Wilmot
Literacy Assignment
Marine Yeasts

Saccharomyces cerevisiae is one of two major types of yeast discussed in cell biology. This species of yeast is single-celled and has been largely important in winemaking, baking, and brewing for centuries. *S. cervisiae* uses a type of reproduction called budding. (Wikipedia contributors, 2020a) The second type of yeast that we focus on is called *Schizosaccharomyces pombe. S. pombe* is a unicellular yeast that is also used in brewing. However, unlike the first yeast, these cells reproduce by fission and are consequently named "fission yeast." (Wikipedia contributors, 2020b)

If we take a better look at these two methods of reproduction, budding and fission, we'll find that they are both asexual means of reproduction where a new organism develops from two counterparts. In budding, the yeast cells are typically round and the cell division cycle begins at one particular site where a single bud continuously grows until division occurs. (Hartwell 1974) This growth is closely coordinated with nuclear division which drives DNA replication and segregation. (Johnston, 1977) Budding results in cloning, there is the original mother cell and a smaller daughter cell. (Wikipedia contributors, 2021c) In contrast, fission yeast cells are typically rod-shaped and elongate through tip growth. Eventually the cell will split at the center into two symmetrical daughter cells that have the potential to grow to the same size as the mother cell. (Wikipedia contributors, 2021d)

When studying cell biology, the four most common types of yeasts that are talked about are *Candida, Cryptococcus, Debaryomyces,* and *Rhodotorula.* All of these reproduce by either budding or fission. *Rhodotorula* is a unicellular yeast that is easily identified by its distinctive reddish/orange colonies. This is a result of pigments created by the cell to block out certain waves of light that would otherwise be damaging to the cell. (Wikipedia contributors, 2021e) This species of yeast is widespread throughout nature and can be found in a variety of sources that include soil, seawater, air and plants. (Larone, 2002) *Debaryomyces* is a species of yeast that reproduces by multilateral budding. It can be found in natural substrates and in different types of cheeses. (Barnett, 2000) *Candida* is another well-known yeast that is the most common cause of fungal infections worldwide. Most of the different species of this yeast are harmless, however if a person's immune system is already compromised then *Candida* can invade and cause disease. Many species are found in gut flora but they can also be found in the gastrointestinal tract, along with the skin. (Wikipedia contributors, 2021f) The last of these yeasts is *Cryptococcus* and is similar to *Candida* in the sense that it can also cause infection. It is found most often in soil and bird droppings and can infect the lungs if the spores are inhaled.

Between 2016 and 2018 a study was done on several black yeasts, each of which fall into these four categories. The intent of the study was to identify and assess how fungi in non-terrestrial environments (i.e. the ocean) grew and divided. (Gostincar, 2012.) What was found during the study is that these four yeasts displayed unconventional cell cycle behavior. The first of these yeasts was called *Hortaea werneckii.* This yeast can divide by both fission and budding with each cell gaining a new a single nucleus (Figure 3A and 3B) There was also proof that instead of consistently dividing with just one mode of reproduction *Hortaea werneckii*

alternated between both budding and fission. *H. werneckii* yeast has an average cell cycle time of 730 mins which is rather long compared to some of the other yeasts isolated for this study.

Knufia petricola is another yeast that was isolated for this study. With this yeast, spherical shaped cells were seen after several cycles. These spherical cells were produced on linear chains and occasionally the chain would branch out, thus creating a second linear chain and causing the colony to be dendritic in shape. When we talk about the length of a cell cycle, it is typically broken up into two stages. The "time before budding" phase and the "cell growth" stage. Together the two make up a complete cell cycle (Mitchison-Field, et al. 2019) It was interesting to find that the time before budding phase was rather variable. In some cases, the mother initiated a bud in as little as ten minutes, but the overall average time taken to initiate a bud was 110 minutes. Furthermore, the cell growth stage for this yeast was also variable with an average of 193 minutes. (Figure 4, Mitchison-Field, et al. 2019.) Altogether the full cell cycle duration had a mean of 499 minutes and was rather variable.

If you look at another one of the yeasts that were studied, *Aureobasidium pullulans* you will notice that while the cell cycle was still varied, the average time for each cycle length was only 159.5 minutes. (Figure 5. Mitchison-Field, et al. 2019) One of the traditional features of budding yeast is that only a single bud is produced each cycle. This ensures that with each mitosis cycle, both the mother and daughter cell receive a single nucleus. However, with *Aureobasidium pullulans* multiple buds were produced simultaneously, sometimes up to six buds from the same mother cell. This makes them multi-nucleate as well. (Mitchison-Field, et al. 2019) According to the research, the cell cycle length does not appear to be affected by the number of simultaneous buds produced by the mother.

Yet another yeast that was isolated for this study is also the most complex when it comes to morphology and the least like the other yeasts studied. *Phaeotheca salicorniae* has identifiable yeast cells and hyphal cells with these cells having the ability to switch bidirectionally between the two types. The cells will begin as yeast cells and will then swell and elongate as they go through multiple divisions. (Figure 6, Mitchison-Field, et al. 2019) After septa is formed, the colony of *P. salicorniae* will undergo meristematic conversion which results in the production of round cells. The cells can go one of two ways, one event allows the cells to transition into a second cell type by producing hyphae, but on the other hand, yeast cells are abundantly produced and remain in the matrix of the cell. These yeast cells will be very similar to the original yeast cells. (Mitchison-Field, et al. 2019)

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