**READING PASSAGE 1**

You should spend about 20 minutes on **Questions 1-13** which are based on Reading Passage 1 below.

# Insects and Inspired Artificial Robots

**A**

The creation of artificial devices with life-like characteristics has been pursued for over 2,000 years, beginning, as did so many things in our modern world, in Ancient Greece. For example, among the inventions of Hero of Alexandria were a windmill-operated pipe organ and a mechanical theatrical play.

**B**

With the raise of cybernetic approaches in the late 1940s and early 1950s. A wide variety of electromechanical machines designed to mimic biological processes and systems were constructed. Perhaps the best-known and most directly relevant to biorobotics is W. Gray Walters' robotic "tortoises" Elsie and Elmer. Walters was a physiologist who made important early contributions to electroencephalography and clinical neurophysiology. His tortoises were small mobile robots covered by a hard shell. The robots were driven by steerable motorized wheels and possessed a headlight, a light sensor, and a touch sensor that responded when the shell was hit. Their behavior was controlled by electronic circuit analogues of neural circuits. The behavioral repertoire of the tortoises included exploration, both positive and negative phototropism, and obstacle avoidance. The activation of these different behaviors in interaction with the robots' environment could produce a variety of behavioral sequences. Although originally designed to explore Walters' theories of brain function, the tortoises became objects of popular fascination in much the same way that ancient automata did.

**C**

The seeds of the modern renaissance of biorobotics were sown from the mid 1980s to mid 1990s. A key event in this resurgence was Rodney Brooks' work on behavior-based robots. Although not as directly based on biology as later work would be, Brooks argues that nontrivial and flexible behavior in a robot could be generated by the interaction between simple control machinery and its environment, demonstrating his point with robots accomplishing such tasks as insect-like walking. Another important milestone was Raibert's work on hopping and legged robots, which emphasized the central role of energetics in the dynamic balance and locomotion of animals. Based on studies of serpentine motion, Hirose developed a number of snake-like locomotors and manipulators. In the early 1990s, Beer, Quinn, Chiel & Ritzmann developed a series of hexapod robots based directly on cockroach and stick insect body morphology and neural control. Early biorobotic work on the sensory side includes Franceshini's robotic compound eye based on

studies of insect eyes and motion-sensitive neurons in the fly, Webb's robotic model of cricket phonotaxis and Grasso et al's robotic model of lobster chemical orientation strategies. An early example of robots whose control was based on theories of human brain function is given by the work of Edelman et al.

**D**

There has been an explosion of work in biorobotics in recent years, with robotic vocal tracts, jaws, retinas, expressive faces, hands, arms, legs, etc. deployed on robotic worms, snakes, ants, flies, crickets, cockroaches, walking stick insects, dinosaurs, bats, lobsters, tuna, pickerel, turkeys, apes and humanoids. Thus, no brief survey could possibly do justice to the range of work being undertaken.

**E**

A recent example of biologically-inspired robotics is Spenko et al's work on a hexapedal robotic climber called RiSE. In order to grip a vertical surface, this robot combines both bonding mechanisms inspired by the structure of gecko feet and interlocking mechanisms inspired by the structure of insect spines and claws. In addition, its design is based on a set of principles that have been found to be common to many climbing animals: a sprawled posture keeps the body close to the surface so as to reduce the pitch-back moment; front limbs pull inward and rear limbs push outward so as to counteract the pitch-back moment; a long body reduces the pull-in force required of the front limbs; lateral forces act inward toward the central axis of the body; complaint legs, ankles and toes so as to distribute contact forces. Each of the six legs of RiSE have two degrees of freedom and the robot also possesses s static tail that presses against the surface to reduce the pull-in forces required of the front legs. The robot uses a wave gait in which only one leg at a time is lifted from the surface. In addition to an open-loop gait generator, RiSE utilizes a variety of feedback controllers, including traction force control, normal force control and gait regulation. In addition, the robot has a pawing behavior that allows a foot that fails to grasp on initial contact to reestablish a grip on the climbing surface. Spenko et al have demonstrated that RiSE is able to traverse a variety of horizontal and vertical surfaces, including climbing trees and brick or cinder block walls.

