問題１．次の文章を読み、設問に答えなさい。なお「*」の付いた語句は本文の後に語注があるので参考にしなさい。

①A recent study from the University of Manchester has seen microplastics* in the headlines: looking across 40 riverbeds* in urban, suburban and rural regions of northwest England, the team of researchers found that all but one of the sites they investigated were polluted with microplastic. Some contained more than 500,000 particles of microplastic per square meter - the highest concentration ever found in any body of water （ a ） date.

Microplastics are （ A ） than tiny pieces of plastic, less than 5 millimeters （ b ） diameter. The smallest microplastic particles detected, however, are considerably smaller than this - thousands could fit on a single pinhead. ②In fact, it is likely that very tiny plastic particles exist which are simply too small to detect using standard research methods. Most of us are familiar with the plastic items we use day-to-day as being relatively large - certainly larger than a microplastic particle. So where microplastic comes from may seem a bit of a mystery.

Generally speaking, ③microplastics are categorized as 'primary' or 'secondary' based on their origin. 'Primary' implies that microplastic particles were 'deliberately' produced as part of a manufacturing process. A large source of such microplastic particles are cleaning products. They are also widely used to manufacture medicines – microbeads* have versatile* properties which can be exploited, for instance, to help deliver drug components to particular sites in the body. Another important primary source of microplastics are textiles - tiny plastic fibers can rub off fabrics when they are washed.

'Secondary' microplastics arise when large plastic materials are progressively broken down into smaller fragments through environmental processes. There are two stages to this process. First, the plastics are degraded*. Usually, degradation* occurs during exposure of plastic to sunlight. When plastics are exposed to UV light* they undergo 'photo-oxidative degeneration' - breakdown through the action of light. The second stage to the process is fragmentation*. The weakened, fragile plastic will fall apart into tiny particles. Degradation and fragmentation occur very efficiently on beaches, where sand reaches high temperatures and the plastic is exposed to plenty of light. Plastics already in bodies of water, such as the sea, are at lower temperatures and are generally exposed to less UV light. Additionally, they tend to get coated in biofilms*, which makes the plastic more resistant to degradation. As such, the vast majority of secondary microplastics originate on beaches, and are subsequently washed in to the sea.

No matter where microplastics originate, the final common end-point in their journey is the oceans. Microplastics from domestic and industrial use are collected in sewage* and wastewater, and can be washed out of riverbeds and off beaches during rainstorms. Often, they end up in the sea directly, either due to accidents during transport, or through human littering* of coastlines. As we already saw, because degradation occurs (B) efficiently once plastics are in the water, direct littering of the ocean is a much less important source of microplastic compared to beaches.

(c) present, it is not entirely clear what effect microplastics have on marine wildlife. Importantly, they are similar (d) size to phytoplankton*, which forms the staple diet of zooplanktons*. It has been observed in laboratory studies that zooplanktons do not differentiate* between phytoplankton and microplastic particles when feeding. Zooplanktons themselves are consumed by larger marine organisms, including fish. (C) , microplastics can have an effect on every level of the marine food chain.

Although there is a possibility that microplastics are directly toxic to marine organisms, this seems (D) - most organisms don't have the means to break down microplastics in their digestive tracts*, and as such, the particles are thought to be relatively inert*. However, microplastics usually contain precursors* left over from the manufacturing process, and also accumulate by-products* of degradation as they are exposed to heat and sunlight. Such compounds are thought to be toxic, and there is evidence that they 'leak out' of microplastics over time. This in itself contributes to the overall level of pollutants* in the ocean. It is also possible that such chemicals could reach harmful levels within marine organisms through the progressive build-up of microplastics in the food chain.

A much bigger area of concern is the way in which microplastic particles interact with pollutants in the water. The biggest culprits* involved in this interaction are chemicals known as 'Persistent Organic Pollutants*' or POPs. POPs become accumulated on the surface of microplastic particles, and achieve concentrations many times higher than in the surrounding water. Due to ④this effect, POP-coated microplastic particles are likely to have toxic effects on marine microorganisms, such as planktons. POPs then gradually accumulate in tissues and organs of larger marine species. They particularly seem to collect in fat tissues. The extent of damage this could cause is still unclear, but all consensus* is that it is likely to have a considerable impact on marine ecosystems.

