UNIVERSITY OF ILORIN

THE TWO HUNDRED AND SIXTY-NINETH (269TH)
INAUGURAL LECTURE

"THE MATTER OF THE HEART ON THE SURVIVAL OF ANIMAL AND MAN"

By

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DEPARTMENT OF VETERINARY PHYSIOLOGY AND BIOCHEMISTRY,
FACULTY OF VETERINARY MEDICINE,
UNIVERSITY OF ILORIN, NIGERIA

THURSDAY, 21ST NOVEMBER, 2024

This 269th Inaugural Lecture was delivered under the Chairmanship of:

The Vice Chancellor

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My Lord Spiritual and Temporal,
Gentlemen of the Print and Electronic Media,
Esteemed Invited Guests, Friends and Relations,
Distinguished Students of the Faculty Veterinary Medicine,
Great Students of the University of Ilorin,
Distinguished Ladies and Gentlemen

Preamble

The Vice Chancellor sir, I seek refuge in Allah against the devil and I begin this inaugural lecture in the name of Allah, the most Beneficent, and the most Merciful. Allah is the first without any Reference point of starting and He will be the last without any point of termination to His existence. The Creator of all Creatures, the Fountain of wisdom and the Lord of the Universe. With gratitude to the Almighty Allah, I stand before this distinguished audience to deliver the 269thinaugural lecture of the University of Ilorin, today, the 21st November, 2024.

The first Inaugural Lecture in the Faculty of Veterinary Medicine since its inception was delivered by Professor

Suleiman Folorunso Ambali on 6th February, 2020. The title of the Lecture was 'Preventing Pesticides from Poisoning away our Health and Future- The Oxidative Approach'. To God be the glory, my inaugural lecture is the 2nd in the Faculty.

Today, I have the honour of delivering the 269th inaugural lecture. The 1st from the Department of Veterinary Physiology and Biochemistry, University of Ilorin. I am also privileged to be the first female Physiologist across both human and Veterinary Physiology units; and the first woman from the Faculty of Veterinary Medicine to present an inaugural lecture in this University. The title of which is 'The Matter of the Heart on the Survival of Animal and Man' I am greatly indebted to the Vice Chancellor, Prof Wahab Olasupo Egbewole and the University Administration for giving me this opportunity.

My Journey to Veterinary Medicine

My primary school education was protracted because of movement from one town to another when I was living with my senior brother who was a military man. During my secondary education (at Yejide Girls' Grammar School, Ibadan) my teachers liked me. In fact, I was always a favourite of almost all the teachers. We had many very good expatriates as teachers (Indians, Ghanaians, Canadians and so on) who were very committed and made learning easy for us. I was one of the best in my class and was finally appointed as the day students' head girl in my final year. When I was in form five, one of the Vice-Principals of the school (Mr. Bankole commonly called 'Baba Banky') called me and two other girls and said 'Miss. Atanda, I will collect Jamb form for you and I will like you to do Veterinary Medicine.' He faced the other two girls and said 'you will do Law and you will do Human Medicine.' Noticing the confusion on my face, he said 'I know you are unfamiliar with Veterinary Medicine. 'It is the study of how to treat and care for animals.' 'It is not yet popular in Nigeria but Veterinary Doctors abroad are very rich'. Lo and behold, the courses he chose for us were what the three of us studied and are living on to date. He

took the JAMB form for three of us at N10.00 (ten Naira each). We did the examination and the three of us passed. Aliamdulillahi robilialamin. I completed Veterinary Medicine as a degree at University of Ibadan, and became a Veterinary Surgeon in 1985, which is 39 years ago and here I am. After 12 years in private practice, I transitioned to the academia. Now by the grace of Almighty Allah I stand before you as a Professor of Physiology and Dean of the Faculty.

How did I become a Physiologist?

I decided to fold up my flourishing private veterinary practice and join academia to enable me to have enough time to take care of my children when I realised that I needed more time to be with them. I started my academic career at Ladoke Akintola University of Technology, Ogbomoso with the assistance of the late Professor M. A. Salau of blessed memory, who was then the Vice Chancellor. I was directed to him by his uncle in Ibadan. When I got there, he told me his university just established the MB;BS program me and he needed staff in the Department of Physiology to scale the hurdle of the forthcoming accreditation. He asked me if I could teach Physiology, and I answered in the affirmative. That marked the commencement of my journey as a physiology teacher, a course that I so much loved as it is the heartbeat of the medical sciences. I accepted to teach Physiology and I have since then loved Physiology as a course. I have taught almost all the systems in Physiology and mentored many individuals, both medical and veterinary doctors, as well as other paramedical graduates. I did my Masters and Ph.D. in the Physiology Department, University of Lagos. My Ph.D. supervisor (late Professor C. N. Anigbogu) was a Cardiovascular Physiologist and that was how I became a Cardiovascular Physiologist.

Notion of Physiology

Physiology is simply the study of normal functions of the body in a normal environment. It is the science of life. It is the branch of biology that aims to understand the mechanisms of

living things, from the basis of cell functions at the ionic and molecular level to the integrated behaviour of the whole body and the influence of the external environment. Research in physiology helps us to understand how the body works in health and how it responds and adapts to the challenges of everyday life. It also helps us to determine what goes wrong in disease, facilitating the development of new treatments and guidelines for maintaining human and animal health. The emphasis on integrating molecular, cellular, systems and whole-body functions is what distinguishes physiology from the other life sciences.

Physiology of the Heart

The heart is the muscle (like a fist) that pumps blood to all parts of the body. The blood pumped by the heart provides the body with oxygen and the nutrients it needs to function. The heart is enclosed in a sac called pericardium, which contains a thin serous fluid that acts as a lubricant for the mechanical activities of the heart. The heart has three layers: an outer layer, the epicardium, the middle layer, the myocardium and the inner layer, the endocardium. There are variations in the shape and number of chambers in the heart in many animals.

Mammals (including man) and birds have a four-chambered heart (Figure 1) that completely separates the oxygenated from the deoxygenated blood. It pumps only oxygenated blood through the systemic circulation while the deoxygenated blood is pumped to the lungs. Reptiles have three-chambered hearts (two atria and one ventricle; figure 2), but in crocodilians the ventricles are partially separated so some mixing of oxygenated and deoxygenated blood occurs. The Fish have a two-chambered heart, one atrium and one ventricle: (figure 3) blood flows uni-directionally from the heart through the gills and then to the rest of the body.