**F**

A powerful example of biorobotic modeling is provided by the aerodynamics of insect flight. Although quasi-steady-state aerodynamical analyses of the sort used to understand aircraft have been successfully applied to larger animals, they have not been very successful for explaining the generation of lift in small flying insects due to the tiny wingspans, relatively slow flight speeds and extremely fast wing movements involved. However, a recent biorobotic model by Dickinson and colleagues has begun to shed considerable light on the unsteady aerodynamics insect flight. Because of the delicate size and high speed of insect wings, direct

measurement of the forces involved is extremely difficult. For this reason, a robotic model with a 60 cm wingspan was used to explore the non-steady-state airflow during hovering by the fruit fly Drosophila melanogaster. In order to reproduce the Reynolds number relevant to small insects flying in air, their model was submerged in mineral oil and scaled both in space and time. Force sensors at the base of one wing allowed direct measurement of the forces produced and illumination of air bubbles in the tank allowed direct observation of the fluid flow around the robotic wings. Dickinson and colleagues found that three major mechanisms contributed to lift generation in the model. First, vortices formed at the leading edge of the wing produce lift during much of the power stroke. Second, additional lift is produced by circulation of air around the wings due to rapid rotation at the beginning and end of each stroke. Third, further forces are produces at the start of each upstroke and downstroke due to collisions of the wings with the swirling wake produced by the previous stroke, a mechanism termed wake capture. Due to the sensitivity of these latter two mechanisms to the timing of wing rotation, the model suggests that the control of small details of wing motion can be used in steering flight.

**Questions 1-6**

Choose the most suitable headings for paragraphs **A-F** from the list of heading below.

*Write appropriate number (**i-x**) in boxes **1-6** on your answer sheet.*

**NB** *There are more headings than paragraphs, so you will not use them all.*

**List of Headings**

**i** A biorobotic model exploring insect flight
**ii** Modern practices of artificial device usage
**iii** Robotic climber better than gecko
**iv** Insect fight inspires the applications of steering operation
**v** Prosperity of biorobot family
**vi** The revival of modern biorobotics
**vii** Combine machines and environment
**viii** The advent of robots and their effects on modern society
**ix** The most famous biorobot in early days
**x** Bionics device is not a modern conception

**1** Paragraph **A**
**2** Paragraph **B**
**3** Paragraph **C**
**4** Paragraph **D**
**5** Paragraph **E**
**6** Paragraph **F**

**Questions 7-11**

Use the information in the passage to match the people (listed **A-E**) with opinions or deeds (listed **7-11**) below.

*Write the appropriate letters **A-E** in boxes **7-11** on your answer sheet.*

**NB** *Some people may match more than one discovery.*

**A** W. Gray Walters

**B** Rodney Brooks

**C** Michael Dickinson

**D** Spenko et al

**E** Edelman et al

**7** _____ made contributions to neurophysiology.

**8** _____ endowed robots with agility from the innovation of machinery environmental fit.

**9** _____ generated mechanical intelligence inspired by the way human brain works

**10** _____ modified mechanical models based on the structure of insects.

**11** _____ found the mechanism of insect flight

**Questions 12-13**

Choose words from the passage to answer the questions **12-13**, writing **NO MORE THAN THREE WORDS** for each blank.

**12** What plays the most critical role in Raibert's hopping and legged robots?

**13** What allowed direct measurement of the lifting forces of the biorobotic model?

**READING PASSAGE 2**

You should spend about 20 minutes on **Questions 14-26** which are based on Reading Passage 2 below.

# Extinction of Aussie Animals

**A**

World Wildlife Fund Australia has revealed its list of extinct wildlife to coincide with Australia Day. The list covers a wide range of species, from birds to reptiles, marsupials, insects and even flowers. Top of the list is the green and gold frog which has had its home decimated by drought." Many Aussie spices need our help in order to survive," WWF threatened species program manager Kat Miller said. "Without knowing the reason many had disappeared for, we will risk losing another 346 animal and 1249 plant species listed as threatened under federal legislation. Australia has the one of the worst record of mammal extinction in the world". WWF

Australia said 9 percent of birds, 7 percent of reptiles and 16 percent of amphibians are extinct since early human settlement.

