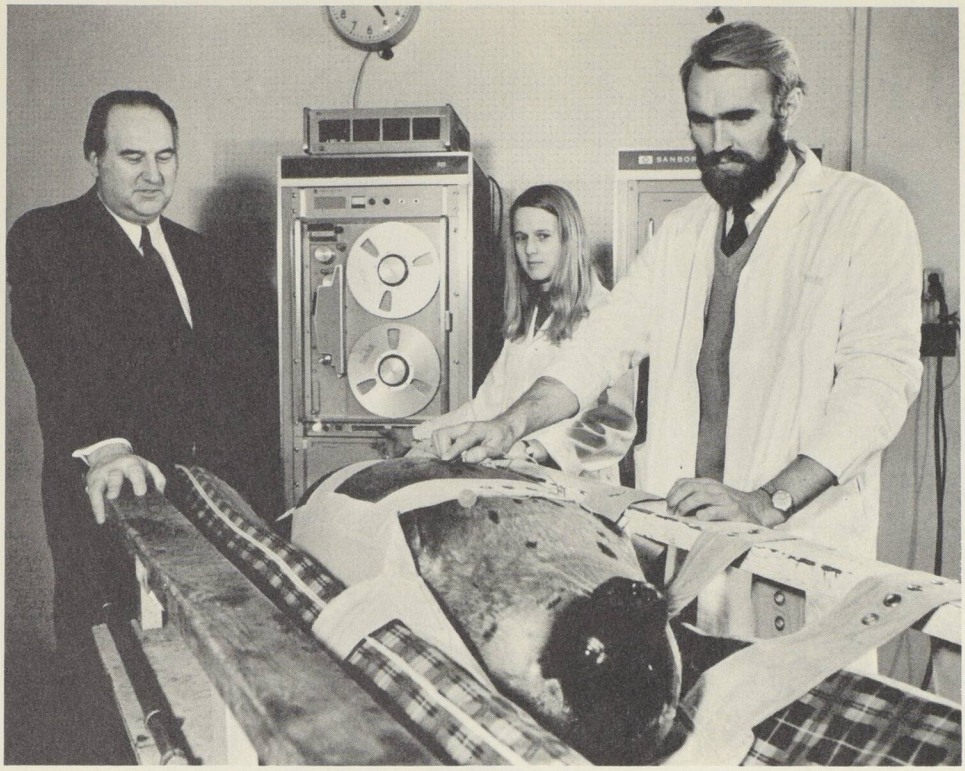

Dr. Keith Ronald (left) watches Mrs. Diane Vanderpol and Dr. Nils Oritsland, Post-doctorate Fellow from Norway, prepare a seal for an electrocardiogram.

Madame Diane Vanderpol et le Dr Nils Oritsland, boursier post-doctorat norvégien, préparent un phoque pour un électrocardiogramme, sous le regard du Dr Keith Ronald (à gauche).

harp seal

ing that perhaps seals can handle longer dives with age.

The circulatory system of the seal also is designed for deep dives and sustained swimming. During a dive the seal "shunts" blood away from most of the body and into the heart and brain. Sphincters squeeze the vessels shut. A huge blood vessel running along the inside of the spine acts as the main passageway of blood during a sustained dive. It ensures an adequate supply of oxygen to the brain. The animal also fills sinuses with blood when it dives, a phenomenon recently observed by X-ray techniques.

Seals in the laboratory turn on this diving mechanism, a "playing possum" type reaction, when startled. If one of the scientists, while taking a blood sample, misses a vein in the flipper, the animal immediately diverts the blood flow from the flipper. For several hours, attempts at drawing blood are futile.

The seal has control over its heart rate, changing from ten beats a minute to over 180 (or vice versa) in a split second. During a dive, an adult seal slows its heart from about 80 to eight beats per minute. Bradycardia, the slowing of the heart, fascinates many because humans do not usually exert such control. If this mechanism could be controlled in man, it would be invaluable for heart surgery and anaesthesiology.

Even with the specially adapted circulatory system, the seal cannot store enough oxygen to last through a 30-minute dive. Muscle structure also attributes to diving ability. The muscles differ from human muscles in containing more myoglobin, a red pigment which, like haemoglobin, stores oxygen. Having a higher affinity for oxygen than haemoglobin, the myoglobin draws the oxygen out of the blood as it circulates through the muscle. After several minutes, however, the blood no longer has enough oxygen to sustain muscular movement.

Energy production then proceeds without oxygen, through the process of glycolysis — the anaerobic utilization of glycogen (a carbohydrate stored in the muscles and liver). The usual process of energy production breaks proteins and carbohydrates into carbon dioxide and water; glycolysis produces lactic acid, which is released to the blood. Eventually, this lactic acid finds its way to the liver where (after the dive) it is converted back to glycogen and again stored in the muscles. The tremendous stores of fat (blubber) may be used as an energy source, but they serve primarily as insulation from the icy northern waters.

"We don't know the extent of glycolysis and oxygen utilization during a dive," says Dr. Ronald. "Does glycolysis start when the oxygen is completely depleted? Do they occur simultaneously? How long can the seal produce energy by glycolysis? How much lactic acid can the seal tolerate in its blood?

A series of experiments soon to start at the University of Guelph will determine the brain's utilization of oxygen during a dive. By sampling the blood entering and leaving the brain during the dive, and measuring its oxygen content, scientists will determine how much oxygen is used.

Lactic acid accumulation in the cerebral spinal fluid may indicate the occurrence of glycolysis in the brain. The metabolite, lactic acid, may diffuse into the spinal fluid to prevent a change in pH (acidity) in the brain (which would disrupt the delicate metabolic equilibrium). Other mechanisms of supplying oxygen to the blood may include an increase flow rate or a hyperventilation of venous blood — a process which would enable the blood to store more oxygen per unit volume.

Sensory experiments, designed to determine the seal's sensitivity to sound and light, are also in progress at the university. An anechoic (without echo) water tank dominates one laboratory. This unusual tank, lined with