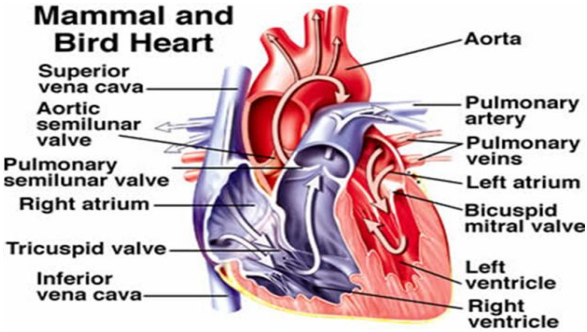

Figure 1: Mammals and Birds heart (**Azeez** *et al.*, 2023, fundamentals of Veterinary Medicine text)

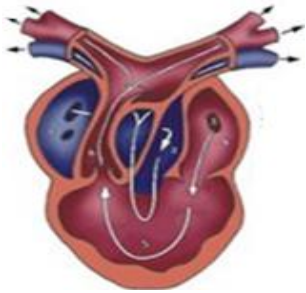

Figure 2: Reptiles Heart **(Azeez** *et al.*, 2023, fundamentals of Veterinary Medicine text)

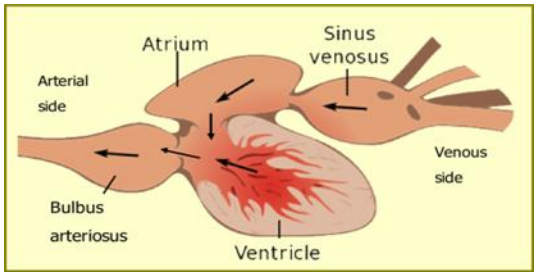

Figure 3: Fish Heart **(Azeez** *et al.*, 2023, fundamentals of Veterinary Medicine text)

Valves in the Heart

There are valves in the heart that regulate the flow of blood within the chambers of the heart and between the chambers and major blood vessels. The tricuspid valve is present between the right atrium and the right ventricle while the bicuspid or mitral valve is present between the left atrium and the left ventricle. Semilunar valves regulate the flow of blood between the ventricles and the major blood vessels. The aortic valve is between the left ventricle and the aorta, while the pulmonary valve is present between the right ventricle and the pulmonary artery. The function is to regulate the flow of blood in one direction only. Backward flow is prevented when the valves are closed.

Types of Blood vessels

The two major types of blood vessels are the arteries and the veins. The arteries composed of the Aorta, large arteries, small arteries and arterioles and capillaries. The veins consist of the venules, small veins and large veins (inferior and superior vena cava).

The aorta is called the Windkessel vessel, as it contains elastic tissue in its wall and hence, it recoils when stretched. The elastic recoiling of the aorta is called the Windkessel effect. The large arteries, small arteries and the arterioles are called resistance vessels, they contain thick smooth muscle supplied by sympathetic noradrenergic fibres and offer peripheral resistance as they narrow down to smaller arterioles hence are called resistance vessels. Resistance vessels end in capillaries. The capillaries are situated between arterial and venous systems. Capillaries are called exchange vessels, as the exchange of respiratory gases, nutrients, metabolic wastes, etc., takes place between capillaries and tissues. The capillaries open into venules, which in turn end in veins. The venous blood from veins, opens into large veins and then into vena cavae. The vena cavae opens into the right atrium. The venous system holds large amounts of blood, up to 55 - 60% of blood volume and are called capacitance vessels.

Composition of the Heart:

The heart predominantly consists of (a) Myocardial or contractile cell- cardiomyocites, which are involved in the mechanical activities of the heart (b) The electrical or conducting cells are involved in the electrical activities of the heart which send signals to the heart muscle to contract. They include Sino-atria node (SA node), Atrio-ventricular node (AV node), Bundle of His, Right & left Bundle branches, and the Right & left Purkinje fibers. The rhythmic contractions of the atria and ventricles are regulated by the transmission of electrical impulses that pass through the cardiac conduction system interposed within the contractile myocardium.

The sinoatrial (SA) node is a collection of specialised cells (pacemaker cells), located in the upper wall of the right atrium, where the superior vena cava enters (Figure 4). These pacemaker cells can spontaneously generate electrical impulses. The wave of excitation created by the SA node spreads via gap junctions across both atria, resulting in atrial contraction (atrial systole) – with blood moving from the atria into the ventricles. The AV node is located within the atrioventricular septum. After the electrical impulses spread across the atria, they converge at the atrioventricular node. The AV node acts to delay the impulses by approximately 120ms, to ensure the atria have enough time to fully eject blood into the ventricles before ventricular systole. The wave of excitation then passes from the AV node into the Bundle of His. The Bundle of His shortly divides to right and left bundle branches; which transmits the electrical impulse to the right and left Purkinje fibres of the ventricles, respectively. Purkinje fibres are sub-endocardial plexus of conduction cells that rapidly transmits cardiac action potentials from the bundle branches to the myocardium of the ventricles. This rapid conduction allows coordinated ventricular contraction (ventricular systole) and blood is moved from the right and left ventricles to the pulmonary artery and aorta respectively. Purkinje is the fastest conducting cell out of the four special cells.

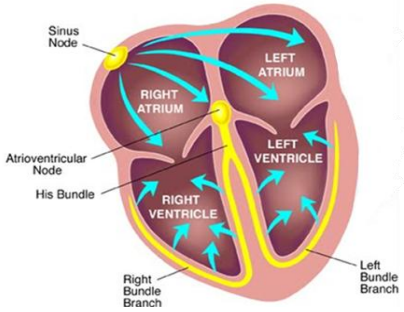

Figure 4: The Heart with Electrical Conducting Cells (**Azeez** *et al.*, 2023, fundamentals of Veterinary Medicine text)

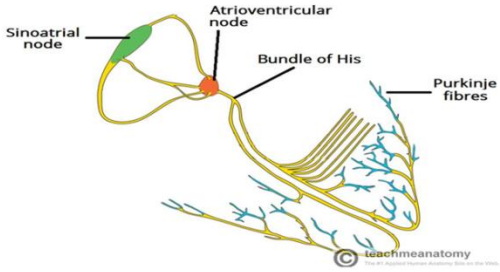

Figure 5: The Electrical Conducting Cells of the Heart **(Azeez** *et al.*, 2023, fundamentals of Veterinary Medicine text)

Physiological Properties of the Heart

1. Spontaneous Rhythm

This is inherent,(Figure6) by which the heart initiates its own beating without the influence of external sources. The ability to do this is due to cells of the conducting system which have an unstable membrane potential that results in spontaneous depolarisation. This occurs in the SA node, AV node, the bundle of His and Purkinje fibres. Pacemaker potentials are partly due to fast inward sodium current (I) and mostly due to inward calcium currents which are also responsible for the upstroke.

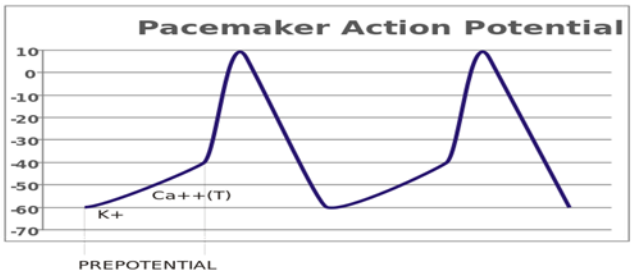

Figure 6: The Pacemaker Action Potential (Download for free at http://cnx.org/contents/14fb4ad7-39a1-4eee-ab6e)

2. Prolonged Repolarisation

The action potential in the myocardial or contractile cells lasts about 250 milliseconds (0.25s.), (Figure 7) compared with about 2ms in skeletal muscle. This is because the repolarization phase of the potential is prolonged in cardiac muscle. The prolongation of the action potential is due to a "slow inward calcium current" which allows Ca^{2}+ ions to move inside the cell, causing the plateau, and thus resulting in "persistent depolarization" (i.e. positive membrane potential). The nature of the heart muscle is explained here. It contracts and relaxes continuously throughout one's life and this prolonged repolarization is designed to prevent fatigue in the heart muscle.

