PART B: READING COMPREHENSION

INSTRUCTIONS: Read the following passage and answer the questions on pages 4 to 7 of the examination booklet.

Adapted from **Bugs of Wonder**

by Margaret Munro

1 One lives in a solution so salty it would make you gag. Another thrives at temperatures hot enough to kill most other living things. "They're perfectly happy," says biochemist Patrick Dennis of the microbes in a toasty 80-degree Celsius vat in his University of BC lab.

2 The heat-loving microscopic organisms, like their salt-loving cousins in a flask down the hall, are some of the stranger members of the ever-expanding microbial family that is shaking up long-held assumptions about life, its origin and its resilience.

3 "We're starting to see microbes in places that are just unbelievable," says UBC microbiologist Bob Hancock, rattling off some of the improbable locales. "They seem to defy just about everything we know about life."

4 Tiny organisms have been found laying down gold deposits in South America; surviving on a diet of basalt rock several kilometres underground in Sweden; residing in scalding deep-sea vents off the BC and Washington coast; living on frigid rocks in the Antarctic.

5 They've "put the lie" to the name of the Dead Sea, which scientists now realize can teem with invisible life. Microbes may even be growing on distant planets, according to geophysicists studying tantalizing signs of life on a meteorite from Mars.

6 It's possible—but impossible to prove without a better extraterrestrial sample—that life on Earth started when contaminated dust or rock dropped in from space. Such microscopic aliens may, according to evolutionary biologists, have planted the microbial seeds that over the eons branched into the tree of life found on Earth today.

7 Even without such space invaders, the tree has recently been shaken to its roots.

8 A vast family of new microorganisms, which has been named archaea, has been found living in everything from the backyard garden to the deep sea floor. Archaea are so different from bacteria that biologists have decided they deserve their own branch on the tree of life.

9 Scientists are also realizing just how critical a role microbes played in shaping the planet: they gave the atmosphere its oxygen two billion years ago; they were critical to the formation of the biosphere; they helped shape many energy and mineral deposits by concentrating everything from gold to oil.

10 A Canadian team has concluded that microbial handiwork laid down the famed Serra Pelada gold field in the Amazon jungle. The scientists say the rich lode—more than 100 tonnes—was produced not by the accepted mechanisms of ore formation but by swarms of microbes that over millions of years concentrated the gold from jungle soils and rivers and rocks.

OVER

11 Researchers are also digging up piles of evidence—such as deposits packed with strings of tiny crystals that microbes strung together like tiny diamonds—that microorganisms helped lay down many of the world deposits of carbonates, phosphates, oxides and sulphides.

12 "It is really very obvious there is a strong link between geoscience and microbiology," says Hojatollah Vali, a bio-mineralization specialist at McGill University and a member of the NASA team that analysed signs of microbial life on the Mars meteorite earlier this year.

13 As biologists like to point out, the life that's invisible to the naked eye remains one of the most important forms of life on the planet.

14 Polar bears and spotted owls may be environmental darlings. But as UBC's Dennis puts it, they're "bit players." It's microbes that dominate life on earth.

15 Though incredibly small, he notes that they're also incredibly common.

16 "They're everywhere," says Dennis.

17 Each millilitre of sea water contains as many as 10 million single-celled organisms. Up to half of them may belong to the recently discovered microbial family, archaea. Unlike phytoplankton that live on in the sea's top layer, archaea and bacteria are found from the top to the bottom of the sea.

18 This is why some scientists—Dennis among them—figure microbes are the most common form of life on the planet.

19 "They're major players in terms of biomass," Dennis says. "Yet we have relatively little understanding of what they're doing."

20 "They're turning out to be far more diverse and complex than we expected," adds Rosie Redfield, a UBC microbiologist who, like Dennis, is part of the evolutionary biology team put together by the Canadian Institute for Advanced Research.

21 "We know so little about the biology around us," says Redfield, who marvels over the way knowledge about microbes is "just exploding."

22 Until recently most bacteria and archaea have been ignored because they're as innocuous as they are ubiquitous: they don't cause disease and death. Most are difficult to grow in a laboratory.

23 "Only one per cent of the microbes found in sea water will grow in culture," Dennis says.

24 The recent discovery of microbes in so many unexpected places, coupled with the advent of gene-analysing techniques, has enabled scientists to realize how diverse the microbial world is.

25 Archaea, for example, look like run-of-the-mill bacteria under the microscope. In fact, scientists thought for years they were bacteria. Only after genetic inspection did scientists realize they were a distinct breed of life.

26 Archaea employ very different and more sophisticated biochemical processes than bacteria do, and followed an evolutionary path all their own. To get a better read on what sets them apart, Dennis's UBC team has been breaking down two strains of archaea to molecular pieces.

27 One thrives in a high-salt environment that would literally suck life out of other life forms. These microbes occur around the world in salt ponds and other high-salt environments, including the Dead Sea. They've even been found inside salt crystals in British salt mines.

28 The other microbe they are dissecting is a heat-lover known as sulfolobus. It is common in hot springs, geysers and deep-sea vents, where temperatures can hit 350 degrees Celsius.

29 The UBC work is part of an international research effort to define the chemical tricks the microbes use to survive in extreme environments.

30 Powerful chemical bridges are built into the microbes' proteins to hold the molecules together. This allows the proteins, which include enzymes and other chemical workhorses, to maintain their shape and function in heat and salt that would destroy the flimsier proteins common to other microbes.

31 There are plenty of practical applications for the tough molecules. Some enzymes from heat-loving archaea have already been put to work in genetic engineering machines, where they copy and splice together genetic molecules. And they may prove valuable in industrial processes that require high heat.

32 There is speculation that organisms in the archaea family are the closest remaining descendants of Earth's earliest life forms. That is because so many of the microbes thrive in extreme environments that might have been common when primordial stew swirled around the planet.

33 Dennis says recent speculation that microbes lived on Mars once again raises the possibility that life on Earth was seeded from space. It's clear from biochemicals found in everything from archaea to humans that all life on Earth shares common ancestors: proteins, genes and nucleic acid on Earth all use the same building blocks. And life on other planets could use the same chemicals. But without an extraterrestrial sample, the question will remain unanswered.

34 While the scientists have used every possible tool at their disposal to prove the meteorite was once inhabited by Martian microbes, Vali says the evidence remains suggestive but inconclusive. "We don't have the proof yet."

OVER