabbit heart must be perfused through the coronary circulation to maintain viability. Langendorff published his study 'Investigations on the surviving mammalian heart' in 1895. The Langendorff method enjoys considerable, and increasing, popularity among investigators examining the function and metabolism of the heart¹. The simple preparation described here can be set up in a few minutes. More elaborate instrumentation is possible (see below).

Dissection

Anaesthetise a rabbit with pentobarbitone. Open the chest wall widely, and then rapidly remove the heart, taking care to remove at least 10 mm of the aorta to allow a cannula to be inserted. Place the heart in a dish of physiological saline, and squeeze gently to remove blood from the chambers. If necessary, trim the aorta to a point just before its first branch. Attach the aorta to a cannula and perfuse at approximately 20 mL/min with physiological saline at 35–36 °C, from a reservoir about 1 m above the heart. A water jacket around the heart keeps it warm. Attach a small hook to the apex of the ventricles and connect this to the force transducer with a thread (usually around a small pulley to keep the transducer dry).

Plate 10 shows the rabbit heart with a cannula inserted into the aorta and tied with thread. This is fitted into the water jacket, with a small hook attached, as shown in Plate 11. Plate 12 shows the full Langendorff heart apparatus, with the thread from the hook attached to a force transducer.

Experiment

Chart Settings

This is a two-channel arrangement with a PowerLab, Bridge Amp, and force transducer (connected to Channel 1). In Chart, the range for Channel 1 (Force) should be chosen to suit the maximum force to be exerted on the transducer. The final scale after units conversion and so on should be –1 to 5 g wt. The sampling rate should be at least 100/s or 200/s (a moderately high rate is needed to record the heartbeat accurately). The view

compression should be 50:1 to 200:1. A low-pass filter of 10 or 20 Hz should be chosen in the Bridge Amplifier dialog box. Channel 2 should be set up to show the rate computed from Channel 1 using the Ratemeter function from its Computed Input dialog box (computed range 500 BPM, fastest tracking, average 1, set up to trigger correctly from the force trace).

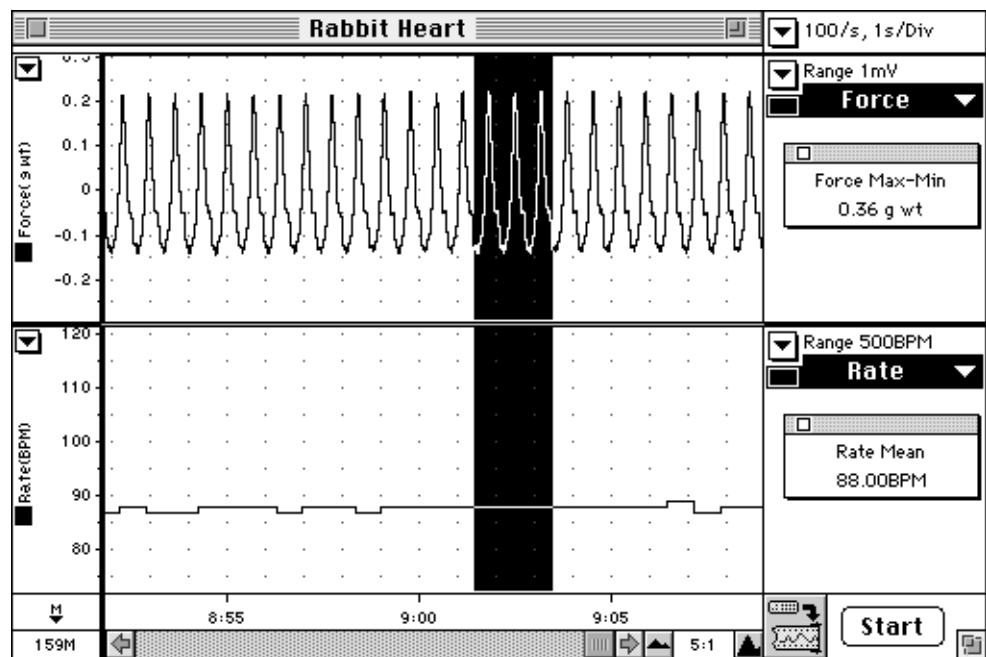
If desired, Channel 3 can be set up to display heart rate with the 'Cycle Variables' Chart extension, as described in Experiment 6.