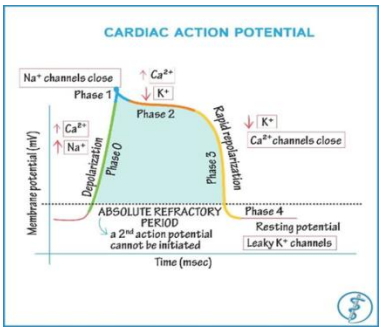

Fig 7: Action potential from ventricular myocardium

0 = Depolarization
1 = Initial rapid repolarization
2 = Plateau
3 = Late rapid repolarization
4 = Return of resting membrane potential

Figure 7: Action potential from ventricular myocardium (Download for free at http://cnx.org/contents/14fb4ad7-39a1-4eee-ab6e)

The Circulatory System

The circulatory system consists of the cardiovascular and lymphatic systems. There are two types of circulatory systems in animals: the opened and the closed. In an open circulatory system, blood is transported into a cavity. The blood bathes the organs directly, supplying oxygen and removing waste from the organs. It flows at a very slow speed due to the absence of smooth muscles, which, as we earlier stated are responsible for the contraction of blood vessels. Examples of open circulatory system are found in the invertebrates (crabs, insects, snails, etc.)

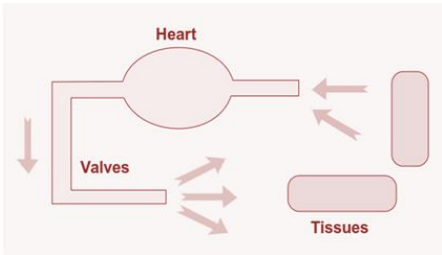

Figure 8: Open Circulatory System (organisimal Biology, Georgia Tech)

In the Closed circulatory system: Blood is transported by the vessels from the heart in a single direction (Figure 9), delivering oxygen and nutrients to cells and removing waste products. The closed circulatory system can be single as seen in fish or double as seen in mammals and birds.

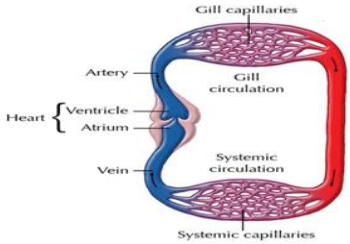

Figure 9: Single Closed Circulatory System as seen in Fish (organisimal Biology, Georgia Tech)

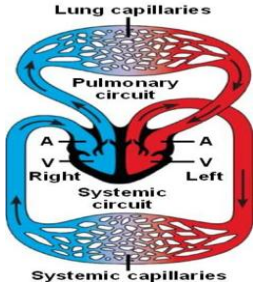

Figure 10: Double Closed Circulatory System as seen in Mammals and Birds (organisimal Biology, Georgia Tech)

Organisation of the Cardiovascular System in Mammals and Birds

The cardiovascular system consists of the heart (as a pump) and the blood vessels. These are arranged in two pump series which maintain a continuous flow of blood around the body. The two pumps are (a) the left ventricle, providing blood flow to the systemic circulation and (b) the right ventricle, providing flow to the pulmonary circulation. The output of the left ventricle is the same as that of the right ventricle called cardiac output. Cardiac output (CO) is the volume of blood pumped by the heart per minute. Stroke volume is the volume of blood pumped per beat. CO varies in different animals. The four determinants of CO are: heart rate, contractility, preload and the after-load.

Functions of the Cardiovascular System

The cardiovascular system has three general functions:

1. **Transportation** (e.g., O2, CO2, nutrients, wastes, hormones). It transports oxygen (O2) to the tissues, carbon dioxide (CO2) out of the tissues, nutrients around the body, hormones to the target organs and the waste products out of the body through designated organs.
2. **Regulation**: it regulates the pH, temperature and osmotic pressures within specific range tolerated by the body of different animals and in conjunction with the environmental conditions.

3. **Protection:** it contains cellular elements that protect against foreign molecules and diseases, immunity as well as clotting to prevent excessive loss of blood.

Electrocardiogram (ECG)

ECG is the recording of the electrical activity of the heart, conducted to the surface of the body (ions in body fluid convert the body into a volume conductor) When electrodes are placed at appropriate positions on the body electrocardiogram is recorded. A normal recording of an ECG wave shows P, QRS, and T waves sometimes a U wave is also recorded. ECG is measured by placing electrodes directly on the skin and reading the potential difference between them.

1. The bipolar limb leads, records the potential difference between the two limbs. Accordingly, there are three types of leads present. These are:
   Lead I (between right arm and left arm)
   Lead II (between right arm and left leg)
   Lead III (between left arm and left leg).

In the bipolar limb leads, if we know the potentials in two leads the third lead can be determined. According to Einthoven's law (A Dutch Physiologist), the sum of the potential in lead I and III will be equal to the potential in lead II. Thus: Lead I + Lead III = Lead II.

2. Unipolar augmented limb leads
   In this method, there are three leads- aVR, aVL and aVF which when connected the three limb leads pass through 5000 ohms resistance to get 0 potential (Wilson's terminal).

It should be noted that an electrode is a conductive pad that is attached to the skin and enables the recording of current. An ECG lead is a graphical description of the electrical activities of the heart and it is created by analysing several electrodes.

Veterinary Electrocardiography had its beginnings with Studies in the Horse

The first normal equine electrocardiogram published (1910) was a record, that von Tschermak obtained from Einthoven. This decade was followed by a 20-year period of ever-increasing publications on applied electrocardiographs in veterinary medicine. toxicological studies, and records from non-domesticated mammals.

There are lots of variations in ECG of different species of animals. Classification can follow 3 general characteristics:

1. Relative duration of QT interval and ST segment
2. QRS-vector direction and sense
3. Constancy of T-wave polarity (T-wave lability)

Many species (rodents, insectivores, bats, and kangaroos) have short QT intervals, NO 'ST' segment.

The QRST complex consists of rapid QRS deflections that merge with the slower T wave and its duration is about half that of mechanical systole. The transmembrane action potentials of these species do not have a distinct plateau.

MY CONTRIBUTIONS TO KNOWLEDGE

Method of carrying out ECG in Man and various Animals

Vice Chancellor sir, resting ECG is often measured within one minute while the heart rate variability (HRV) is often measured for 30 minutes. Man will be made to lie down; the electrodes will be placed accordingly and the reading will be taken. Digital electrocardiographic equipment are available that makes the reading easy unlike in the past. Digital Electrocardiographic machines are now available in various forms carrying five electrodes. Two will be attached to the right and left legs respectively, two will be attached to the right and left arms respectively while the fifth will be placed on the heart area.

Large animals like the horse, sheep, goat will be made to stand on a non-conducting surface, allowed to rest for few minutes before the electrodes are clipped and measurements taken. The electrodes must be carefully attached so that it will

not inflict pain on the animal. The animal may attack if it feels insulted. Once the animal is carefully handled, they don't just attack. Each of the electrodes will be connected to the corresponding area after gel has been applied. If the animal is very hairy, there may be need to shave to allow direct contact with the skin. Rodents like the rats will be given anaesthesia while other animals can be restrained to the convenience of the recorder and the animal. Recording must be done on a non-conducting surface. ECG will be measured in birds while in recumbent positions. Electrocardiography is an essential tool in making diagnoses when conditions with cardiovascular symptoms are presented for treatment. (Figure 11).

