



Enzymatic approach to FODMAPs

a guidebook by Kiwi Biosciences

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Food groups that cause trouble



CARBOHYDRATES

While simple carbs like glucose and fructose can be a great source of energy, complex carbohydrates like FODMAPs (lactose, GOS and FOS), are made of chains of sugar molecules that our bodies cannot use unless they are broken down.

FIBRES

Some fibres are great for our microbiome and can act as prebiotics, helping beneficial bacteria grow in our gut. However, where most carbs can be broken down, fibre is a bit more stubborn and a large portion of it passes through our bodies undigested.

FODMAPS

Rebellious and disruptive, FODMAPs can often disturb smooth digestion. And when they bump into our gut microbiome, it can get quite windy (mainly due to the gas-releasing fermentation process). Though natural, this process can cause digestive pain and discomfort and even make us avoid entire food groups.

What are FODMAPs

FODMAPs like fructan and lactose are poorly digested carbohydrates. They pull excess water into the intestines and get fermented by intestinal bacteria. This can get gassy! For some individuals, these phenomena can trigger gut symptoms like abdominal pain, constipation, excessive gas, bloating, and diarrhoea.

- F** fermentable
- O** oligosaccharides,
- D** disaccharides
- M** monosaccharides
- A** and
- P** polyols



FODMAPs and IBS

An effective therapy for Irritable Bowel Syndrome (IBS) among other gastrointestinal disorders is a diet low in fermentable oligo-, di-, monosaccharides, and polyols (FODMAPs) which results in an improvement in 50-80% of patients [1].

FODMAPs are poorly absorbed short-chain carbohydrates that may drive commensal microbial gas production, promoting abdominal pain, bloating, and other symptoms related to IBS.

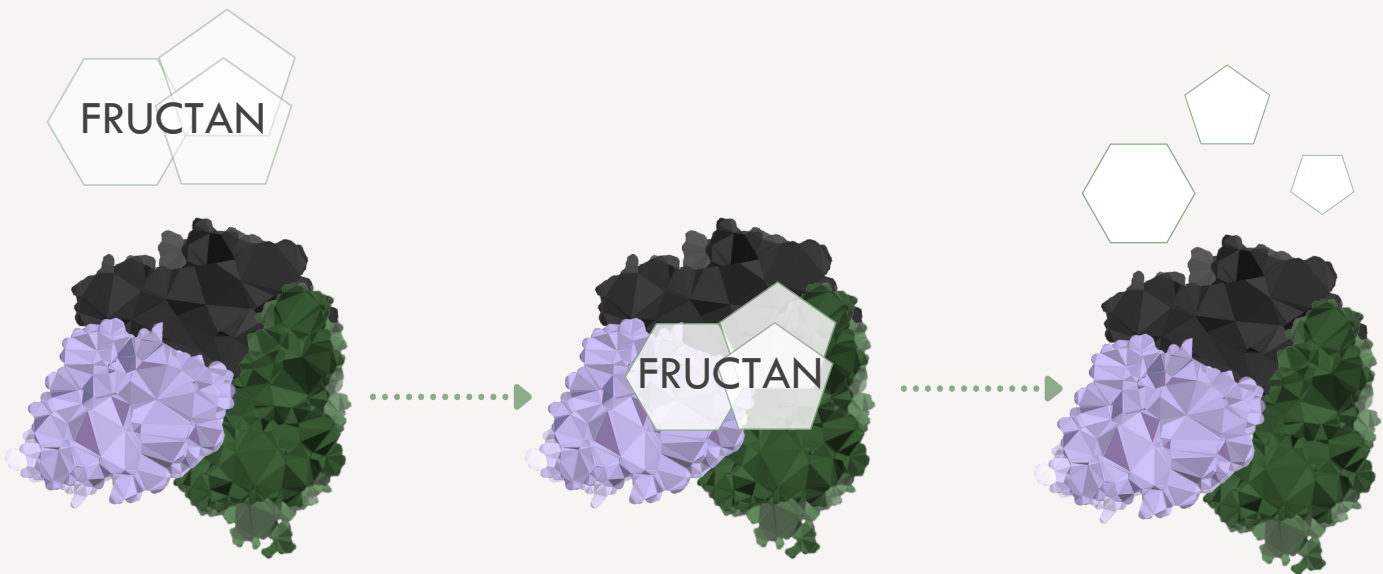
However, the diet is not meant to be sustained long term, with concern for nutritional deficiencies, disordered eating, and gut microbiome changes [2].