**B**

The conservation group said half the mammals that have become extinct globally in the last 200 years have been Australian species. Ancient hunters and gatherers may have triggered the failure of the annual Australian Monsoon some 12,000 years ago by burning massive tracts of the country's interior, resulting in the desertification that is evident today, says a new study. Researcher Gifford Miller of the University of Colorado at Boulder said the new study builds on his research group's previous findings that dozens of giant animal species became extinct in Australia 50,000 years ago due to ecosystem changes caused by human burning. This study, appearing in Geology, indicates such burning may have altered the flora enough to decrease the exchange of water vapor between the biosphere and atmosphere, causing the failure of the Australian Monsoon over the interior.

**C**

"The question is whether localized burning 50,000 years ago could have had a continental-scale effect," said Miller. "The implications are that the burning practices of early humans may have changed the climate of the Australian continent by weakening the penetration of monsoon moisture into the interior". A paper on the subject by Miller appears in the January issue of Geology. Co-authors include CU Boulder's Jennifer Mangan, David Pollard, Starley Thompson and Benjamin Felzer of the National Center for Atmospheric Research in Boulder and John Magee of Australian National University in Canberra.

**D**

Geologic evidence indicates the interior of Australia was much wetter about 125,000 years ago during the last interglacial period. Although planetary and meteorological conditions during the most recent ice age caused Earth's major monsoons to waver, all except the Australian Monsoon were "reinvigorated" to full force during the Holocene Period beginning about 12,000 years ago, he said. Although the Australian Monsoon delivers about 39 inches of rain annually to the north coast as it moves south from Asia, only about 13 inches of rain now falls on the continent's interior each year, said Miller. Lake Eyre, a deep-water lake in the continent's interior that was filled by regular monsoon rains about 60,000 years ago, is now a huge salt flat that is occasionally covered by a thin layer of salty water.

**E**

The earliest human colonizers are believed to have arrived in Australia by sea from Indonesia about 50,000 years ago, using fire as a tool to hunt, clear paths, signal each other and promote the growth of certain plants, he said. Fossil remains of browse-dependent birds and marsupials indicate the interior was made up of trees, shrubs and grasses rather than the desert scrub environment present today.

**F**

The researchers used global climate model simulations to evaluate the atmospheric and meteorological conditions in Australia over time, as well as the sensitivity of the monsoon to different vegetation and soil types. A climate model simulating a forested Australia produced twice as much annual monsoon precipitation over the continental interior as the model simulating arid scrub conditions, he said.

**G**

"Systematic burning across the semiarid zone, where nutrients are the lowest of any continental region, may have been responsible for the rapid transformation of a drought-tolerant ecosystem high in broad-leaf species to the modern desert scrub," he said. "In the process, vegetation feedbacks promoting the penetration of monsoon moisture into the continental interior would have been disrupted". More than 85 percent of Australia's mega fauna weighing more than 100 pounds went extinct roughly 50,000 years ago, including an ostrich-sized bird, 19 species of marsupials, a 25-foot-long lizard and a Volkswagen-sized tortoise, he said.

**H**

Evidence for burning includes increased charcoal deposits preserved in lake sediments at the boundary between rainforest and interior desert beginning about 50,000 years ago, Miller said. In addition, a number of rainforest gymnosperms – plants whose seeds are not encased and protected and are therefore more vulnerable to fire –went extinct at about that time. Natural fires resulting from summer lightning strikes have played an integral part in the ecology of Australia's interior, and many plant species are adapted to regimes of frequent fires, he said. "But the systematic burning of the interior by the earliest colonizers differed enough from the natural fire cycle that key ecosystems may have been pushed past a threshold from which they could not recover."

### Questions 14-16

Reading Passage 2 contains 8 paragraphs **A –H**.

Which paragraphs state the following information?

*Write the appropriate letters **A-H** in boxes **14-16** on your answer sheet.*

**14** Why did an interior Australian lake change to a dry flat?

**15** When did an ostrich-sized bird go extinct?

**16** Why did the ancient settlers in Australia burn the forests?

### Questions 17-20

Choose **ONE** phrase from the list of phrases **A-G** below to complete each of the sentences 17-20 below.

Write the appropriate letters (**A-G**) in boxes **17-20** on your answer sheet.