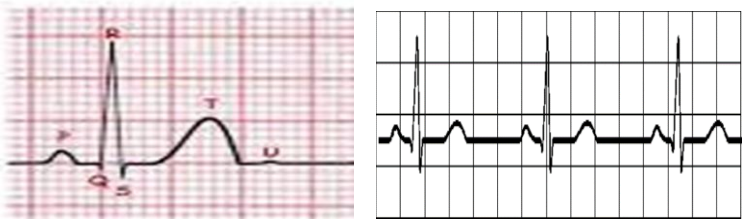

Figure 11: QRS complex and RR interval (Research gate)

R waves i.e. the RR interval in large squares
Rate = 300/RR e.g. RR = 4 large squares
300/4 = 75 beats per minute

The P wave represents Atrial depolarisation

Height: When a P wave is taller than 2.5mm can be called P pulmonale. It occurs due to Right atrial hypertrophy. Causes may include: pulmonary hypertension, Pulmonary stenosis, Tricuspid stenosis.

Length: A P wave with a length >0.08 seconds (2 small squares) and a bifid shape is called P mitrale It is caused by left atrial hypertrophy and delayed left atrial depolarization. Causes include: Mitral valve disease or Left Ventricular Hypertrophy (LVH).

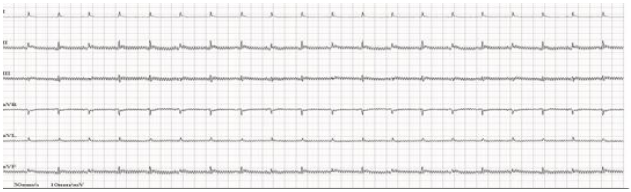

Figure: 12 Atrial fibrillations with irregularly irregular rhythm and a wavy baseline (**Azeez** *et al.,* 2017)

The atrial fibrillation (AF) (Figure 12) is as a result of exposure to petroleum products. Features of AF may include tachycardia. The rhythm is usually irregularly irregular. No P waves are discernible – instead there is a shaky baseline. This is because there is no order to atrial depolarisation, different areas of atrium depolarise at will.

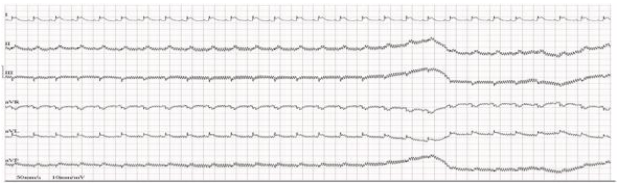

Figure 13: Ventricular fibrillation as seen in Akorede...**Azeez** *et al.,* (2022)

Ventricular fibrillation (Figure 13) is a life-threatening heart condition that causes the heart's ventricles to malfunction, resulting in an irregular heartbeat and low cardiac output. The most common symptom of V-fib is sudden collapse and loss of consciousness; that may include chest pain.

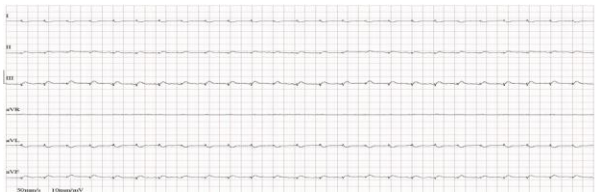

Figure 14: Bundle branch block in rats exposed to diesel (**Azeez** *et al.,* 2014)

This is a result of ischemia in the rats. Impulse is unable to spread to ventricular myocardium, The 'T' wave is taller than half of QRS and indication of myocardial infarction as (Figure 14, 15 & 16) (Kolawole.., **Azeez** *et al.*, 2021).

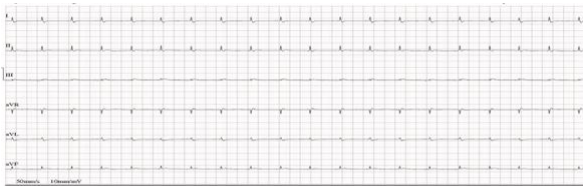

Figure 15: Bundle branch block as STZ induced diabetic rats (Olatunji…**Azeez** *et al.,* 2022)

It suggests a ventricular conduction problem

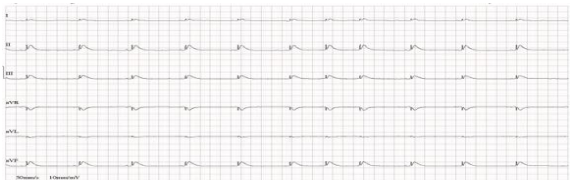

Figure 16: ***Myocardial infarction (Kolawole et al...Azeezet*** *al*., 2021)

Myocardial infarction (MI) with 'T' waive taller than half or more of the size of the preceding QRS. This was seen in Isoproterenol induced myocardial infarction. There may be Hyperkalaemia

Vice Chancellor sir, I worked on how petroleum products affect man and animals through all routes of contact (**Azeez,** 2014). Ingestion by eating it in food, drinking in water, inhalation (the most common) and contact with the skin. In the study, emissions from diesel vehicles are more harmful than those from petrol vehicles (Vidal, 2013). Diesel combustion exhaust (Figure 17) is a source of atmospheric soot and fine particles, which is a component of air pollution implicated in human cancer, heart and lung damage (Nawrot *et al.*, 2011) as well as mental functioning, (Power *et al.*, 2011) Moreover, diesel exhaust contains contaminants listed as carcinogenic for humans

by the international agency for Research on cancer (IARC) (part of the World Health Organization of the United Nations), as present in their List of IARC Group 1 carcinogens. In 2014, diesel exhaust pollution accounted for around one quarter of the pollution in the air and a high share of sickness caused by automotive pollution

Figure 17: Heavy truck, with visible particulate soot. International Agency for Research on Cancer (IARC) Retrieved August 14, 2016

Mr. Vice Chancellor, the recreational use of inhaling hydrocarbons and other volatile solvents for the purposes of creating a euphoric state is becoming increasingly common. Methods used for this abuse, include "sniffing" (directly inhaling vapours), "huffing" (placing a hydrocarbon-saturated rag over the mouth and nose and then inhaling), or "bagging" (inhaling via a plastic bag filled with hydrocarbon vapours) (Barnes, 1985) (Figure 18). Petrol sniffing is a major problem that destroys health and families. The practice was first observed in 1951, and is believed to have been introduced by US servicemen stationed in the nation's top end during World War II (MacLean, 2007).

Figure 18: Young boys sniffing petrol for recreational purposes. (National Film and Sound Archives, 2000)

Figure 19: Exhaust from a Diesel-operated Car snapped during my Ph.D. Research (2013)

Diesel exhaust has been found to contain many toxic air contaminants. Diesel engine emits a complex mixture of air pollutants, composed of gaseous and solid material. The visible emissions in diesel exhaust are known as Diesel Particulate Matter (DPM) which includes carbon particles or "soot". Diesel exhaust also contains a variety of harmful gases and over 40 other known cancer-causing substances. It is a carcinogen that causes lung cancer and it is associated with bladder cancer. Exposure to diesel exhaust and Diesel Particulate Matter (DPM) is a known occupational hazard to truckers, railroad workers and miners, using diesel-powered equipment in underground mines. Adverse health effects have also been observed in the general population at ambient atmospheric particle concentrations. This translates to a loss of about 14 years of life for people who die from disease associated with DPM exposure (USEPA, 2009). Exposure has been linked with acute short term symptoms such as headaches, dizziness, light headedness, nausea, coughing, difficult or laboured breathing, tightness of the chest and irritation of the eyes, nose and throat. Long term exposure can lead to chronic, health problems such as cardiovascular disease, cardiopulmonary disease and lung cancer. Ambient traffic-related air pollution was associated with decreased cognitive function in older men (Coble, 2010; Stewart, 2010 and WHO, 2012).

