INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Paper

The Role of Laboratory Animals in Pharmacological Testing and Drug Development

Dr. Pasupulati Haritha*, Jarupla Mahika, Ambala Syama, Mogilicherla Archana, Dr. Ramadevi Pemmereddy

Bharath School of Pharmacy, Hyderabad, Telangana- 501510, India.

ARTICLE INFO

Published: 21 Aug 2026
Keywords:
Preclinical testing, Experimental animals, Carcinogenicity, Transgenic animals, Developmental biology
DOI:
10.5281/zenodo.22044480

ABSTRACT

Animal research has long contributed to advances in medicine and drug development. By observing how diseases progress and how medicines affect living organisms, researchers gain valuable insights into how similar treatments might respond in humans. These studies also help scientists understand biological processes and identify possible safety risks before new drugs move on to clinical testing. Over the years, animal research has played an important role in improving medical treatments, including the development of vaccines and other life-saving therapies. Different animals are chosen for studies depending on how closely they relate to humans, how manageable they are in research settings, how consistent the results tend to be, and whether their use meets accepted ethical standards. Along with describing the roles of different laboratory animals used in experimental pharmacology, this work highlights their importance in drug discovery, disease studies, and broader biomedical research.

INTRODUCTION

After a therapeutic molecule is discovered, it is crucial to study how animals behave and react to it for human use. The choice of an appropriate animal model is based on physiological, anatomical, and behavioural similarities to humans in order to guarantee the applicability and transferability of the experimental findings. One of the initial stages in the study and creation of novel drugs is the use of animal models to comprehend how a disease manifests in the body. Any medicinal agent must pass a rigorous preclinical evaluation process, which involves the use of animal models, before it is deemed safe and effective for use in humans. Thus, pharmacokinetics (absorption, distribution, metabolism, and excretion), pharmacodynamics

***Corresponding Author:** Dr. Ramadevi Pemmereddy
Address: *Assistant Professor, Department of Pharmacology, Bharath Institute of Pharmacy, Hyderabad, Telangana- 501510, India.*
Email ✉: ramadevipemmireddy002@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

(mechanism of action), and possible toxicological effects that a drug might produce can all be observed in a whole-system setting that animal models offer.

DISCUSSION

A wide variety of animals are commonly used in pharmacological studies, selected based on their physiological relevance to human systems.

(1) HAMSTER

Mesocricetus auratus is also called as Syrian or golden hamster. In the past 5 yrs hamsters have been increasingly useful in pharmacological and toxicological investigations. The extensive use of hamsters in research can be attributed to their fast reproductive cycle and relatively large litter size, which average around six pups per litter.

TABLE 1: EXPERIMENTAL USE OF HAMSTERS

Area of the study	Description	References
Teratogen studies	Short gestation period of Hamsters allows studies on effects of teratogens and pregnancy drugs. Hamsters are twice more sensitive to strychnine than mice.	[1,2]
Blood Pressure	Hamsters show similar BP response to acetylcholine and epinephrine as other mammals; used to study pharmacological effects on BP.	[3]
Amyloidosis	Syrian hamsters have proven to be a valuable animal model for the study of amyloidosis due to the similarity in disease progression and response to stimuli when compared to humans. The induction of amyloid deposition through subcutaneous injections of casein and lipopolysaccharide (LPS) effectively mimics systemic inflammation and promotes amyloid formation.	[4]
Other applications	Hamsters are used to study different drugs used in human disease conditions such as muscle dystrophy, epilepsy, atrial thrombosis, carcinogenesis, type 2 diabetes mellitus.	[5,6]

(2) MARMOSET

Marmoset (*Callithrix jacchus)* are numerous species of long-tailed American monkeys, similar in appearance as squirrels. The common marmosets live in the scrub forest of northeastern Brazil and weighing 400 grams with 15-30 cm height. Their average life span is about 5 to 7 years and a maximum life span of 16.5 years.

TABLE 2: EXPERIMENTAL USE OF MARMOSETS

Area of the study	Description	References
Pharmacodynamic Studies	Marmosets are widely used in pharmacodynamic research, especially in neuroscience, immunology, and infectious diseases.	[7]
Neuroscience	Used as models for Parkinson's disease and Alzheimer's disease, which primarily affect humans and also aid in studying pharmacokinetics of biologics.	[8]
Infectious Diseases	Marmosets are used as models to study bacterial and viral infections due to their ability to closely mimic human disease progression.	[9]

Psychiatric Diseases	Used as experimental models for understanding symptoms and mechanisms related to anxiety, panic, stress, and obsessive-compulsive disorder (OCD).	[10]
Antibiotics & Drug Research	The effects of rapamycin have been studied in marmosets, where oral administration of the drug has been shown to enhance both lifespan and health span in these non-human primates.	[11]

(3) OWL

Owls (*Strigiformes)* are birds which are found in all regions, except in polar ice caps and some remote islands. Owls are utilized to investigate the pharmacokinetic properties of Meloxicam, a pain-relieving drug, with studies showing an increase in plasma concentration following oral administration. In general, owls and other bird species are commonly used to examine the pharmacokinetics of analgesic medications [12].

(4) DROSOPHILA MELANOGASTER

Drosophila melanogaster also known as 'fruit-fly' or 'lesser fruit fly' and less commonly called as 'vinegar fly' or 'banana fly' or 'pomace fly'. Their development time differs with the external temperatures. Under optimum temperatures at 25°C, their life span is about 50 days. The shortest development time is 7 days, which is at 28°C. Development time increases at higher temperatures due to heat & stress. Heart rate is of 4-6 beats/min and their body weight is about 1-1.5 mg.