Enzymes: a new solution to a known problem

Enzymes [4] are proteins that regulate the rate at which a plethora of metabolic and chemical processes occur in our bodies. Thus they are called biological catalysts.

An enzyme is a highly specialized protein that acts on a specific molecule, called the enzyme's substrate. One instance some of us are familiar with is when specific digestive enzymes break

down the various components such as carbohydrates, fats, and proteins in the food we eat. This process allows our bodies to absorb the nutrients it offers and turn them into energy.



Similarly, fructan-specific enzymes can selectively bind and chew these large,

difficult-to-absorb molecules into simple sugars.

A fundamental task of proteins is to act as enzymes - catalysts that increase the rate of virtually all the chemical reactions within cells. ^[5]

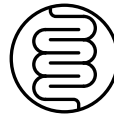
Types of enzymes

Metabolic enzymes



set up our general health, enabling hearing, vision, movement, and every essential function of our bodies.

Digestive enzymes



break down food into nutrients that can be absorbed and turned into energy and waste that needs to be discarded.

Food enzymes



found in raw foods and meant to support the digestion of that particular food itself, though can be destroyed during cooking. ^[6]

ENZYME	AMYLASE	LACTASE	PROTEASE
PRODUCED BY	salivary glands, pancreas	small intestine	pancreas, gastric glands
ROLE	breaks starch into glucose	breaks lactose into glucose and galactose	breaks proteins into simple peptides and amino acids

examples of common enzymes

How enzymes can help us

While fast-fermentable fibres like FODMAPs promote gut health they can also, cause trouble for people with increased gut sensitivities. The usual approach involves identifying individual triggers and limiting their intake, if not restricting them altogether, as part of a low-FODMAP diet.

Luckily, an enzymatic approach can enable people to receive the benefits of these fibres without having digestive discomfort, pain or other symptoms.

It's important to remember that certain enzymes are designed specifically to address particular FODMAP groups.



FODMAP SUBSTRATE

ACTIVE ENZYME

Fructan (inulin, FOS) ----->Fructan hydrolase

Galacto-oligosaccharides (GOS) ----->Alpha-galactosidase

Lactose ----->Lactase



MONASH
UNIVERSITY
LOW FODMAP
CERTIFIED™

F  D Z Y M E™
BY KIVI BIOSCIENCES

FODZYME®[®], a novel enzyme supplement

FODZYME® is the world's first enzyme blend to directly tackle the FODMAPs fructan, GOS, and lactose. If you are wondering about polyols, we are working on a novel polyol-targeting enzyme as we speak. Our enzymes are very specialised proteins produced by micro-organisms that break down specific substrates, in this case, FODMAP molecules.

FODZYME® works as you digest your meal by breaking down the FODMAPs into simple sugars, that are quickly absorbed in the small intestine, effectively eliminating the FODMAPs in your gut

When sprinkled on or mixed with high-FODMAP meals, FODZYME's novel patent-pending enzyme blend breaks down the FODMAP molecules (apart from polyols, but a solution is in development) into more digestible simple sugars, helping you savour every bite.

Within its novel formula, FODZYME's fructan hydrolase enzyme breaks down fructans, found in common foods we consume like garlic, onion, beetroot, bananas, dates, zucchini, and many more.