Vice Chancellor sir, Petroleum products are useful chemical compounds which form an integral part of our modern technology. They have been reported to cause deleterious effects on health following their inhalation. **Azeez,** *et al*., (2012a) in our

paper titled, ‘‘Variability in Cardiovascular Functions and Baroreflex Sensitivity following Inhalation of Petroleum Hydrocarbons’’; we worked on the isolation and chemical characterisation of various petroleum products, and also investigated in rat model of Sprague Dawley strain, the variability in cardiovascular functions and possible mechanism following inhalation of petroleum products. Exposure to petrol, diesel, and kerosene vapours was done using modified nose-inhalation exposure method Figure 20), used as previously described. The animals were exposed for five minutes daily. At the end of the exposure, the animals were transferred to a petroleum-free section of the animal house. The initial and final volumes of petroleum products in the beaker before and after exposure were respectively recorded. The differences in volume per day were used as the estimated relative concentrations of the vapours used.

Plate 4: Inhalation chamber

Figure 20: Improvised nose-inhalation chamber

When compared with the controls, all exposed groups showed a significant ($P<0.05$) increase in systolic, diastolic, mean arterial blood pressure (MAP), and heart rate (HR). In comparison with the control, exposure to petroleum products also led to significant ($P<0.05$) increase in baroreflex sensitivity in the diesel- and kerosene-exposed rats. Baroreflex sensitivity was comparable in the control and petrol-exposed rats ($P>0.05$). Body weight gain was significantly ($P<0.05$) reduced in petroleum products exposed rats. The results from the study demonstrated that petroleum hydrocarbons impaired body weight gain in experimental animals exposed to various petroleum products (Figure 21). This finding

agrees with previous studies which showed that petroleum solvents dissolve fat and lipids in the body with resultant degeneration of fat stored in the body. It is also in agreement with the results of Uboh *et al.*, 2009; which showed that petrol vapours induced growth suppression and weight loss.

Baroreflex response was significantly ($p<0.05$) increased in diesel and kerosene groups compared with control. However, the increase in the petrol was only significant for a while and returned to the control level by 25 seconds. This suggests that with exposure to petrol the baroreceptors still reset the blood pressure to a new higher than normal value as though normal. The activities of baroreceptors have been altered by diesel and kerosene such that they can no longer reset the arterial blood pressure (Figure 22) . Exposure to diesel was most deleterious in all except in the inhalation group (**Azeez** *et al.*, 2014).

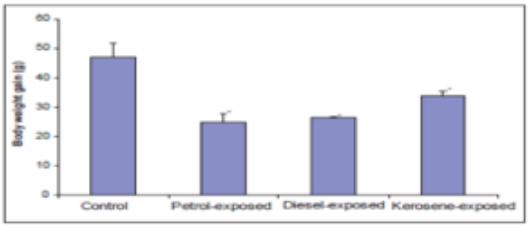

Figure 21: Effects of Petroleum Products on Body Weight Gain **(*Azeez* *et al.*,** 2012)

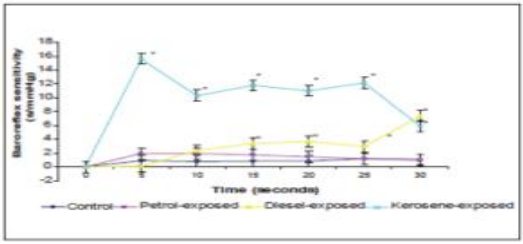

Figure 22: variation in baroreflex sensitivity **(Azeez** *et al.*, 2012)

Mr. Vice Chancellor, **Azeez,** *et al.*, (2012b) carried out a study on Exposure to petroleum hydrocarbon: Implications in lung lipid peroxidation and antioxidant defense system in rats. Exposure to petroleum hydrocarbons significantly induced lipid peroxidation with a consequent rise in malondialdehyde (MDA), and a decrease in superoxide dismutase (SOD) and catalase (CAT) activities and glutathione (GSH) levels. Exposure to petroleum hydrocarbons also caused an alteration in the histomorphology of lung tissues. Our findings implied that exposure to petroleum hydrocarbons by inhalation is a risk factor in the pathophysiology of pulmonary dysfunction (Figure 23) . This could explain the edema and haemorrhagic necrosis of lung tissue seen in this study following exposure to petroleum hydrocarbons. This is suspected to be due to the leakage of fluid into the extra vascular space with resultant haemorrhagic necrosis. Continuous coughing and respiratory disturbance may be the signs following this exposure which may not be traceable to the exposure of petroleum products.

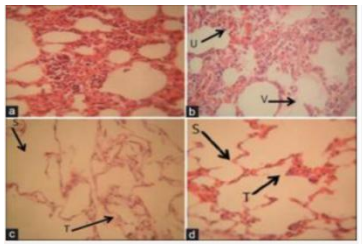

Figure 23: lung parenchyma in control and rats exposed to petroleum products

Vice Chancellor sir, in our work titled 'Oxidative status in rat kidney exposed to petroleum hydrocarbons', **Azeez,** *et al.*, (2015), it has been confirmed that exposure to petroleum hydrocarbon led to significant rise in serum urea and creatinine, and renal tissue malondialdehyde. It also caused significant reduction in urinary urea and creatinine, and reduced glutathione, superoxide dismutase, and catalase activities of renal tissue homogenate. However, serum and urine concentrations of albumin and total protein were comparable in all groups. Interestingly, the significant reduction in urinary urea and

creatinine seen in hydrocarbon exposed animals was not dependent on the route of exposure. It was presumed that continuous exposure to petroleum product could result in damage which might not be traceable to petroleum product effect.

Vice Chancellor sir, another study by **Azeez,** *et al.*, (2016) titled, 'Changes in erythrocyte membrane properties following exposure to premium motor spirit (petrol vapour) and modulatory effects of *Moringa oleifera* and vitamin C in Wistar Rats', evaluated the effect of petrol vapour on properties of erythrocyte osmotic fragility (EOF) (Figure 24) , erythrocyte sedimentation rate (ESR) (Figure 25) and red cell indices as well as the comparative beneficial effect of *Moringa oleifera* and Ascorbic acid (vitamin C) on their values. This study showed that inhalation of petrol vapour 10 minutes every day for eight weeks caused increased fragility of the erythrocyte to normotonic (0.9) and hypotonic solutions. The increased EOF observed indicates the ability of the petroleum hydrocarbon to compromise the integrity of the erythrocyte membrane increased oxidative damage to the erythrocyte membrane (Wagner *et al*, 1986) which may result in anemia. The hydrocarbon component acted as xenobiotics on the lipid bilayer with a consequent increase in the membrane instability leading to osmotic fragility. There may also be membrane fluidity and ultimate destruction of the bilayer integrity of erythrocyte membrane (Girotti, 1985). There was an alteration of the Na-K+ pump mechanism that maintains a low level of sodium ion concentration inside the cell by the hydrocarbon component of petrol.