TABLE 3: EXPERIMENTAL USE OF DROSOPHILA MELANOGASTER

Area of the study	Description	References
Genetics	Used in developmental biology, cell biology, neurobiology, and genetics. First used by Thomas Hunt Morgan in 1910. Helped discover sex-linked inheritance, multiple alleles, and gene mapping.	[13]
Age-related Studies	Suitable model for testing anti-aging drugs and studying age-related diseases like Parkinson's, Alzheimer's, Huntington's, cardiovascular disease, muscular dystrophy, and metabolic disorders.	[14,15]
Anti-seizure Medications	Fischer et al used bang-sensitive mutants (e.g., parabss1) to test seven anti-seizure drugs. Mutants show seizures after mechanical stimulation, making them ideal for screening seizure treatments.	[16]
Toxicity studies and Carcinogenic studies	Drosophila has proven to be an effective *in vivo* model for investigating the mechanisms of action, toxicity, and bioavailability of drugs used in the treatment of colorectal, thyroid, brain, and various other cancers.	[17,18]
CNS Studies	Drosophila are widely used in Central Nervous System (CNS) studies due to their genetic tractability, conserved genes with humans, rapid life cycle, and comprehensive genetic resources. The fruit fly's small yet informative CNS, coupled with advanced genetic tools like the Gal4/UAS system, allows for detailed analysis of neuron function, glial cell interactions, and the implementation of neural computations.	[19]

(5) CHAENOCEPHALUS ACERATUS

Chaenocephalus aceratus is commonly known as the blackfin icefish or Scotia Sea fish, is a species

of crocodile icefish. Because it lacks red blood cells and haemoglobin, it is frequently referred to as the "white-blooded fish." It grows best in Antarctic waters that are close to the freezing point of saltwater (about -2°C).

Blackfin ice fish is used as model for examining the drugs like Sodium EDTA, Verapamil and atropine. These drugs shown the inhibition of sustain contraction and increases calcium supply and caused progressive relaxation. Aortic blood flow and cardiac output was studied in this species. The ventral aortic blood flow, measured by electromagnetic flow meter, increased during hypoxia and decreased during the hyperoxia and the cardiac output was well regulated in these species [20].

Zebra fish gives vertebrates and has a backbone like humans and have close relation to humans than commonly used invertebrates' models, such as insects and worms. Due to its clear eggs which can be developed outside the body, allow watching a zebra fish egg grow into a newly formed fish under a microscope Lifespan of zebra fish is considered to be approximately 5 years and length of the adult fish is about 6 cm. When compared to other animals for drug testing like rats, mice, frog, monkeys, zebrafish is most commonly and easily found and can develop the larvae in-vivo within 24 hrs, and cost effective, easy to handle, shares higher similarities in brain, heart, genes with humans. These benefits made the use of zebrafish as a model made easier.

(6) ZEBRAFISH

TABLE 4: EXPERIMENTAL USE OF ZEBRA FISH

Area of the study	Description	References
Genetics	Zebrafishes are used as a model for biomedical studies, especially in genomics and developmental biology. Free-swimming larvae are ideal for studying hearing/balance disorders (ototoxicity), locomotion, and social learning.	[21]
Neuroscience	Due to structural similarity to the human brain but with less complexity, zebrafish are used to study brain physiology, anatomy, and behavior, including cognitive and behavioral research.	[22]
Cancer studies	Doxorubicin is an antitumor agent belonging to the class of neoplastic agents and is commonly used in the treatment of cancers such as lymphoma, leukemia, and breast cancer. Although therapeutic doses are approximately 500 mg/m² of body surface area and have been reported to benefit around 3–4% of patients, its clinical application is limited by dose-dependent cardiotoxicity. Zebrafish has emerged as a valuable model organism for studying doxorubicin-induced cardiotoxicity.	[23]
Antipsychotic Studies	Zebrafish serve as an alternative to rats for evaluating cardiotoxic effects of first-generation antipsychotic drugs (e.g., aripiprazole, risperidone), overcoming limitations of rodent models.	[24]
CNS Studies	Ideal for CNS research due to transparent embryos, genetic similarity to humans, and real-time neural imaging. Used to study epilepsy, autism, Parkinson's disease, and spinal cord injuries.	[25]

(7) AFRICAN GREEN MONKEY

The African green monkey is a vervet monkey native to sub-Saharan Africa. African green

monkey, has emerged as a promising alternative model in pharmacological research, offering several advantages over other commonly used primates. They are medium- sized primates, with males being slightly larger than females. Males typically weigh between 4.5 and 7.5 kg (10 to 17 lb), while females weigh between 4 and 6 kg (9-13 lb). Normal body temperature is 36.0°C – 39.5°C (96.8°F – 103.1°F) and heart rate around 74 beats per min. They exhibit sexual dimorphism, with males generally being larger and heavier than females. African green monkey, has emerged as a promising alternative model in pharmacological research, offering several advantages over other commonly used primates. Areas of research: Pharmacokinetics, Antimicrobial efficacy, Ocular pharmacokinetics, Neurological disorders. African green monkey has a lifespan of ablut15 years in captivity and 10-13 years in the wild. They reach sexual maturity at about 4-5 years of age.

EXPERIMENTAL USES OF AFRICAN GREEN MONKEY:

Research on infectious diseases and Vaccine development:

Along with explaining the roles of different laboratory animals used in experimental pharmacology, this work shows the animals remain important in drug research, disease studies, and biomedical science. [26,27].

Neurological research:

These animals are often used in research on Parkinson's disease and other disorders of the nervous system. When African green monkeys and other non-human primates are involved in studies, researchers follow strict rules to ensure the animals are treated humanely and kept safe.