An issue with microplastics is that they do not biodegrade* - or at the very least, biodegrade at extremely slow rates. This means that once present, they cannot be removed from the environment through natural processes. (E) , they are often too small to be efficiently removed through mechanical means from the bodies of water that they occupy. This means that the best way to limit the damage done by microplastics is to ensure that they do not enter marine ecosystems in the first place.

As recognition of microplastics as a major ecological concern grows, scientists, governments, and industries are slowly beginning to catch up with attempts to limit the harm done. However, as the study from the University of Manchester shows, we still have a long way to go in our understanding of the true scale of microplastic pollution, and the magnitude of the effect this is having on natural ecosystems.

出典；Isabelle Cochrane, Microplastics: why the big deal? The Naked Scientists Science Features (13 April 2018) より抜粋、一部改変

［語注］

microplastic　マイクロプラスチック
riverbed　河床、川底
microbead　ビーズ状の微細プラスチック
versatile　多用途の
degrade　質を下げる
degradation　分解、劣化
UV light　紫外線
fragmentation　破砕、断片化
biofilm　バイオフィルム、菌膜
sewage　下水
littering　ごみの投棄
phytoplankton　植物プランクトン
zooplankton　動物プランクトン
differentiate　区別する
digestive tract　消化管
inert　不活性の
precursor　前駆物質
by-product　副産物
pollutant　汚染物質
culprit　（好ましくない状況の）原因

Persistent Organic Pollutant　残留性有機汚染物質

consensus　一致した意見

biodegrade　生分解する

［設問１］本文中の空所（ A ）から（ E ）に入る語句として最も適切なものを、それぞれの選択肢ア～オから１つ選び、その記号を答えなさい。

（ A ）ア. nothing more　イ. anything more　ウ. something less
エ. everything less　オ. anything less

（ B ）ア. more and more　イ. no more　ウ. no less
エ. much less　オ. more or less

（ C ）ア. In this way　イ. On top of that　ウ. On the contrary
エ. In comparison　オ. For the meanwhile

（ D ）ア. acceptable　イ. predictable　ウ. probable
エ. reasonable　オ. unlikely

（ E ）ア. Additionally　イ. Continuously　ウ. Fortunately
エ. Incredibly　オ. Increasingly

［設問２］本文中の（ a ）から（ d ）に入る適切な前置詞を一語で答えなさい。

［設問３］下線部①の研究により、どのようなことが判明したか。句読点を含めて 75 字以内の日本語で答えなさい。

［設問４］下線部②を日本語に訳しなさい。

［設問５］下線部③の primary 及び secondary は、マイクロプラスチックの生成過程に関して具体的に何を意味しているのか。両者の違いが分かるように、句読点を含めて 75 字以内の日本語で答えなさい。なお、その際、primary は「前者」、secondary は「後者」と表記しなさい。

［設問６］下線部④は具体的にはどのようなことを指しているか。句読点を含めて 60 字以内の日本語で答えなさい。

［設問７］マイクロプラスチックを薬品に添加することにより得られる利点は何か。句読点を含めて 30 字以内の日本語で答えなさい。

［設問８］以下のア～クの文のうち、本文に一致するものを全て選び、その記号を答えなさい。

ア．英国のある地域では、マイクロプラスチックの拡散状況が解明され、生態系への悪影響が報告されている。

イ．海棲動物はプラスチックを消化せずに排出するため、マイクロプラスチックの汚染を心配する必要はほとんどない。

ウ．海中のプラスチックは紫外線にさらされることが少なかったり、バイオフィルムで覆われたりするため、比較的劣化しにくい。

エ．プラスチックの劣化によって生成される物質は、毒性があり、環境中に放出されると考えられている。

オ．問題視される POPs の多くはプラスチックに由来し、プラスチックの微細化により、その発生が促進される。

カ．濃縮された POPs は筋肉組織に集積し、生物にとって重大な悪影響があることが実証されている。

キ．マイクロプラスチックの拡散に対処する最善の方法は、投棄されたプラスチックを劣化前に回収することである。

ク．マイクロプラスチックに関して、汚染の規模や生態系への影響の研究はあまり進んでいない。

問題２．次の文章を読み、設問に答えなさい。なお「*」の付いた語句は本文の後に語注があるので参考にしなさい。

Almost all histories of vaccination* state that Edward Jenner became aware of the benefits of cowpox* from a conversation with a milkmaid* who claimed that she was immune* to smallpox* because she had had cowpox. According to variations of this story, milkmaids were known (a) their beauty. In fact, the milkmaid story is a myth invented by Jenner's biographer*, John Baron, 13 years after Jenner's death in order to protect his reputation in the middle of the many assertions* that he did not discover cowpox. Jenner never claimed to have been responsible for discovering the benefits of cowpox and referred to a vague ①"rumor in the dairies." However, there is a contemporary account of the events that led Jenner to appreciate the possibilities of vaccination with cowpox that was published during Jenner's lifetime and that he never denied.