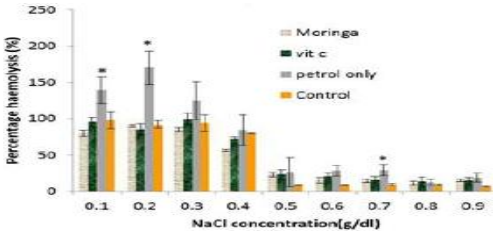

Figure 24: Erythrocyte osmotic fragility following exposure to petrol, kerosene and diesel compared with control group (**Azeez** *et al.,* 2016)

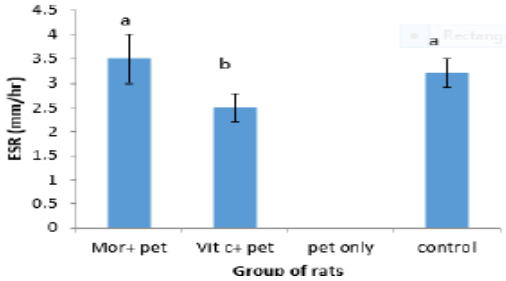

Figure 25: Erythrocyte sedimentation rate (ESR) following exposure to petrol, kerosene and diesel compared with control (**Azeez** *et al.*, 2016)

Vice Chancellor sir, **Azeez,** *et al.*, (2015), carried a study titled, 'Cardiotoxicity induced by inhalation of petroleum products.' We studied the effects of petroleum products on cardiac tissue architecture and creatine kinase (CK- MB) (Figure 26). Forty male Sprague Dawley rats were exposed to diesel, kerosene and petrol by inhalation for eight weeks, and at the end of the study, blood samples were collected, blood pressure was measured and animal heart was harvested for histological study. Blood pressure and serum creatine kinase (CK-MB) were significantly higher in the exposed rats compared with controlled rats. Degeneration of myocardial tissue was observed in the exposed rats (Figure 27). The findings from the study revealed that the cardio-toxic effect of petroleum products is via creatine kinase-dependent mechanism.

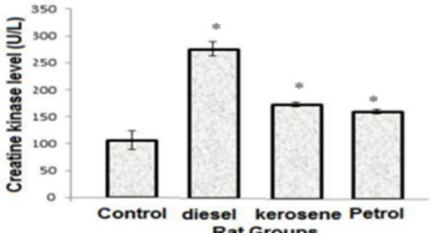

Figure 26: Variation in the level of creatinine kinase in control and rats exposed to petroleum products (**Azeez** *et al.*, 2015)

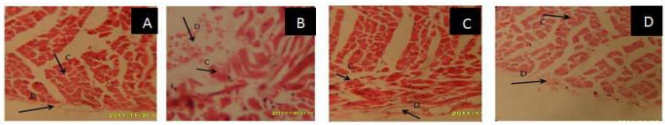

Plate 1
A: Photomicrograph of cardiac tissue in control rats showing normal myocytes (C) and normal apex (D).
B: Photomicrograph of cardiac tissue in rats exposed diesel showing ranging degree of cellular degeneration (C) that appeared to have originated from the apex (D).
C: Photomicrograph of cardiac tissue in rats exposed to kerosene showing focal loss of myocyte /degeneration.
D: Photomicrograph of cardiac tissue in rats exposed to petrol showing area of mild degeneration (C) and some degree of apical degeneration (D)

Figure 27: showing effects of petrol, kerosene and diesel on cardiac architecture compared with control (**Azeez** *et al.*, 2015)

Vice Chancellor sir, in another study, **Azeez** *et al.*, (2017), examined the *Moringa oleifera* amelioration of atrial fibrillation induced by exposure to petrol vapour in Wistar Rats. The study was carried out to evaluate the actions of *Moringa oleifera* aqueous extract in ameliorating the effect of petrol vapour on atrial functions of Wistar Rats compared to that of standard anti- hypertensive drugs (*captopril and candesartan cilexetil)* on cardiovascular functions and osmotic fragility of rats exposed to petrol vapour. Electrocardiography was done using EDAN 10. There was significant increase ($p<0.05$) in erythrocyte osmotic fragility (EOF) of the rats exposed to petrol vapour only. However, *Moringa oleifera*, *captopril* and *candesartan cilexetil* significantly ameliorated this effect. There was no significant difference in the amelioration of *Moringa oleifera* and *candesartan cilexetil*. There was absence of p-wave suggesting a disruption in atrial contractility, as well as significant increase in heart rate observed in the electrocardiogram of petrol only group, this was significantly restored in the *Moringa oleifera*, *captopril* and the *candesartan cilexetil* group. The results showed that exposure to petrol vapour elevated EOF, resulted in atria arrhythmia and increased heart rate. These effects were ameliorated by pretreatment with *Moringa oleifera, captopril* and *candesartan cilexetil*. The amelioration in *Moringa oleifera* group was comparable with that of candesartan cilexetil suggesting that *Moringa oleifera* may have an Angiotensin II receptor blocker effect.

Mr. Vice Chancellor, Kolawole…,**Azeez**, *et al.,* (2021); investigated the possible cardioprotective effects of aqueous ripped Musa paradisiaca (Plantain) peel extract (MPPE) in an isoproterenol (ISO)-induced Myocardial infarction (MI) rat model relative to aspirin as a standard drug. The screening of MPPE revealed the presence of secondary metabolites, including flavonoids and phenols. The LD50 was above 5000 mg/kg. Rats administered ISO developed MI evidenced by increased cardiac troponin-I (cTn-I), pro-inflammatory cytokines (IL-1β, IL-6, and TNF-α), malondialdehyde, and ST segment elevation on the ECG (Figure 28) . Further, there was a reduction in antioxidant enzymes and membrane-bound Na+/K+ATPase activities. Pre-treatment with MPP promoted restoration of cardiomyocytes with no side effect compared to aspirin. Significantly, it increased CAT, SOD, and Na+/K+ ATPase activities and decreased pro-inflammatory cytokines, MDA, and cTn-I, thereby reducing the elevation of ST-segment on the ECG to near normal. Results from the histopathological study support the cardioprotective effects of MPP. Conclusively, the MPP confers protection to the myocardium through its antioxidant and anti-peroxidation properties that act as possible mechanisms in ISO-induced MI in rat models.

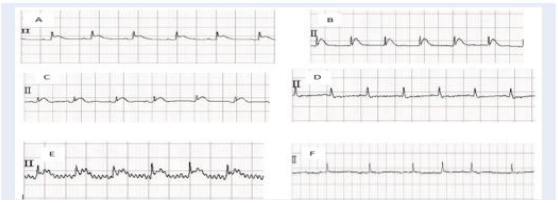

Figure 28: Electrocardiographic changes on ECG paper. (A) Normal control group showing regular R-R and normal PR interval (B) model group showing ST segment elevation, irregular R-R interval 'S' is above isoelectric baseline with narrow QRS. (C) Group pre-treated with 100 mg/kg extract showing narrow and short ST segment irregular R-R interval. (D) Group pretreated with 200 mg/kg extract showing atrial fibrillation, irregular R-R interval and S above isoelectric baseline. (E) Group treated with30mg/kg of aspiring showing atrial and ventricular fibrillation with irregular RR interval (Kolawole.., **Azeez** *et al.,* 2021)

Vice Chancellor sir, Dahiru Ashiru..,**Azeez** *et al.*, (2022), carried a study on Prophylactic and Therapeutic Effect of *Moringa oleifera* leaf Extract on Petrol-Induced Hematological, Serum Biochemical, and Histological Changes in Wistar Rats. The results showed neutrophilia, and lymphocytosis. Serum biochemistry analysis revealed hyponatremia, hyperkalemia, and hyperchloremia while histology slides show no tissues damage and treatment with *Moringa oleifera* showed a positive response.