(8) GOAT

Goats have distinctive features including rectangular pupils for wide-angle vision, four chambered stomach for digestion. Goats are mostly diurnal animals. Goats normal body temperature falls between 101.3°F-103.5°F (38.5°c- 39.7°c). Respiration rate is 10-30 breaths per min and heart rate is 70-90 beats per min. The life expectancy of goats is generally between 15 and 18 years. Goats have been used in experimental for a variety of purposes, such as drug metabolism and absorption studies, testing drug efficacy and safety and nutritional studies.

EXPERIMENTAL USE OF GOAT

Goats are employed in many experimental contexts, most notably as animal models in agricultural and biomedical research. They act as models for researching human illnesses, creating novel treatments, and comprehending the behaviour of animals.

Research in Biomedicine:

Models of animals: Human diseases such as paratuberculosis, tuberculosis, and other infectious diseases are studied using goats as animal models [28,29]

Stem Cell Research: They are employed in research on stem cells for regenerative medicine and tissue engineering, especially in the musculoskeletal system [30].

Transgenic Goats: Genetically modified goats can be used as bioreactors to produce valuable proteins in their milk. Recombinant proteins are produced in transgenic goats for medical applications [31].

Reproductive Biotechnology: Reproduction biotechniques, such as embryo cryopreservation, sperm sexing, and genome editing, are studied using goats to improve livestock production [32]

Behavioral Studies: Goats are used in studies to understand their social behaviour, communication patterns, and cognitive abilities. Goats can be used in therapy programs to improve the well-being of individuals in hospitals, nursing homes, and other settings [33].

(9) GERBIL

Mongolian gerbil is a small laboratory rodent. Gerbils are phenotypically related to rat and also known as "jirds" or "sand rat". They are preferred in laboratory because of easy in handling, mild and quiet nature. The average lifespan of a Gerbil is 3 to 5 years, though some gerbils can live up to 8 years or even longer. Normal body temperature of gerbils is 98°F to 102°F (37°c -39°c), respiration rate is 70-120 bpm with heart rate 250-500 per min.

EXPERIMENTAL USE OF GERBIL

Gerbils are used in experimental studies due to their genetic predisposition to convulsions and their suitability.

Due to their propensity for convulsions and their suitability as models for conditions like otitis media and epilepsy, gerbils are frequently employed in experimental research. Additionally, they are useful in research on neurological conditions, brain development, and the functioning of hearing and vision.

Epilepsy

Gerbils, particularly some strains, exhibit a genetically determined propensity for seizures, making them useful for studying epilepsy patterns and testing antiepileptic drugs [34].

Parasitic Diseases and Viral infections

Gerbils are used to study parasitic diseases like schistosomiasis and filariasis, allowing researchers to understand the infection process and develop treatments. Gerbils can be infected with viruses like Rift Valley fever virus to study encephalitis and other related diseases [35,36]

Behavioural Studies

Gerbils can be used in behavioural studies, such as exploring their responses to environmental changes or their social interactions. Gerbils are used in research on how they process auditory and visual information, which can provide insights into the development and function of sensory systems [37].

(10) Rats

The Laboratory rats have widely been used for studying various diseases in the field of neurology, metabolic diseases, cardiovascular diseases, cancer biology, toxicology, reproductive biology etc.

TABLE 5: EXPERIMENTAL USES OF RATS

Area of the study	Description	References
Genetics	A large number of inbred strains that exhibit a variety of phenotypes and serve as numerous models of human characteristics and illness have been identified. There is now an array of disease models available because more than 350 rat genes have been found to be involved in the underlying causes of diseases or to be crucial in important biological processes that are modified in diseases.	[38]
Neurological studies	Rats are used for neuroscience studies including Parkinsons disease, stress disorders, Schizophrenia, anxiety, depression, epilepsy. Various evaluation disease models such as open field test, swimming	[39]

	behavior, tail suspension test, elevated pls maze test can be best studies in rats.	
Cardiovascular studies	Rats are widely used to study cardiovascular diseases such as myocardial infarction, hypertension, coronary artery disease, congestive heart failure. Larger size compared with mice, physiological similarity with the human heart makes the rats suitable for conducting surgical procedures like coronary ligation method, ECG analysis, chemical induced disease models.	[40,41]
Metabolic studies	Genetically engineered rat models like Zucker rats, Goto-kakizaki rats are used for studying obesity ad diabetics. These models are helpful in studying pathophysiology of pancreatic diseases, obesity, diabetis, insulin resistance and to test various drugs against these diseases.	[42]
Toxicological research	Various strains of rats have been used in toxicological studies such as acute, sub-acute and chronic toxicological studies. The metabolic pathways of these animals are similar to humans, thus making these animals suitable for studying dose response relationships, pharmacokinetic and toxicokinetic studies.	[43,44]
Oncology	Rat carcinogenicity studies are an essential component of determining the possible human cancer risk, especially for chemicals that might be present in the environment or in novel medications. A number of transgenic rat models have been developed to aid in the study of in vivo mutagenesis and carcinogenesis.	[45]

(11) MICE

Mice are extensively used in research due to their small size, short reproductive cycles, biological similarities with the humans.