In 1796, Fewster, a country surgeon based in the Gloucestershire town of Thornbury, wrote about an event that had occurred in 1768. That year, he and two colleagues, Hugh Grove and Daniel Sutton, began inoculating* people against smallpox. "We found in this practice that a great number of patients could not be infected with smallpox poison, although repeated exposure under most favorable circumstances for taking the disease," Fewster recounted. "Finally the cause of the failure was discovered from the case of a farmer who was inoculated several times unsuccessfully, yet he assured us that he had never suffered the smallpox, but, says he, 'I have had the cowpox lately to a violent degree.'" It turned out that the other patients with no response to smallpox inoculation had all had cowpox as well.

Fewster described his observation to his medical society, which was composed (b) about seven other local surgeons and apothecaries*. Among them were the Ludlow brothers, Daniel and Edward. In 1768, Jenner was their apprentice*. He probably heard (c) them about the phenomenon that would ensure his fame. Jenner told his friend James Carrick Moore that 1768 was the year he learned of cowpox. Both Fewster and his partner Grove were experienced doctors who had practiced in Gloucestershire (d) many years. The fact that they hadn't heard of the phenomenon suggests there was no general folk belief that having been infected with cowpox offered protection against smallpox.

When Jenner returned to Gloucestershire in 1774, he joined the medical society with Fewster and the Ludlows. ②Baron wrote that cowpox was a frequent topic of conversation but wasn't considered particularly important.

Even after Jenner published reports of his first experiments with cowpox, ③Fewster didn't think the phenomenon was of any significance, in part because he considered cowpox to be more severe than the side effects of smallpox inoculation. "Inoculation of the smallpox seems to be so well understood that there is little need of a substitute," he wrote. The cowpox finding "is curious, however, and may lead to other improvements." Fortunately, Jenner realized that if natural cowpox produced immunity, then inoculated cowpox would do so as well.

Fewster, who died in 1824, was recognized (e) the discoverer of the benefits of cowpox in his, and Jenner's, lifetimes. His obituary* recorded that he was "universally considered in Thornbury as the first person who noted the effects of vaccine virus." Because of the "skill and perseverance*" of both Fewster and Jenner, it continued, "the blessings of vaccine virus were distributed through the earth."

④There are many paradoxical* aspects of the cowpox story. The vaccinia virus* used in the final smallpox eradication drive* was not in every case cowpox, and its origin remains unknown. Fewster, who made the observation that led to Jenner's experiments, didn't believe his finding had any value. And the widely believed version of the story, involving the beautiful milkmaid, is a myth. ⑤In reality, the trail that led to the eradication of smallpox began with a simple clinical observation and its communication to a medical community 250 years ago.

出典；N Engl J Med. 2018 ;378(5):414-415．より抜粋、一部改変

［語注］

vaccination 予防接種
cowpox 牛痘
milkmaid 乳搾りする女性
immune 免疫のある
smallpox 天然痘
biographer 伝記作家
assertion 断言、断定、主張
inoculate 接種する、植え付ける
apothecary 薬剤師
apprentice 徒弟、見習生
obituary 死亡記事
perseverance 忍耐、忍耐力
paradoxical 矛盾した
vaccinia virus ワクシニアウイルス
eradication drive 撲滅運動

[設問１]（ａ）から（ｅ）に入る適切な単語を答えなさい。

[設問２] 下線部①が示す事柄を、句読点を含めて40字以内の日本語で答えなさい。

[設問３] 下線部②を日本語に訳しなさい。

[設問４] 下線部③を日本語に訳しなさい。

[設問５] 下線部④が示す３つの内容を、それぞれ句読点を含めて60字以内の日本語で説明しなさい。

[設問６] 下線部⑤を日本語に訳しなさい。

[設問７] この論説文の最も適切なタイトルを以下から１つ選び、その記号を答えなさい。

a. Jenner as the father of vaccination
b. Common features of smallpox and cowpox
c. The myth of the milkmaid
d. The 250-year history of cowpox
e. The Ludlow brothers' contribution