Mr. Vice Chancellor, **Azeez** *et al.,* (2021) studied the effects of partial pancreatectomy on the insulin and the electrocardiography (ECG). We proposed that vitamin C (Vit. C) could have maintenance impact on TNF-a, IL-6, IL-8, insulin, and ECG parameters of pancreatic wound healing of Wistar rats. The outcomes of this study are a testament to the fact that administration of 1,000 mg/kg Vit C would not only serve as antioxidant, but would also alleviate cardiovascular complications associated with diabetes in individuals with such post-pancreatectomy complications.

Vice Chancellor sir, Oriolowo.., **Azeez** *et al.,* (2023) investigated the phenomena of diapause in the larval and pupal developmental stages of *Cirinaforda* through a measure of its developmental metabolic rates. A total of 36 larvae and 80 pupae were used for the experiment. The insects were reared and maintained under ambient temperature and relative humidity (25-32oC; 75-85%RH) in the laboratory. Metabolic rate was progressively measured as individual's rate of O2 consumption and CO2 evolution using spirometric and titrimetric methods respectively. The study revealed that C. forda experienced an extremely low metabolism during pupa development which suggested diapause development in the insect and this period of highest metabolic suppression occurred in pupae of age between 90-150days.

In another study carried out by **Azeez** *et al., (*2022), on effect of heat stress on vital and hematobiochemical parameters of healthy dogs (the study was carried out over a period of two seasons: Hot dry and hot cold seasons),the exposure of healthy

dogs to HA/HR conditions induced heat stress, which may have an adverse effect on their immune status, thereby affecting their health and welfare.

Vice Chancellor sir, Akorede.., **Azeez** *et al*., (2022) studied the mitigative potentials of methanol leaf extract of *Moringa oleifera* on chronic carbamazepine-induced haemo-biochemical and thyrotoxicity in male Wistar rats. Carbamazepine (20 mg/kg) was given for 15 days then followed by *M. oleifera* (200 mg/kg) 30 minutes later. The regimens were given once daily for 15 weeks via gavage. Blood and serum samples were evaluated for haematological parameters, liver biochemical enzymes and thyroid hormone analysis. The results revealed that *M. oleifera* leaves extract mitigate against alteration in parameters measuring haematological, biochemical and thyroid functions. The study concluded that amelioration against CBZ-evoked alteration in haematological indices, biochemical enzymes and thyroid function by *M. oleifera* leave extract was partly due to its nutritional values and phytochemical constituents that confer protection on blood vascular system, and hypothalamic-pituitary axis.

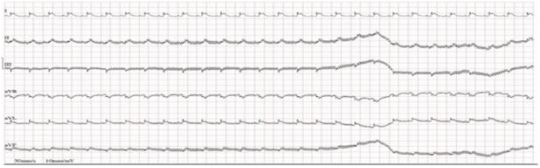

Figure 29: Ventricular fibrillation as seen in Akorede...**Azeez** *et al.*, (2022)

Vice Chancellor sir, my team of researchers observed that there was need to go into the study of the ECG of various animals so as to use this in clinical diagnosis. In veterinary hospitals, cases that present with cardiovascular conditions sometimes require electrocardiography as a tool for diagnosis. We, therefore, venture into electrocardiographic studies of

various animals including rats, dogs, horses, donkeys, pythons, crocodiles and poultry.

Vice Chancellor sir, I have a chapter in an Elsevier book titled 'Endothelial signalling in vascular dysfunction and disease from bench to bedside'. The title of my own paper is,"Comparative assessment of electrocardiographic parameters of some birds—an essential diagnostic tool in veterinary practice". In this study, we were able to compare the ECG of many healthy birds.

As part of my contribution to knowledge, we investigated the ECG of many animals as displayed below.

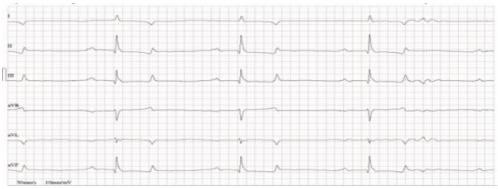

Figure 30: ECG in the horse: Very low heart rate and slow rhythm. P is bifid and long ST segment (**Azeez** *et al.*, 2019)

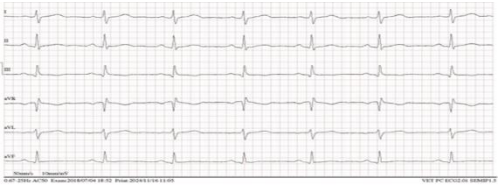

Figure 31: ECG in dog (**Azeez** *et al.*, 2019)

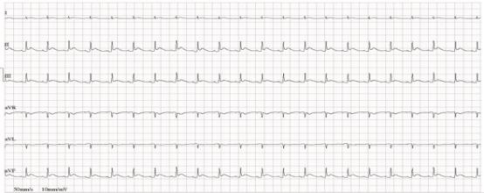

Figure 32: ECG in the rat (**Azeez** *et al.*, 2019)

The ventricular TMAPs do not have a plateau and there is no period during repolarization when most cells are isopotential. Thus, no ST segment appears in the ECG of rats.

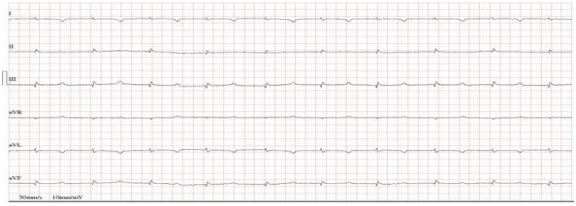

Figure 33: The West African Dwarf goat (**Azeez** *et al.*, 2018)

The Q is more pronounced than in the red Sokoto goat

In the poultry

ECG in the bird is easier to perform in the dorso-lateral position.

Clinical presentation: heart disease should be suspected when patients are presented with dyspnea, coughing, weakness, lethargy, exercise intolerance, collapse/syncope, or coelomic distention and more (Stunk and Wilson 2003). Early in the course of cardiac disease, birds may present without any obvious signs. Birds may also be presented for acute death singly or in flock with no history to suggest the presence of heart disease (Stunk and Wilson 2003). Detailed history is important to help determine risk factors that may contribute to heart disease.