TABLE 6: EXPERIMENTAL USE OF MICE

Area of the study	Description	References
Genetics	Mice are among the most genetically tractable animal models. Gene editing tools such as CRISPR/Cas9, as well as a huge number of transgenic, knockout, and humanised mice models, make them excellent for studying human genetic illnesses.	[46]
Immunology	Mice have played a crucial role in immunology research, including vaccine development, autoimmune diseases, transplant rejection, and cancer immunotherapy due to the widespread availability of immunodeficient and humanised strains.	[47]
Cancer Studies	Mice serve as an excellent animal for developing cancer models, genetically engineered cancer models, xenograft models, spontaneously induced models are widely used.	[48]
Neurological Disorders	Mice are used to study various neurodegenerative diseases like Alzheimer's, Parkinsons disease, autism etc. In addition to genetic models, chemical and lesion-based models are utilised to simulate neurological illnesses by creating specific brain damage or neurochemical imbalances. Furthermore, mouse models offer an excellent platform for testing possible neuroprotective and medical therapies, including as small-molecule medicines, gene therapy methods, and stem cell-based treatments.	[49,50]

Metabolism & Diabetes	Ob/ob and db/db mouse models are useful for researching obesity, diabetes, and metabolic syndrome. Their small size and rapid reproduction make them excellent for long-term nutritional studies.	[51]
Cardiovascular Studies	Transgenic mice are used to explore genetic contributions to atherosclerosis, hypertension, and heart failure. $ApoE^{-/-}$ and $LDLR^{-/-}$ mice are popular models for studying lipid metabolism and vascular function.	[52]
Infectious Disease & Vaccines	Mice are used to study the pathogenesis of viral, bacterial, and parasitic infections. Their immune responses are well-characterized, and many vaccine candidates are first tested in murine models.	[53]

(12) FERRET

Ferrets are native to North America; they live in prairie dog burrows. These animals are used as a model to study the illness, severity and effects in lower & upper respiratory tracts caused by infuenza [54]. During the covid period, several vaccines were introduced, and the specified vaccine is used to treat coronavirus i.e., SARS-CoV, where nearly 10 vaccines were approved by WHO, but after the administration of the vaccine, many have developed SARS (severe acute respiratory syndrome). The study conducted by Gough et al confirms that ferrets are a suitable model for studying mild or asymptomatic SARS-CoV-2 infection, reflecting many aspects of early-stage or subclinical human COVID-19. Ferrets are especially useful for investigating viral transmission, immune response, and testing of intranasal vaccines or antivirals [55].

(13) SEA HORSE

Common names of sea horse are estuary seahorse, yellow seahorse, spotted seahorse. Seahorses are uniquely used in experimental research for studying male pregnancy and reproduction. Male seahorses possess a brood pouch, functionally similar to a mammalian uterus, which supports fetal development. This pouch contains beneficial microorganisms such as *Marinomonas*, *Holomonas*, and *Aeribacillus* that aid in fetal nutrition and immune support. Ongoing research focuses on understanding the development, function, and immunological role of the brood pouch in male pregnancy [56].

(14) CHICKEN

Chickens are commonly employed in biomedical research because of their vulnerability to different viruses, making them useful for studying viral infections, immunological responses, and vaccine development [57]. Their retinas are used as models in neuroscience to investigate visual system development and neuronal plasticity [58]. The embryos of chicken are used in studying the growth of tumor cells, metastasis, and angiogenesis, and also to test new cancer drugs and therapies [59]. Chicken's are also used as experimental model for studying atherosclerosis due to their similar lipoprotein levels to humans. Chicken embryos are useful in developing models of heart conditions in atrial septal defect, or hole in the heart [60]**.** The first cancer-causing virus, Rous sarcoma virus, was identified in chickens. The isolated chicken intestine (often the duodenum or ileum) is a classic *in vitro* model used in pharmacology and physiology to study the effects of cholinergic and anticholinergic agents on smooth muscle contraction [61].

(15) MEDAKA

Medaka is also known as Japanese rice fish or *Oryzias latipes* or killfish. These are small (1.4—3.6 cm) and are native to East Asia (Japan). They are euryhaline which are present in both brackish and freshwater. They can survive at wide range of temperature like 0°C or till 42°C.

EXPERIMENTAL USE OF MEDAKA

Toxicology & Ecotoxicology

Medaka is used to evaluate or check the effects of chemicals, pollutants, and other environmental stressors on aquatic life [62].

Space *Biology*

Medaka is also been used in space missions to study the effects of microgravity on their development and reproduction.[63].

Cancer *Research*

Medaka is used in carcinogenesis studies to understand the development of tumors and the effects of various substances on tumor formation. [64].

Nanotoxicology

Medaka is used to study the toxicity of nanomaterials, such as graphene oxide.

Cardiovascular studies

Medaka used for the ECG analysis and these organisms are also used for the testing the effect of Verapamil, a calcium channel blocker drug. Adult Medaka used to evaluate the acute toxicity of drugs like Diclofenac, Triclosan, Carbamazepine in a semi-static water and we observed there is no toxicity. [66]

(16) XENOPUS LAEVIS

Xenopus laevis is an amphibian and also called as clawed frog. It is a genus of highly aquatic frog native from Sub-Saharan Africa. Xenopaus laevis is an inactive creature and is a dimorphic organism. Their life span is about 15 yrs and with the body weight of 60gms. These species are entirely aquatic and are usually found in lakes, Ponds, Sea, rivers and also in man- made reservoirs. They can survive without food even for a year.

TABLE 7: EXPERIMENTAL USE OF ZEBRA FISH

Area of the study	Description	References
Embryonic Development and Organogenesis	Xenopus embryos are widely used to study fundamental processes such as gastrulation, neurulation, and organogenesis, including the development of the heart and nervous system	[67]
Cell and Molecular Biology	Oocytes of Xenopus serve as a powerful tool for the heterologous expression of membrane proteins, ion channels, and G-protein-coupled receptors, enabling functional characterization of these molecules	[68]
Human Disease Modeling	Xenopus represents a powerful and versatile model system for investigating the mechanisms underlying congenital heart diseases, left–right patterning defects, and other developmental abnormalities	[69]
Regeneration Research	Xenopus serves as a key model for studying tissue and organ regeneration, particularly in the spinal cord, brain, and limbs	[70]
Cancer Studies	Allegrucci C et al studied the effects of various anticancer studies on the embryonic development of Xenopus laevis. All the anticancer drugs except cisplatin have shown malformations like abnormal edema, head, eye and abnormal heart at highest	[71]

	concentration. This indicates anticancer drug may affect embryogenesis.	
Epilepsy Research	Valuable for studying seizures, early brain development, and GABAergic signaling; supports high-throughput and developmental neuroscience research.	[72]
Hepatotoxicity Studies	Paracetamol-induced liver injury was examined in Xenopus embryos, demonstrating effects comparable to those observed in humans experiencing hepatotoxicity due to paracetamol overdose.	[73]
Genetic and Molecular Research	Xenopus oocytes are widely utilised to investigate the biological and molecular mechanisms of genetic material, enhancing the comprehension of the pathophysiology of numerous human disorders.	[74]