It is paramount for the enzymes to be well incorporated into the food so they can reach the FODMAP substrates as soon as possible before they trigger symptoms in the lower GI tract. This is why we developed our product as a powder, the most effective form for the enzymes to homogenise quickly with the food in your system.

Efficacy of FODZYME® in a high-fidelity simulated gastrointestinal environment

FODZYME® was administered concurrently with 3g of inulin (a common source of fructan) in SHIME® [3], a multi-compartment scientifically validated model of the complete human gut, to study the efficacy of FODZYME’s fructan hydrolase in fructan degradation.

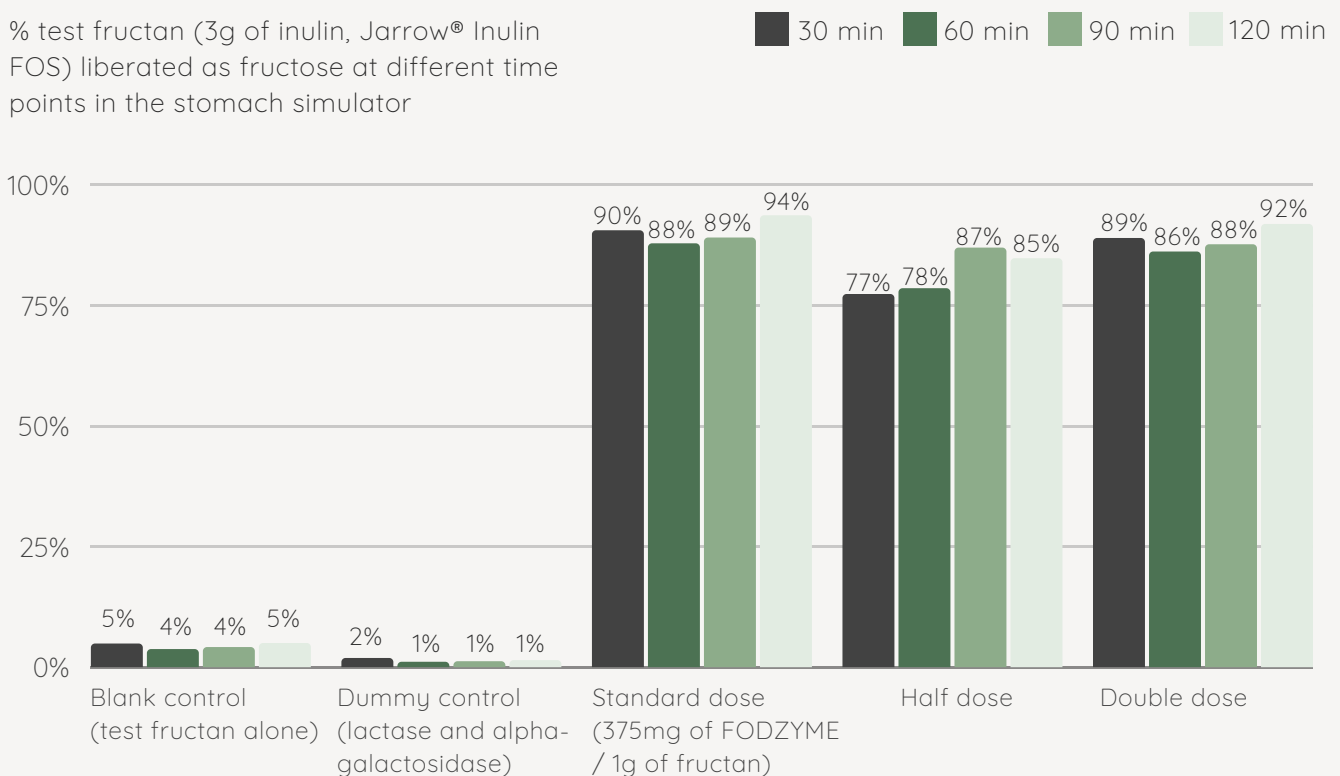
Lactase and alpha-galactosidase, the two other enzymes in FODZYME’s formulation,

were assessed as an additional control arm to verify the specificity of fructan hydrolase in fructan hydrolysis.