Data Pad miniwindows can be set up to show the comment number and text, the beat amplitude (using the Max–Min function) for the Force channel, and the mean of the selection for the Rate channel.

Protocol

In the absence of drugs, a typical recording from the heart should resemble Figure 7–1. Channel 1 shows force and Channel 2 shows heart rate. The time axis has been expanded to 5:1 to show individual heartbeats.

Figure 7–1
Typical recording from isolated perfused rabbit heart.

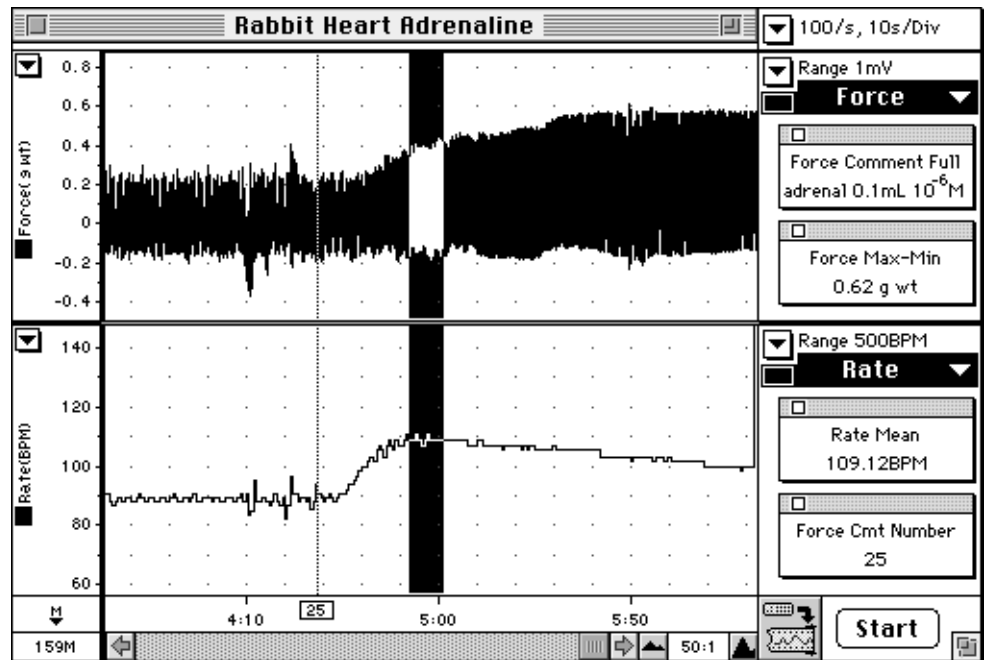


Responses to drugs are best obtained by injecting 0.05–0.2 mL of an appropriate concentration of the drug into a rubber section of the perfusate tubing. (Captopril is an ACE inhibitor.)

adrenaline	10^{-6} or 10^{-5} M
noradrenaline	10^{-5} M
isoprenaline	10^{-6} or 10^{-5} M
acetylcholine	10^{-5} or 10^{-4} M
captopril	0.1 mL of 10^{-6} M

Figure 7–2 shows changes in force and heart rate in isolated perfused rabbit heart, following injection of adrenaline into the coronary perfusate.