(17) PIGEON

Pigeons are birds belonging to family Columbidae, which also includes Doves. Pigeons are most frequently used in the experimental research, particularly in Psychology and behavioural science, to study various cognitive studies including learning, discrimination, and categorization. They are also used as animal model in research studies like study aspects of vision and social communication. Additionally, pigeons ate also used in operant conditioning experiments, demonstrating their ability to learn through reinforcement and punishment. In recent studies, by using animated digital models of pigeons it is concluded that pigeons can categorize different locomotive animal gaits and types of complex human behaviour [75]. Pigeons are also used in microbiological and genetic research, especially to look into the genetic factors that make Escherichia coli resistant to antibiotics. This research is important to understand the underlying mechanisms of resistance to antibiotics [76].

(18) LLAMAS

Llamas are domesticated South American camelids. A healthy llamas have heart rate ranging between 60-90 beats per minute and Crias (baby llamas) heart rate ranging from 80-120 bpm. Normal respiration rate of llamas at rest is between 10-30 breaths per min. Llamas are induced ovulators, meaning ovulation occurs after mating, typically from 24-36 hours later, which allows for breeding at any season of year. Females reach puberty around 12 months, while males often don't become reproductively functional until 3 years old. Llamas are increasingly being used in medical research, mainly in virology, due to their unique characteristics of antibodies and the ability to produce "Nano bodies" that can be engineered into therapies.

EXPERIENTAL USE OF LLAMAS

The use of llamas in biomedical research has increased recently, especially in virus-related studies. This is due to the fact that they create unique antibodies called nanobodies, which are more stable and smaller than ordinary antibodies. They are helpful for creating novel therapies and diagnostic instruments for infectious diseases and other medical conditions because of these characteristics.

HIV Research:

Antibodies produced by llamas have been shown to work against different strains of HIV, suggesting new possibilities for vaccine research and targeted therapies. Due to their strength and accuracy, llama-derived nanobodies are also increasingly being used in diagnostic testing [78].

COVID-19 Research and infectious diseases:
During the COVID-19 pandemic, nanobodies derived from llamas were found to bind strongly to the SARS-CoV-2 virus and prevent it from entering human cells. This discovery helped speed up research into llama-based treatments for severe coronavirus infections. [79]

Other Infectious Diseases:

The use of llama antibodies in the treatment and prevention of other bacterial and viral infections is being investigated in ongoing studies, increasing their significance in the field of global health research. [80]

(19) HORSE

The horse (Equus ferrus caballus) is a large, herbivorous mammal that has been domesticated for thousands of years for work, transport, companionship, and research. Horses typically have a lifespan of 30–35 years, with mature adults weighing between 300–1000 kg, depending on breed and nutrition. Normal physiological parameters include a body temperature of 99–105°F (37.2–40.5°C), heart rate of 28–48 beats per minute, and a respiration rate of 8–16 breaths per minute.

EXPERIMENTAL *USE OF HORSE*

Horses have historically played a significant role in biomedical, pharmacological, and veterinary research, owing to their size, physiology, and unique biological characteristics. They continue to be valuable both in human medicine and veterinary sciences.

Equine-Assisted Services

Research has explored the effects of equine-assisted services on human stress levels, including the ability of horses to perceive and respond to human emotions and stress. Such studies provide insight into animal–human interactions and their therapeutic potential [81].

Antitoxin Development:
Horses contributed to the development of therapies for diphtheria and dysentery by producing antitoxins, which were highly effective in neutralizing bacterial toxins [82].

(20) CAENORHABDITIS ELEGANS

Caenorhabditis elegans is a eukaryotic, multi-organ, transparent nematode (Hermaphrodite worm) which lives in the interstitial water of soil and survives by feeding on microbes. It is a free-living of 1mm in length that lives in temperate soil environment. C.elegans has two natural genders female(XX) and male (XO). The female – hermaphrodite can produce up to 300 progenies via self fertilization which produces easy generation of genetically identical progeny. This soil nematode offered great potential for genetic analysis, partly because of its rapid (3-day) life cycle, small size (1.5-mm-long adult), and ease of laboratory cultivation.

EXPERIMENTAL USE OF C.ELEGANS

C. elegans is an invaluable model organism in biomedical research due to its small size, short life cycle, transparent body, and fully sequenced genome. It can be easily cultured in Petri dishes with Escherichia coli as a food source, and large populations can be maintained with minimal resources. These advantages have made C. elegans a cornerstone in experimental biology.

Parkinson's studies

Parkinson's disease is studied using C. elegans as a model. Despite the absence of the human alpha-synuclein (PARK1) gene in its genome, transgenic strains that overexpress this protein have been

created. Researchers can examine the effects of pathological alpha-synuclein aggregation on neuronal health and degeneration using these models [83].

Disease Modeling

C. elegans has been extensively used to study various human diseases, including Alzheimer's disease, polycystic kidney disease, and cancer. By replicating disease-related genetic and molecular processes in the worm, researchers gain valuable insights into the mechanisms underlying these conditions [84].