Findings indicated a rapid breakdown of fructan to fructose in gastric conditions with ~90% of the inulin mass converted to fructose within 30 minutes thus demonstrating resilience to both gastric pH and protease activity.

FODZYME®'S ENZYMATIC DIGESTION IN SIMULATED GASTRIC CONDITIONS

% test fructan (3g of inulin, Jarrow® Inulin FOS) liberated as fructose at different time points in the stomach simulator



90%

of the inulin mass was degraded within 30 minutes, demonstrating resilience to both gastric pH and protease activity.



**TRY FODZYME® TO
MAKE YOUR FOOD PAINLESS**

Product safety

The FODZYME® formula has three carbohydrases: lactase, alpha-galactosidase, and fructan hydrolase. Carbohydrases form the major class of enzymes that catalyses the breakdown of long-chain carbohydrates into simple sugars. For instance, the sub-class of fructan hydrolases includes enzymes that can break down fructose-containing oligosaccharides (FOS) and polysaccharides such as inulin.

All the three enzymes in FODZYME® have been extensively used in the food and beverage industry. They have been produced using fermentation processes from *Aspergillus* species, a kind of microbe (fungus) that has been used for the fermentation of food for more than 2 millennia and to manufacture food enzymes for over 50 years [7]. Hundreds of enzymes produced in these species are considered safe by regulatory authorities world over. Moreover, carbohydrases from these fungal species in general have been classified GRAS (Generally Regarded As Safe) by the US FDA.



Microbially derived enzymes Generally Recognised as Safe by the FDA

Description of Enzyme Preparation

Carbohydrase, cellulase, glucose oxidase-catalase, pectinase, and lipase from *Aspergillus niger*

Carbohydrase and protease from *Aspergillus oryzae*

Carbohydrase and protease from *Bacillus subtilis*

Invertase from edible baker's yeast or brewer's yeast (*Saccharomyces cerevisiae*) [8]

What's more, enzymes which can both synthesize and breakdown fructans are naturally present in many plants that we grow as food crops. However, during harvesting, storage, ripening and cooking these enzymes might get altered and lose function. Supplementing your meals with FODZYME® can help tackle the problematic fructans then.

Given their prolonged history of use in food processing, FODZYME's enzymes are entirely safe for consumption.

OMNIPRESENT IN EVERY ORGANISM

Enzymes are the extraordinary proteins produced by all living matter, from plants and microbes, all the way to animals and humans.

EACH WITH A UNIQUE ROLE

Each enzyme tackles a certain type of molecule (substrate). In FODZYME®, lactase addresses lactose, alpha-galactosidase - GOS, while the novel fructan hydrolase tackles fructan.

SHAPING YOUR DIGESTION

Specific FODMAP substrates are actively recognized by FODZYME®'s enzymes shaped precisely for them. Once broken down, FODMAPs are released as simple sugars.

INSTANTLY POWERFUL

Activated at the first contact with food and while you chew, our powder enzymes break down FODMAPs into simple sugars before they reach the lower gastrointestinal tract.

About the authors

Kiwi Biosciences has partnered with FODMarket to make FODZYME® available in the United Kingdom and help people enjoy the foods they love with confidence.

Kiwi Biosciences

On a mission to make food painless for all, Kiwi Biosciences is a human-centered biotechnology company based in Cambridge, Massachusetts (USA) devoted to developing elegant scientific solutions for extraordinary gut relief.

FODZYME® is Kiwi Bio's first product; in development still are novel enzymes to tackle additional FODMAP groups like mannitol and sorbitol.

FODMarket

FODMarket is a family-run business and is the UK's first online store dedicated to supplying a multi-brand variety of low FODMAP food products for people living with IBS and similar digestive health issues.

FODMarket's mission is to bring together research-based solutions for people suffering from gut health issues. They recognise that FODMAPs are only one element of a multifaceted approach, so continue to look for innovative solutions for their customers.



