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Nouns are the naming words we use in everyday speech, effortlessly describing the things that populate our material existence. In the world under the microscope, which we first encountered in sudacoes (greetings) the early micronauts began to see different types or kinds of tiny, living things. This chapter is about the names we give to those things, how we go about naming them, what those names tell us and, by implication, what other types of words we are likely to encounter along with this group of nouns.

But first, a little about types of nouns. Their key quality is the noun's ability to specify a given thing and thereby differentiate it from another. Nouns belong to groups, and those groups sometimes belong to other, larger groups in a hierarchy of naming words. One key feature that can sometimes be a bit hard to understand in different languages is gender. Many languages have only two genders; male and female, to the frustration of English speakers who are used to a third very useful gender; neuter. But that is only a whiff of the multiplicity of genders some languages possess. Think what you could do with 15 genders? If gender is the first point of difference between kinds of noun, then the four genders of the language of infection are bacteria, fungi, parasites and viruses.

The properties of each of these kinds of tiny living things are grounds for subdividing each one into subsidiary categories. So bacteria, visible under a light microscope after staining with chemical dyes, were first subcategorised according to their shape and colour. The spherically shaped bacteria were called cocci, and the sausage-shaped bacteria were called bacilli. The words for single bacteria are coccus and bacillus, respectively. While useful in technical accounts, how often do you think bacteria are present as single cells? The colour they take up after staining with dyes is deep purple or vermillion. Purple bacteria are called Gram positive and possess a bacterial cell wall with a thick molecular reinforcement of a substance called peptidoglycan. Vermilion bacteria are called Gram negative and have a much thinner peptidoglycan layer. Combinations of these features give us Gram positive cocci and Gram negative bacilli.

There you have two of the features that are used to work out how bacteria should be named.

The early bacteriologists would then work their way through a small range of properties from their how-to-name-a-new-species toolbox. The template they had to fit their new species to was originally developed by a Swedish biologist named Carl Linne, who is often known by the Latinised version of his name as Linneus. The Linnean classification of living things applies to all biology and follows a hierarchical system of allocating names, starting with Kingdoms and working all the way down a series of progressively smaller branches to Genus and species. For the sake of functional simplicity, bacteriologists normally restrict their everyday conversations to Genus and species, or trim things further, for example; *Staphylococcus aureus* or *S. aureus*.

The words they chose for these early discoveries give away the preoccupations of those early micronauts, if we care to dissect the words. Coccus signifies spherical in shape, while staphylos refers to bunches of grapes. Under the microscope *S. aureus* resembles bunches of red grapes ripening on the vine. So why *aureus* or golden? This was supposedly the appearance of colonies of *S. aureus* growing on the surface of agar plates in the laboratory, though we normally see a dull grey appearance these days. These early bacteriological nouns were a pot pourri of bacteriologists' names; the fast route to scientific immortality. So you can find Pasteur, Escherich, Neisser, Shiga, Salmon, Bruce, Lister, Klebs, Metchnikov in the names of bacteria.

But there are other attributes locked up in the names of bacteria such as the diseases they cause; pneumonia, influenza, meningitis, gonorrhoea, trachoma and so on. Sometimes the name contains clues on where to find the bacteria, or where it was first recognised. Other names indicate key biochemical features like acid-loving, or citrate-using. But here we need to introduce a note of caution; just because the name tells you it was thought to cause influenza or acne when first discovered, doesn't mean that it actually does. Bacterial names can be very misleading.

Some of the fun has gone out of naming newly discovered bacteria in recent times with the introduction of standard-setting committees of worthy taxonomists whose job it is to scrutinise applications for new species names or epithets. There is a process and it is lengthy. But before you whinge about scientific bureaucracy gone mad, consider the alternative: a world in which doctors used different names for the same disease-causing organism in different hospitals, or where anyone could use anything they chose as long as it meant something for them. It is as important to get the name of a new bacterial species right from the outset as it is to choose a new e-mail address. Inaccurate or careless usage of names for different categories can have interesting and unintended consequences.

So how we go about naming new bacteria today relies on comparing the attributes of the proposed new species with the nearest living relative. And herein lies the problem. Mammals and other more complex living things are generally considered to be different species if they cannot mate with other species. They are their own, distinct kind. This simple definition of species cannot be used to define bacteria because they are single-celled organisms. To put it bluntly, they are incapable of sexual reproduction in any form recognisable to us. How we differentiate between bacterial species is a point of disagreement. Generally, bacteriologists separate into two camps; the splitters who are enthusiasts for every increasing numbers of bacterial species, and the lumpers who like everything neat and tidy in as few separate categories as they can get away with.