Developmental Biology and neurobiology

Research on C. elegans has greatly advanced our understanding of important developmental processes like cell differentiation, organogenesis, and the formation of complex tissues. Its transparent body and invariant cell lineage allow scientists to track cell development remarkably accurately. The simple but well-mapped nervous system of C. elegans provides an excellent framework for researching neuronal development, synaptic function, and the effects of drugs or toxins on the nervous system. These investigations have improved our knowledge of both fundamental neurobiology and neurodegeneration associated with disease [85].

CONCLUSION

Pharmacology's study of animal models serves as a link between laboratory discoveries and appropriate human treatment. Every species offers a different perspective on physiology, the course of disease, and drug response, from the tiny fruit fly to the sophisticated primates. Their diversity allows researchers to answer different aspects, like zebrafish and medaka provides an illuminate study of genetics and developmental biology, rodents provide robust models for neurology and metabolism, while the other primates like marmosets and African green monkeys bring a closer understanding of human -specific conditions. Although unconventional models such as llamas, seahorse and pigeons expand the horizons of biomedical research, a novel perspective in immunology, reproduction and behavioral science. When taken as a whole, these species offer insights into developing safer, more potent treatments that eventually enhance human health. Animal models continue to be essential on the path from molecules to pharmaceuticals.

ACKNOWLEDGMENTS

The authors would like to acknowledge the facilities provided by the Bharat Institute of pharmacy situated in Hyderabad, Telangana-501510, India in executing this article.

REFERENCES

1. Wiley MJ, Joneja MG. The teratogenic effects of β-aminopropionitrile in hamsters. Teratology. 1976 Aug;14(1):43-52.
2. Ferm VH, Willhite CC, Williams KJ. Teratogenic Dose-Response Relationships of Etretinate in the Golden Hamster, 1984.
3. Factor SM, Sonnenblick EH. The pathogenesis of clinical and experimental congestive cardiomyopathies: recent concepts. Progress in cardiovascular diseases. 1985 May 1;27(6):395-420.
4. Husby G, Sletten K. Chemical and clinical classification of amyloidosis 1985. Scandinavian journal of immunology. 1986 Mar;23(3):253-65.
5. Arsenault et al. Altered Toll-like receptor 9 signaling in Mycobacterium avium subsp. paratuberculosis-infected bovine monocytes reveals potential therapeutic targets. Infection and immunity. 2013 Jan;81(1):226-37.

6. Bhathena et al. Diet-induced metabolic hamster model of nonalcoholic fatty liver disease. Diabetes, metabolic syndrome and obesity: targets and therapy. 2011 Jun 3:195-203.
7. Badihi I, Morris K, Buchanan-Smith HM. The effects of increased space, complexity, and choice, together with their loss, on the behavior of a family group of Callithrix jacchus: a case study. Laboratory Primate Newsletter. 2007; 46:1-5.
8. Chen Y et al. Common marmoset: An emerging non-human primate model for translational applications in brain disorders. Current Opinion in Neurobiology. 2025 Jun 1; 92:102998.
9. Herron IC, Laws TR, Nelson M. Marmosets as models of infectious diseases. Frontiers in Cellular and Infection Microbiology. 2024 Feb 23;14:1340017.
10. Abrahams BS, Geschwind DH. Advances in autism genetics: on the threshold of a new neurobiology. Nature reviews genetics. 2008 May;9(5):341-55.
11. Ross C et al. Metabolic consequences of long-term rapamycin exposure on common marmoset monkeys (Callithrix jacchus). Aging (Albany NY). 2015 Nov 13;7(11):964.
12. Lex ZN et al. Determining the Pharmacokinetic Properties of Two Different Doses of Meloxicam in Barred Owls (Strix varia). Animals. 2024 Oct 26;14(21):3086.
13. Beller M, Oliver B. One hundred years of high-throughput Drosophila research. Chromosome Research. 2006 May;14(4):349-62.
14. Ziehm M, Piper MD, Thornton JM. Analysing variation in Drosophila aging across independent experimental studies: a meta-analysis of survival data. Aging Cell. 2013 Oct;12(5):917-22.
15. Bolus et al. Modeling neurodegenerative disorders in Drosophila melanogaster. International Journal of Molecular Sciences. 2020 Apr 26;21(9):3055.
16. Beghi et al. Global, regional, and national burden of epilepsy, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology. 2019 Apr 1;18(4):357-75.
17. Hartung T. From alternative methods to a new toxicology. European journal of pharmaceutics and biopharmaceutics. 2011 Apr 1;77(3):338-49.
18. Aavikko et al. Loss of SUFU function in familial multiple meningioma. The American Journal of Human Genetics. 2012 Sep 7;91(3):520-6.
19. Robinson et al. The Drosophila adult brain: short overview of structure, function, and resources Graphical Review Paper. Current Research in Insect Science. 2025 May 15:100113.
20. Garofalo F et al. The Antarctic hemoglobinless icefish, fifty five years later: a unique cardiocirculatory interplay of disaptation and phenotypic plasticity. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology. 2009 Sep 1;154(1):10-28.
21. Howe K et al. The zebrafish reference genome sequence and its relationship to the human genome. Nature. 2013;
22. Newman SW. The medial extended amygdala in male reproductive behavior a node in the mammalian social behavior network. Annals of the New York Academy of Sciences. 1999 Jun;877(1):242-57.
23. Jiveskog S et al. N-ras mutations are common in melanomas from sun-exposed skin of humans but rare in mucosal membranes or unexposed skin. Journal of investigative dermatology. 1998 Nov 1;111(5):757-61.