**17** Ancient hunters and gatherers

**18** January issue of Geology

**19** Fossil remains
**20** A climate model
**A** _____ caused the failure of the annual Australian Monsoon by burning tracts.
**B** _____ were responsible for the distinction of an Australian giant animal species because of their massive hunting.
**C** _____ showed that in the past the interior of Australia was not a desert.
**D** _____ altered the flora to decrease the exchange of water vapor between the biosphere and atmosphere.
**E** _____ suggested that the changed climate of the Australian continent was led by the weakened penetration of monsoon moisture into the interior.
**F** _____ indicated that the forests facilitated more rainfall.
**G** _____ indicated that the extinction of an Australian species resulted from changes in the local ecosystem.

**Questions 21-26**
Do the following statements agree with the claims of the writer in Reading Passage 2?
On your answer sheet please write
**TRUE** if the statement is true
**FALSE** if the statement is false
**NOT GIVEN** if the information is not given in the passage.
**21** According to the WWF, Australia has the worst record of animal extinction in the world.
**22** In Australia, hundreds of endangered animals and plants species will keep disappearing.
**23** The distinction of Australian giant animals was a knock-on effect after human burning ceased the monsoon.
**24** Lake Eyre has always been filled with salty water.
**25** It is a theoretic assumption that early humans burned massive tracts in Australia.
**26** Varieties of plants from Australia's interior have now adapted to recurrent fires.

**READING PASSAGE 3**
You should spend about 20 minutes on **Questions 28-40** which are based on Reading Passage 3 below.

**The Myth of the Five Senses**

**A**

We see with our eyes and taste with our tongues. Ears are for hearing, skin is for feeling and noses are for smelling. Would anyone claim that ears can smell, or that tongues can see? As a matter of fact, yes. Paul Bach-y-Rita, a neuroscientist at the University of Wisconsin at Madison, believes that the senses are interchangeable; for instance, a tongue can be used for seeing. This "revolutionary" study actually stems from a relatively popular concept among scientists; that the brain is an accommodating organ. It will attempt to carry out the same function, even when part of it is damaged, by redirecting the function to another area of the brain. As opposed to previous mainstream scientists' understanding that the brain is compartmentalized, it is now more acceptable that the individual "part" of the brain could be somewhat interchangeable.

**B**

Paul Bach-y-Rita's experiments suggest that "we experience the five senses, but where the data comes from may not be so important". In the article "Can You See With Your Tongue?" the journalist was blindfolded with a small video camera strapped to his forehead, connected to a long plastic strip which was inserted into his mouth. A laptop computer would convert the video's image into a fewer number of pixels, and those pixels would travel through the plastic strip as electric current, reaching the grid of electrodes that was placed inside the man's mouth. The scientist told the man that she would soon be rolling a ball towards his right side, left side, or center, and he would have to catch it. And as the journalist stated, "my eyes and ears have no way to tell where it's going. That leaves my tongue... has more tactile nerve endings than any part of the body other than the lips". The scientist rolled the ball and a "tingling" passed over the man's tongue, and he reached out with his left hand and caught the ball.

**C**

If the brain can see a ball through a camera and a wet tongue, many new questions arise. What does this concept imply in terms of blindness and deafness? Rather than attempting to reserve these sensory disabilities through surgeries and hearing aids, should we be trying to circumvent them by using different receptors?4 Can we still trust in the idea of the five senses, or was it wrong to categorize our perception of the outside world so strictly?

**D**

In fact, the "five senses" may well be another story that should be discarded in lieu of new observation. Aside from the emerging possibility of interchanging a tongue and an eye, there is the highly accepted possibility that our original list of senses is incomplete. Many scientists would add at least these two senses to the list: the kinesthetic sense and the vestibular sense. The first is a sense of self, mostly in terms of limbs and their placement. For instance, I know where my right foot is without looking or feeling for it. It is something that my brain "knows". This is said

to be because of information sent to the brain by the muscles, implying that muscles should be added to the list of sensory organs. If more observations were to be collected on this subject, a more accommodating explanation could potentially be reached. Secondly, the vestibular sense is what most would consider a sense of balance.