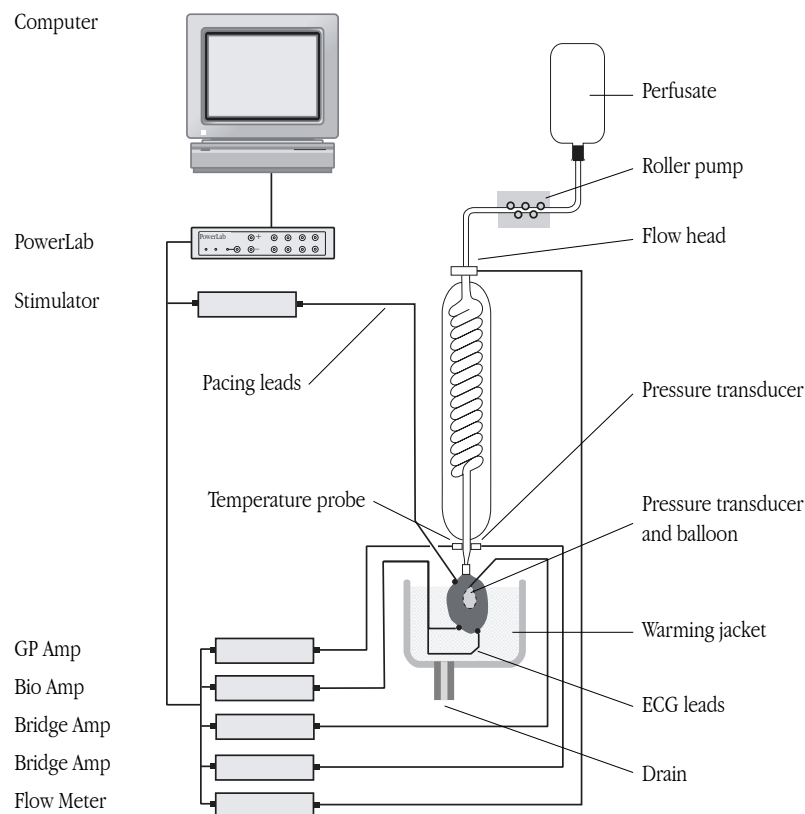
Figure 7–2
Recording from isolated perfused rabbit heart, following injection of 0.1 mL of 10^{-6} M adrenaline into the coronary perfusate.



Further Work

Modifications can be made to the simple preparation described above. For instance, a peristaltic pump may be used for constant-rate perfusion of the heart. Perfusion pressure from the pump may be measured as an indicator of coronary vessel dilation or constriction. A balloon catheter in the left ventricle can be used to measure pressure fluctuations, as an alternative to the simple hook and thread method. In addition, arrhythmias can be induced by perfusion with low-potassium solution. Sinus rhythm can often then be restored by phenytoin (0.1 mL of 10^{-4} M).

Figure 7–3
A schematic of a more elaborate arrangement for the Langendorff heart experiment.



Reference

1. H. Taegtmeier, One hundred years ago: Oscar Langendorff and the birth of cardiac metabolism, *Canadian Journal of Cardiology* 11(11): 1030–1035 (1995).

This historical paper describes the life of Langendorff and the importance of his work.

Plate 10.
Rabbit
heart
prepared
for
perfusion.