24. Abreu MS et al. Acute exposure to waterborne psychoactive drugs attract zebrafish. Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology. 2016 Jan 1; 179:37-43.
25. Bhandari PR. Zebrafish: A novel model in psychopharmacological research. In Zebra fish Model for Biomedical Research 2022 May 31 (pp. 401-420). Singapore: Springer Nature Singapore.
26. Woolsey C et al. Establishment of an African green monkey model for COVID-19 and protection against re-infection. Nature immunology. 2021 Jan;22(1):86-98.
27. Allan JS et al. Species-specific diversity among simian immunodeficiency viruses from African green monkeys. Journal of virology. 1991 Jun;65(6):2816-28.
28. Köhler H et al. Characterization of a caprine model for the subclinical initial phase of Mycobacterium avium subsp. paratuberculosis infection. BMC veterinary research. 2015 Mar 24;11(1):74.
29. Perez de Val B et al. Experimental model of tuberculosis in the domestic goat after endobronchial infection with Mycobacterium caprae. Clinical and Vaccine Immunology. 2011 Nov;18(11):1872-81.
30. Dias IE et al. Mesenchymal stem cell studies in the goat model for biomedical research—A review of the scientific literature. Biology. 2022 Aug 27;11(9):1276.
31. Houdebine LM. Production of pharmaceutical proteins by transgenic animals. Comparative immunology, microbiology and infectious diseases. 2009 Mar 1;32(2):107-21.
32. Wang ZG, Xu ZR, Yu SD. Effects of oocyte collection techniques and maturation media on in vitro maturation and subsequent embryo development in Boer goat. Czech Journal of Animal Science. 2007 Jan 1;52(1):21.
33. Flaherty-Fischette P et al. Parents' Perceptions of the Philly Goat Project's All Abilities RAMble: A Qualitative Study of Animal-Assisted Intervention for Intellectual and Developmental Disorders. Developmental Disabilities Network Journal. 2023;3(2):11.
34. Lee RJ, Lomax P. The effect of spontaneous seizures on pentylenetetrazole and maximum electroshock induced seizures in the Mongolian gerbil. European journal of pharmacology. 1984 Oct 30;106(1):91-6.
35. Xu Y et al. Natural hosts and animal models for Rift Valley fever phlebovirus. Frontiers in Veterinary Science. 2023 Oct 19; 10:1258172.
36. Emerson SU, Purcell RH. Hepatitis E virus. Reviews in medical virology. 2003 May;13(3):145-54.
37. Hurtado-Parrado C et al. Assessing Mongolian gerbil emotional behavior: effects of two shock intensities and response-independent shocks during an extended inhibitory-avoidance task. PeerJ. 2017 Nov 13;5: e4009.
38. Szpirer C. Rat models of human diseases and related phenotypes: a systematic inventory of the causative genes. Journal of biomedical science. 2020 Aug 2;27(1):84.
39. Sarapultsev A et al. Rat Models in Post-Traumatic Stress Disorder Research: Strengths, Limitations, and Implications for Translational Studies. Pathophysiology. 2024 Dec 6;31(4):709-60.
40. Tanase H et al. Genetic analysis of blood pressure in spontaneously hypertensive rats. Japanese Circulation Journal. 1971 Jan 20;34(12):1197-212.
41. Doris PA. Genetics of hypertension: an assessment of progress in the spontaneously hypertensive rat. Physiological genomics. 2017 Nov 1;49(11):601-17.

42. Portha B et al. The GK rat beta-cell: a prototype for the diseased human beta-cell in type 2 diabetes? Molecular and cellular endocrinology. 2009 Jan 15;297(1-2):73-85.
43. Olson H et al. Concordance of the toxicity of pharmaceuticals in humans and in animals. Regulatory toxicology and pharmacology. 2000 Aug 1;32(1):56-67.
44. Gopinathan S et al. In vivo toxicology of excipients commonly employed in drug discovery in rats. Journal of Pharmacological and Toxicological Methods. 2013 Sep 1;68(2):284-95.
45. Szpirer C. Cancer research in rat models. In Rat Genomics: Methods and Protocols 2009 Oct 28 (pp. 445-458). Totowa, NJ: Humana Press.
46. Justice MJ, Dhillon P. Using the mouse to model human disease: increasing validity and reproducibility. Disease models & mechanisms. 2016 Feb 1;9(2):101-3.
47. Shultz LD, Ishikawa F, Greiner DL. Humanized mice in translational biomedical research. Nature Reviews Immunology. 2007 Feb;7(2):118-30.
48. Sharpless NE, DePinho RA. The mighty mouse: genetically engineered mouse models in cancer drug development. Nature reviews Drug discovery. 2006 Sep;5(9):741-54.
49. Jankowsky JL, Zheng H. Practical considerations for choosing a mouse model of Alzheimer's disease. Molecular neurodegeneration. 2017 Dec 22;12(1):89.
50. Lee VM, Trojanowski JQ. Neurodegenerative tauopathies: human disease and transgenic mouse models. Neuron. 1999 Nov 1;24(3):507-10.
51. Surwit RS et al. Diet-induced type II diabetes in C57BL/6J mice. Diabetes. 1988 Sep 1;37(9):1163-7.
52. Zhang SH et al. Spontaneous hypercholesterolemia and arterial lesions in mice lacking apolipoprotein E. Science. 1992 Oct 16;258(5081):468-71.
53. Barouch DH. Challenges in the development of an HIV-1 vaccine. Nature. 2008 Oct 2;455(7213):613-9.
54. Smith DJ et al. Mapping the antigenic and genetic evolution of influenza virus. science. 2004 Jul 16;305(5682):371-6.
55. Au GG et al. Characterisation and natural progression of SARS-CoV-2 infection in ferrets. Scientific reports. 2022 Apr 5;12(1):5680.
56. Kloc M. Seahorse male pregnancy as a model system to study pregnancy, immune adaptations, and environmental effects. International Journal of Molecular Sciences. 2023 Jun 3;24(11):9712.
57. Silva AP, Gallardo RA. The chicken MHC: insights into genetic resistance, immunity, and inflammation following infectious bronchitis virus infections. Vaccines. 2020 Nov 2;8(4):637.
58. Vergara MN, Canto-Soler MV. Rediscovering the chick embryo as a model to study retinal development. Neural development. 2012 Jun 27;7(1):22.
59. Kain KH et al. The chick embryo as an expanding experimental model for cancer and cardiovascular research. Developmental Dynamics. 2014 Feb;243(2):216-28.
60. Laboratory models for atherosclerosis. Kritchevsky D. Adv Drug Res. 1974
61. Everett SD. Pharmacological responses of the isolated oesophagus and crop of the chick. In Physiology of the domestic fowl 1966 (No. 1, p. 261). Oliver & Boyd.
62. Dube M et al. Gene expression changes and toxicity of selected rare earth elements in rainbow trout juveniles. Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology. 2019 Sep 1;223:88-95.