**E**

Why were these two senses not included in our limited list? It might be the result of a lack of external symbolism. A nose or an eye is an obvious curiosity because of the question it generates: "What does this thing do?" But we have no limb or facial organ dedicated to balance or to kinesthetic awareness. On the other hand, if the vestibular sense and the kinesthetic senses occur solely in the brain, are they truly senses? Should experiences be labeled as senses without representation by an external organ? If one believes that the brain is the true sensory organ and the rest are simply interchangeable receptors, then yes, we should remain open to labeling many new "experiences" as "senses". But, is there perhaps an overlying truth that directly relates the five senses to the human experience of life?

**F**

On way of gaining new insight is to explore the animal world of senses. Migrating animals, for example, are said to have a "sixth sense", a term which alludes to all unexplainable phenomenon. In reality, what we call the sixth sense includes any number of unrelated senses that everyday humans do not possess and therefore know little about. Perhaps there is a sense of placement on the earth, similar to the kinesthetic sense of bodily placement, which helps animals return home. Perhaps it is simply a "sense of direction" that is more developed or more substantial than what human possess. Scientists have even conjectured that traces of magnetite, found in pigeons and monarch butterflies, could be used as a compass, enabling the animal to sense the magnetic fields of the earth. Those who use the term "mysterious sixth sense" rarely give details about which of these strange abilities they are referring to? The term relating to "past our understanding" is used in such a sweeping, general way that there is no one solid, falsifiable hypothesis. This term does not bring us closer to our understanding of the senses.

**G**

In addition to internal mysteries, many animals also possess external sensory organs which we do not. Fish, for instance, have an organ that runs along the sides of their bodies called the lateral-line system. It is made of tiny hair-like sensors that receive information about movements in the water. There is even the ability to distinguish between ordinary, background movement and strange movement that could signify a predator or another creature. This sense also helps the fish to "orient themselves within the current and the stream flow". Interestingly, "land vertebrates... lost their lateral-line systems somewhere along the evolutionary path,

all vertebrates started out with them..." Of course, we no longer consider this sense to be a human perception of life because we no longer possess the organ. But has the sense remained? Perhaps the feeling of being watched, of being followed on a dark sidewalk, is a dull shadow of the sense we used to possess. It is particularly noteworthy that this "feeling" of being followed is often referred to as "intuition". How is intuition related to senses? In the same sense, how are emotions and senses the same?

**H**

New stories that could expand our categorical concepts of the senses are emerging constantly, but we seem to prefer holding onto the old concept of five senses. We would urge towards expanding that category numerically and conceptually. There is much to be explored in terms of the relation of sense and emotion, the utilizations and disabilities of the senses, and a vertebrate's need for senses compared to other types of animals, in terms of participating in life. The interconnectedness of our senses within the brain and among the external organs is a concept worthy of more attention and exploration, and it will explored more easily when the old, rather arbitrary myth of the five senses is discarded.

**Questions 28-32**

Reading Passage 3 contains 8 paragraphs **A-H**.

Which paragraphs state the following information?

*Write the appropriate letters **A-H** in boxes **28-32** on your answer sheet.*

**28** Practices of animal migration have helped expand our knowledge of the senses.

**29** The subject caught the ball with the help of his tongue.

**30** The brain knows where my right foot is without looking at it.

**31** An example showing that people's intuition may work.

**32** Humans probably lost a kind of sensory organ during evolution.

**Questions 33-37**

Complete the summary below.

Choose your answer from the list below and write them in boxes **33-37** on your answer sheet.

**NB** *There are more words than spaces so you will not use them all.*

Many scientists believe that our **33** _____ list of senses lacks other important elements, like the sense of kinesthetic and vestibular. For the first itself, majority cases are about the **34** _____ of our arms and legs. For example, we can feel our feet without looking for them, due to the information link between brain and our **35** _____. For the vestibular sense, it would provide us with **36** _____. That these two senses are excluded from our list might be the result of a lack of external **37** _____.

**initial placement sensory organs**
**limb entrain tongue**
**movement stability representation**
**dark muscles picture**

## Questions 38-40

Do the following statements agree with the claims of the writer in Reading Passage 3?

On your answer sheet please write

**TRUE** if the statement is true

**FALSE** if the statement is false

**NOT GIVEN** if the information is not given in the passage.

**38** Senses are transposable just as the tongue can also be used to hear sounds.

**39** Animals are considered to have senses other than the original five.

**40** New stories and research have persuaded us to accept the conception of five senses.