The recent trend in bacterial naming has been to use bacterial DNA to show the genetic proximity of two different bacteria. Whole collections of bacterial strains have been compared to depict their phylogenetic relationships in a branching hierarchical structure that looks like a tree. Slowly, we are coming to terms with the errors that were planted by the early bacteriologists in our naming schemes. There are still many wrinkles to iron out, but one of the most helpful developments has come from our recent ability to analyse the entire DNA complement of a specific bacterium. It is now known that when you add a bunch of genomes from a collection of closely related bacteria, there comes a point where no additional strain belonging to the same species will add any more genes. When you then combine the genome from an unknown strain from a possible new but related species, it shows up as a blip – new genes in the composite genome. So this starts to look like a genetic definition of bacterial species. There is a lot more work to be done on this, to be sure, but early work with specific genetic regions in bacterial genomes clearly shows how flaky some of those early naming schemes were.

So much for the naming of bacteria. Our other genders all present a distinct set of challenges. Fungi are subdivided into single cell organisms known as yeasts, filamentous fungi that form multicellular consortia, and dimorphic fungi capable of both; the mycological version of cross-dressing. The last two groups of fungi have tough cell walls and a defined nucleus, while yeasts, familiar to us as brewers' and bakers' yeast, divide and bud in a form closer to some bacteria. Just tom confuse things a little more, yeasts can form filamentous projections similar to the hyphae of the filamentous fungi.

Parasites include some of the most complex microbes, and a range of organisms that are so large and complex they are easily visible to the naked eye in their adult form. They may have male and female forms capable of sexual reproduction, and can therefore be more easily divided into distinct species. The main types or kinds of parasites that can cause human infection are the single cell protozoa, the worms (tapeworms, roundworms and flukes) and the filarial. The largest of these can hardly be called microorganisms but are lumped in with them as

biological agents of infection for practical reasons.

And so we come to the most dynamic, diverse and potentially catastrophic of all; the viruses. There is still debate over whether these reproducing molecular engines are independent forms of life, because of their need for a home in a cell belonging to another form of more organised life. They are parasites; nature's most efficient squatters, and generally lack one or other type of nucleic acid. So their principal separation into different categories is based on whether they have DNA or RNA, and then in turn whether it is positive or negative strand. In times past, viruses were named after the diseases they caused, and many still are. But this is a purely functional nomenclature. Obviously they are incapable of any form of sexual reproduction, but they are magnificent in their capacity for genetic renovation, particularly the RNA viruses such as influenza virus. These, more than any other type of microorganism close the gap between the presence of the organism and the presence of disease. Admittedly, many infections travel well under the radar but the viruses come much closer to the perfect infective agent; ideally suited to purpose.

The diseases we describe as infections are another group of nouns that do not fit as neatly as you might think with their consequences. Kinds or types of infection divide according to their salient features, and that doesn't necessarily mean according to major kinds of microorganisms. This has been missed by the authors of some of the bigger infectious diseases textbooks. It's worth pausing a moment to think this through. If you need to know what the name of the microbe that causes the disease is before you can look up the disease, doesn't that mean that you won't be able to work out the cause until you know it? The patient doesn't usually arrive in hospital with a referral letter saying "thank you for seeing this case of *Staphyloccus aureus* infection", or "I'd be grateful if you would confirm the cause of this patients infection is parainfluenza virus". No, the patients generally arrive with a list of symptoms, a collection of signs and possibly some preliminary test results. The features of their infections may not even be recognisable as a definite syndrome until later in the natural history of the disease process. And there lies the rub. The earlier you can start treatment, the less risk there is of serious consequences BUT the clinical features of a progressive illness are often clearest later in the process. In recent decades there has been a definite move to detect infection earlier so that antibiotic therapy can be started earlier. The cluster of clinical features used to categorise the pathological process we think of as disease is sometimes known as a syndrome, and often divided into anatomical or physiological categories – skin, gastrointestinal or central nervous systems, for example. So a rapid onset inflammatory process of the lungs with fever, productive cough and difficulty breathing would be called pneumonia. This could be caused by a long list of microorganisms; so long that it is a significant challenge for the clinical microbiology laboratory to work out. But in any individual case of pneumonia, only one of those microbes is likely to be the cause of that specific case of pneumonia. The name of the microorganism might be important to choice of antibiotics, but it is no more than an adjectival addition to the disease name, for example pneumococcal pneumonia. It is quite remarkable that something so small can cause such a lot of trouble.

The last group of nouns we need to review is a group of chemicals; a motley collection of chemicals and natural extracts that can be used to say Goodbye to various microorganisms. These are the antibiotics and antiseptics. Their organisation into different groups could be according to clinical use or intended microbial target, but is by convention usually according to chemical structure and formulation. These are for the most part pharmaceutical products used to stock the armoury for the never-ending battle against infection.

As we come to a close, it is worth reflecting on these three groups of substantives commonly used in the language of infection. The logic used to attribute names to biological agents of infection, the diseases they cause and the therapeutic agents used to treat those infections draw from three distinct regions of the natural sciences. It is not surprising that these can seem like three distinct languages at times. But just as any conversation provides an opportunity to exchange insights, the struggle to describe disease processes led microbiologists to search for anti-infective agents, pathologists to get their minds around germ theory and chemists to turn the products of microbial metabolism into antibiotics. The rewards of learning the language are rich indeed.

TJJ Inglis, 3rd March, 2010.