Predisposing factors

Predisposing factors to heart disease in birds may include species, age, gender, and diet in the development of heart disease in companion avian species [For example broilers (Gallus domesticus) often develop pulmonary hypertension and ascites syndrome, a spontaneous cardiomyopathy thought to develop as a result of increased demand placed on the cardiovascular system by the large breast muscle mass and rapid growth (Stunk and Wilson 2003). Copper deficiency may be linked to the formation of dissecting aortic aneurysms in turkeys

and ostriches (Stunk and Wilson 2003). The ECG exhibited positive P wave, inverted (Q)rS, and positive T wave in all of them. S-S interval was regular in turkey and duck, and irregular in chicken and Chinese geese. The PR-interval in the laying birds and broilers was very long with overlap by QRS. The (Q)rS was shorter in the chicken with very short amplitude, and longer in turkey and duck with longer amplitude. No significant difference was observed in the (Q)rS within the groups. QT-interval was longer in turkey, geese, and duck but shorter in chicken

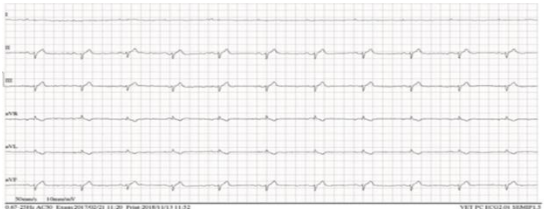

Figure 34: ECG in white geese (**Azeez** *et al.*, 2021)

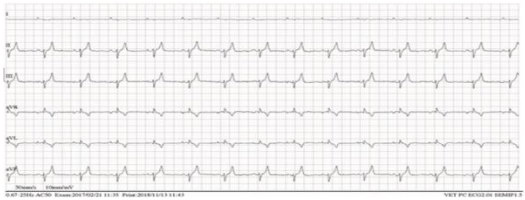

Figure 35: ECG in Domestic duck with very tall T wave at lead II (**Azeez** *et al.*, 2021)

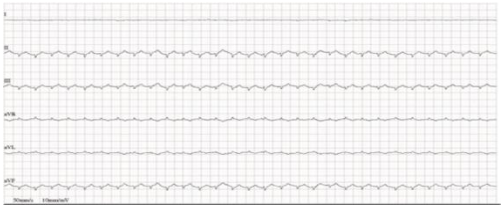

Figure 36: ECG in laying birds (**Azeez** *et al.*, 2021)

ECG in Reptiles

The heart of most snakes is located at a point one-third to one-fourth of its length caudal to the head. Cardiac location varies in snakes according to species, but usually it's found at the junction of the first and second quarter of the animal's body length. The heart of arboreal snake is typically found more cranially in the body than in terrestrial animals.

The African Rock Python (Python sebae) (Figure 38) and royal python are non-venomous snakes of the Sub- saharan Africa. The snakes are widely feared, though rarely kill humans

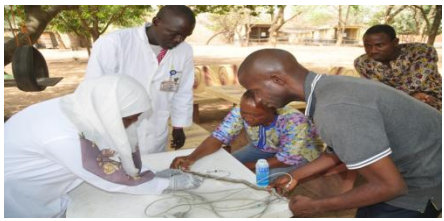

Figure 37: Measuring ECG in the python **(Azeez** *et al.,* 2019)

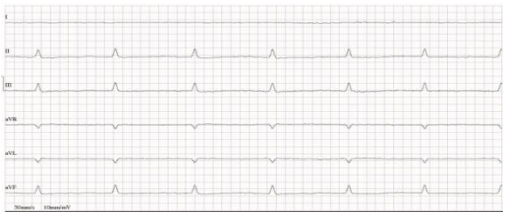

Figure 38: ECG of African rock python

This is not to say that the ECG alone is enough to make diagnosis of cardiovascular challenges in man and animals. Echocardiogram, X-ray may have to be explored for complete and adequate diagnosis.

Community Services

Grants and awards

I was a lead Researcher that won an Institutional Based Research fund (IBRF, 2016/2017) titled: 'Diurnal and seasonal variation of basic physiological parameters of some domestic animals in Ilorin. I had the grants of International Union of Physiological Sciences to attend and present papers at the following conferences: IUPS 2009 in Kyoto Japan, IUPS 2013 Birmingham UK, IUPS 2017 Brazil, BAMA 2019 Cuba.

I have served at various levels through the department, Faculty and University as:

a. Level Adviser to the 1st set of graduates of the Faculty who graduated in 2016.
b. Chairperson, welfare committee of the Faculty, 2013-2019.
c. Postgraduate representative of the Faculty at the Postgraduate board.
d. Faculty representative at the University Ceremonial Committee, 2012-2018.
e. Faculty representative at the University Quiz and Debate committee.
f. Pioneering Ag. Head of Veterinary Physiology and Biochemistry Department, 2012-2016, 2018-2019.
g. Faculty Research Manager, 2016-2019.
h. Chairperson, Faculty quality assurance and accreditation committee.
i. Current Dean of the Faculty, 2023 to date, and
j. The first female Dean of the Faculty.
k. I was a national Amirah Istijabah prayer group of Nigeria for 10 years

I am a reviewer to some local and international journals.
Sokoto journal Veterinary Sciences
Asian Journal of Advanced Research and Reports
Nigerian Journal of Physiological Sciences
African journal of Physiological Science

I was the Chairperson local Organizing Committee of Physiological Society Conference in 2017 at Ladoke Akintola University of Technology.

Conclusion

Vice Chancellor sir, distinguished ladies and gentlemen, the matter of the heart on the survival of animal and man is a reference to the various ways we are exposed to petroleum products. During my surveillance in the study of the routes of exposure to petroleum products and their effects, it was observed that many individuals and animals are exposed on a daily basis. On the road, from petrol vehicle exhaust, diesel vehicle exhaust, and by virtue of exposure at their daily duty post/jobs have fallen victim of cardiovascular issues ranging from high blood pressure, to sudden death from heart attack and more. What makes the whole story absurd is the fact that people will not associate these conditions with their primary duty associated with exposure to petroleum products. In many homes, because of electricity inadequacy, diesel/ petrol generators will be on from night till the morning with emissions all in the environment to be inhaled by the inmates. The heart has been designed to work ceaselessly throughout life by producing adequate cardiac output at a moderate heart rate and blood pressure. These functions are regulated by homeostatic mechanisms involving centers in the brain and other parts of the cardiovascular system so that the heart can cope with internal and external challenges as matter required for survival of man and animals. *Moringa oleifera* was found to ameliorate some of the effects caused by exposure to petroleum products.

Recommendations

Vice Chancellor sir, the fact that physiology constitutes a strong basic foundation in the study of Medicine and Veterinary Medicine curriculum cannot be overemphasized. Therefore, I wish to make the following recommendations that will assist the programme to develop at a pace presently available in other parts of the world:

1. State of the heart equipment currently being used in other parts of the world should be bought for the Department to conduct research that will upgrade the University to the level of 1: 10: 100 aspired by our dear, Vice Chancellor.

2. Human and animals (grazing along major high ways) should avoid/minimise regular exposure to emissions from petroleum products (diesel, petrol and kerosene) as its adverse effects are immeasurable and dangerous to our health. There have been very serious cardiovascular challenges resulting in sudden death which will not be traceable to exposure to petrol or diesel which are very vital in considering the origin of some disease conditions in our environment.

3. Moringa and other medicinal plants should be encouraged to be used for exposed individuals and animals. Nigerian Government should encourage planting of Moringa because of the usefulness of the plant (leaves and seeds).

4. We should do regular checkup of blood pressure and other vital parameters.

5. Government and higher institutions Management should create hygienic environment with zero tolerance for open-air emission of diesel engines and generators so as to save the lives of people working around the engines.

6. Integration of ECG in Veterinary practices: the use of electrocardiography in Veterinary care for diagnostic purposes to aid in the early detection and treatment of cardiovascular issues in animals, especially those exposed to environmental toxins and exotic animals should be encouraged.
7. Support research on antioxidants for protection against environmental pollutants: these studies should be funded on the protective effects of medicinal plants with antioxidants potentials against the harmful impacts of hydrocarbons on cardiovascular and respiratory health.
8. Provide a safer route for gracing livestock, especially during their migration at the peak of the dry season.

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