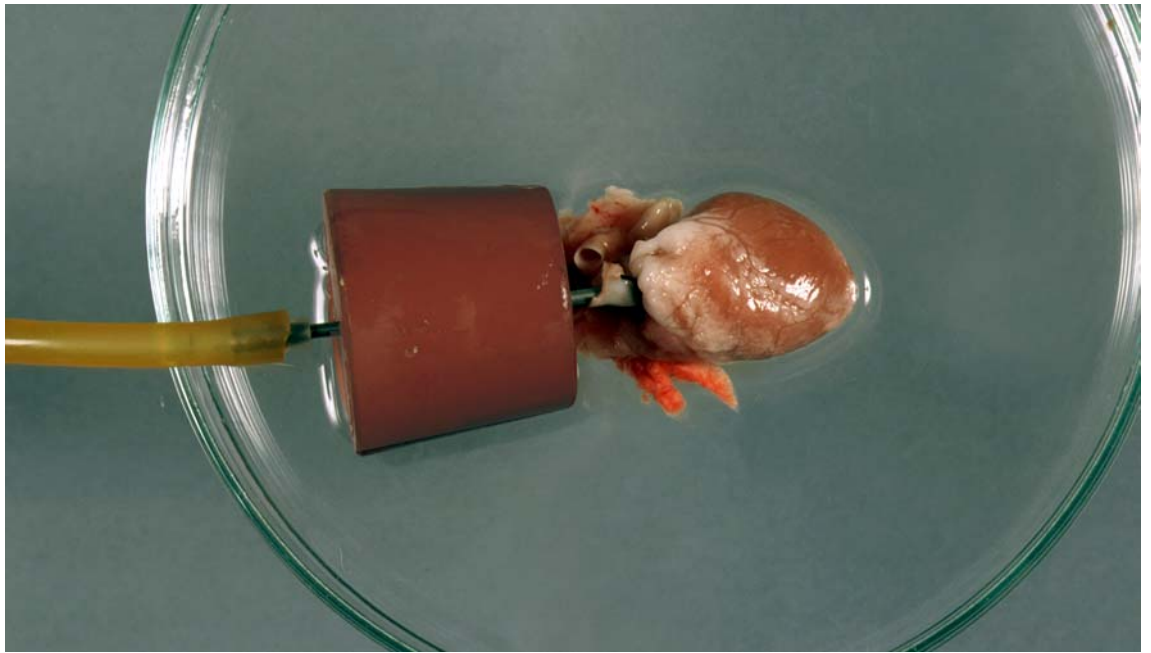


Plate 11. Rabbit heart in water jacket, with
hook attached to ventricles.

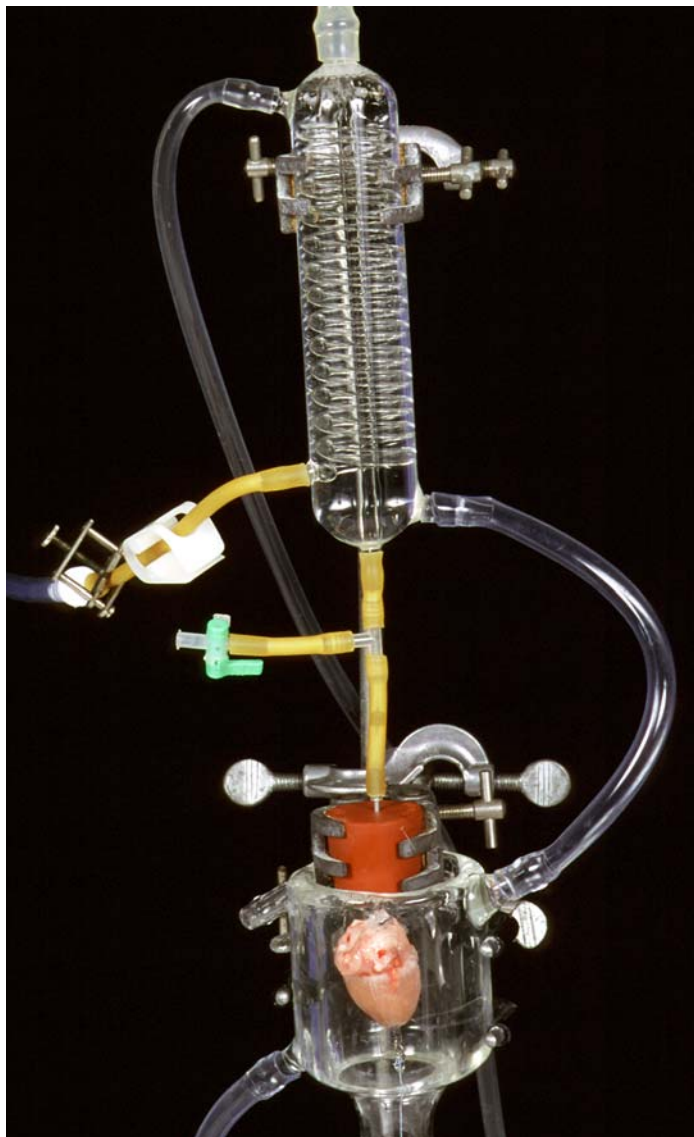


Plate 12. The full Langendorff heart
apparatus.