63. Horn E, Sebastian C. Adaptation of the macular vestibulo ocular reflex to altered gravitational conditions in a fish (Oreochromis mossambicus). Advances in Space Research. 2002 Jan 1;30(4):711-20.
64. Van Dyke T, Jacks T. Cancer modeling in the modern era: progress and challenges. Cell. 2002 Jan 25;108(2):135-44.
65. Colvin VL. The potential environmental impact of engineered nanomaterials. Nature biotechnology. 2003 Oct 1;21(10):1166-70.
66. Noujaim SF et al. From mouse to whale: a universal scaling relation for the PR Interval of the electrocardiogram of mammals. Circulation. 2004 Nov 2;110(18):2802-8.
67. Newport J, Kirschner M. A major developmental transition in early Xenopus embryos: I. characterization and timing of cellular changes at the midblastula stage. Cell. 1982 Oct 1;30(3):675-86.
68. Baena-López LA, Baonza A, García-Bellido A. The orientation of cell divisions determines the shape of Drosophila organs. Current biology. 2005 Sep 20;15(18):1640-4.
69. Kaltenbrun E et al. Xenopus: An emerging model for studying congenital heart disease. Birth Defects Research Part A: Clinical and Molecular Teratology. 2011 Jun;91(6):495-510.
70. Allison DJ, Ditor DS. Immune dysfunction and chronic inflammation following spinal cord injury. Spinal cord. 2015 Jan;53(1):14-8.
71. Allegrucci C et al. Epigenetic reprogramming of breast cancer cells with oocyte extracts. Molecular Cancer. 2011 Jan 13;10(1):7.
72. Bell MR et al. A neuroprotective role for polyamines in a Xenopus tadpole model of epilepsy. Nature neuroscience. 2011 Apr;14(4):505-12.
73. Antoine DJ et al. Mechanistic biomarkers provide early and sensitive detection of acetaminophen-induced acute liver injury at first presentation to hospital. Hepatology. 2013 Aug;58(2):777-87.
74. Boutorine AS et al. Fullerene–oligonucleotide conjugates: photoinduced sequence-specific DNA cleavage. Angewandte Chemie-International Edition. 1995 Jan 3;33(23-24):2462-5.
75. Akins CK, Zentall TR. Imitative learning in male Japanese quail (Coturnix japonica) using the two-action method. Journal of Comparative Psychology. 1996 Sep;110(3):316.
76. Wang A, Hu C. Antimicrobial resistance analysis of Escherichia coli isolated from pigeons in Qingdao, Shandong province, China. Genes. 2022 Aug 24;13(9):1510.
77. Buchacher A et al. Generation of human monoclonal antibodies against HIV-1 proteins; electrofusion and Epstein-Barr virus transformation for peripheral blood lymphocyte immortalization. AIDS research and human retroviruses. 1994 Apr;10(4):359-69.
78. Gray A. Covid-19 treatment hope derived from llamas. The Veterinary Record. 2021 Oct 8;189(7):264.
79. Strokappe N et al. Llama antibody fragments recognizing various epitopes of the CD4bs neutralize a broad range of HIV-1 subtypes A, B and C. PloS one. 2012 Mar 15;7(3):e33298.
80. Muyldermans S. Nanobodies: natural single-domain antibodies. Annual review of biochemistry. 2013 Jun 2;82(1):775-97.
81. Muller-Klein A et al. A Relaxed Horse—A Relaxed Client? An Experimental Investigation of the Effects of Therapy Horses' Stress on Clients' Stress, Mood, and Anxiety. Animals. 2024 Feb 13;14(4):604.
82. PARK WH. Toxin-antitoxin immunization against diphtheria. Journal of the American Medical Association. 1922 Nov 4;79(19):1584-91.

83. Akinyemi AJ et al. Lead (Pb) exposure induces dopaminergic neurotoxicity in Caenorhabditis elegans: Involvement of the dopamine transporter. Toxicology reports. 2019 Jan 1;6:833-40.
84. Wu Y et al. Towards understanding neurodegenerative diseases: insights from Caenorhabditis elegans. International Journal of Molecular Sciences. 2024 Jan;25(1):443.
85. Ahmed S et al. C. elegans RAD-5/CLK-2 defines a new DNA damage checkpoint protein. Current Biology. 2001 Dec 11;11(24):1934-44.

HOW TO CITE: Pasupulati Haritha, Jarupla Mahika, Ambala Syama, Mogilicherla Archana, Dr. Ramadevi Pemmereddy The Role of Laboratory Animals in Pharmacological Testing and Drug Development, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 8, 3248-3264, https://doi.org/10.5281/zenodo.22044480