References

[1] Gearry R, Skidmore P, O'Brien L, Wilkinson T, Nanayakkara W. Efficacy of the low FODMAP diet for treating irritable bowel syndrome: the evidence to date. *Clinical and Experimental Gastroenterology*. Published online June 2016:131. doi:10.2147/ceg.s86798

[2] Hill P, Muir JG, Gibson PR. Controversies and Recent Developments of the Low-FODMAP Diet. *Gastroenterol Hepatol (N Y)*. 2017;13(1):36-45.

[3] Van de Wiele T, Van den Abbeele P, Ossieur W, Possemiers S, Marzorati M. The Simulator of the Human Intestinal Microbial Ecosystem (SHIME®). The Impact of Food Bioactives on Health. Published online 2015:305-317. doi:10.1007/978-3-319-16104-4_27

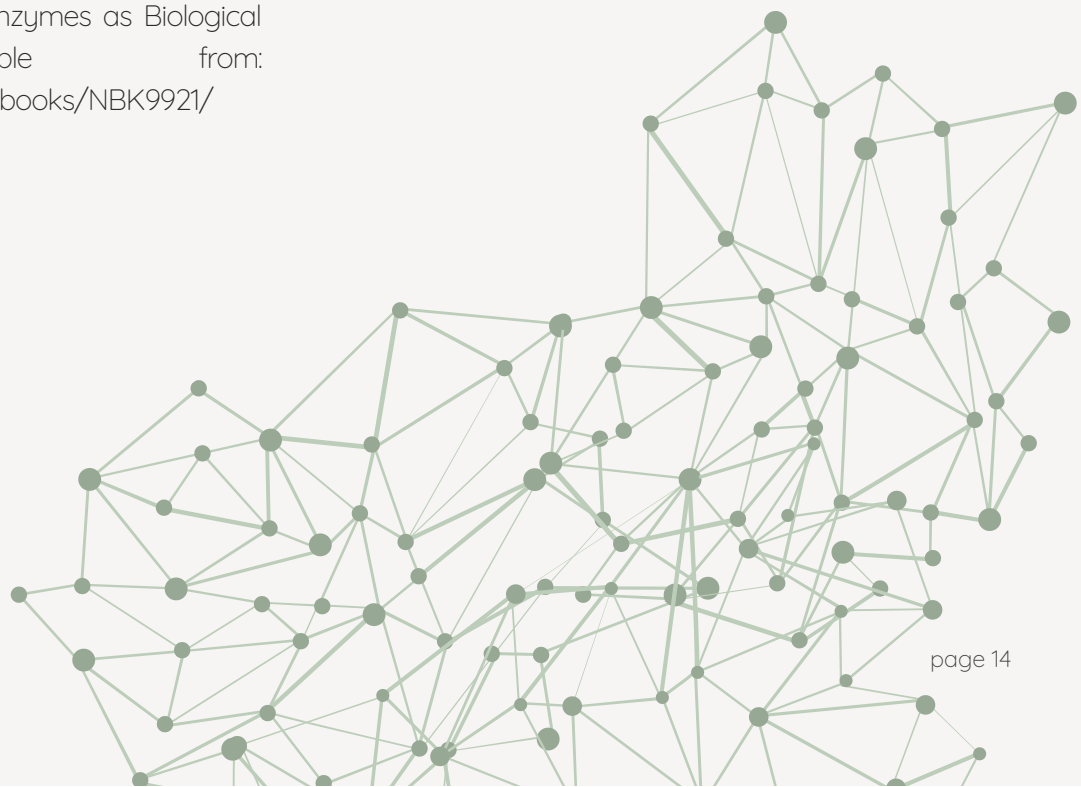
[4] Cooper GM. *The Cell: A Molecular Approach*. 2nd edition. Sunderland (MA): Sinauer Associates; 2000. Glossary. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK9926/>

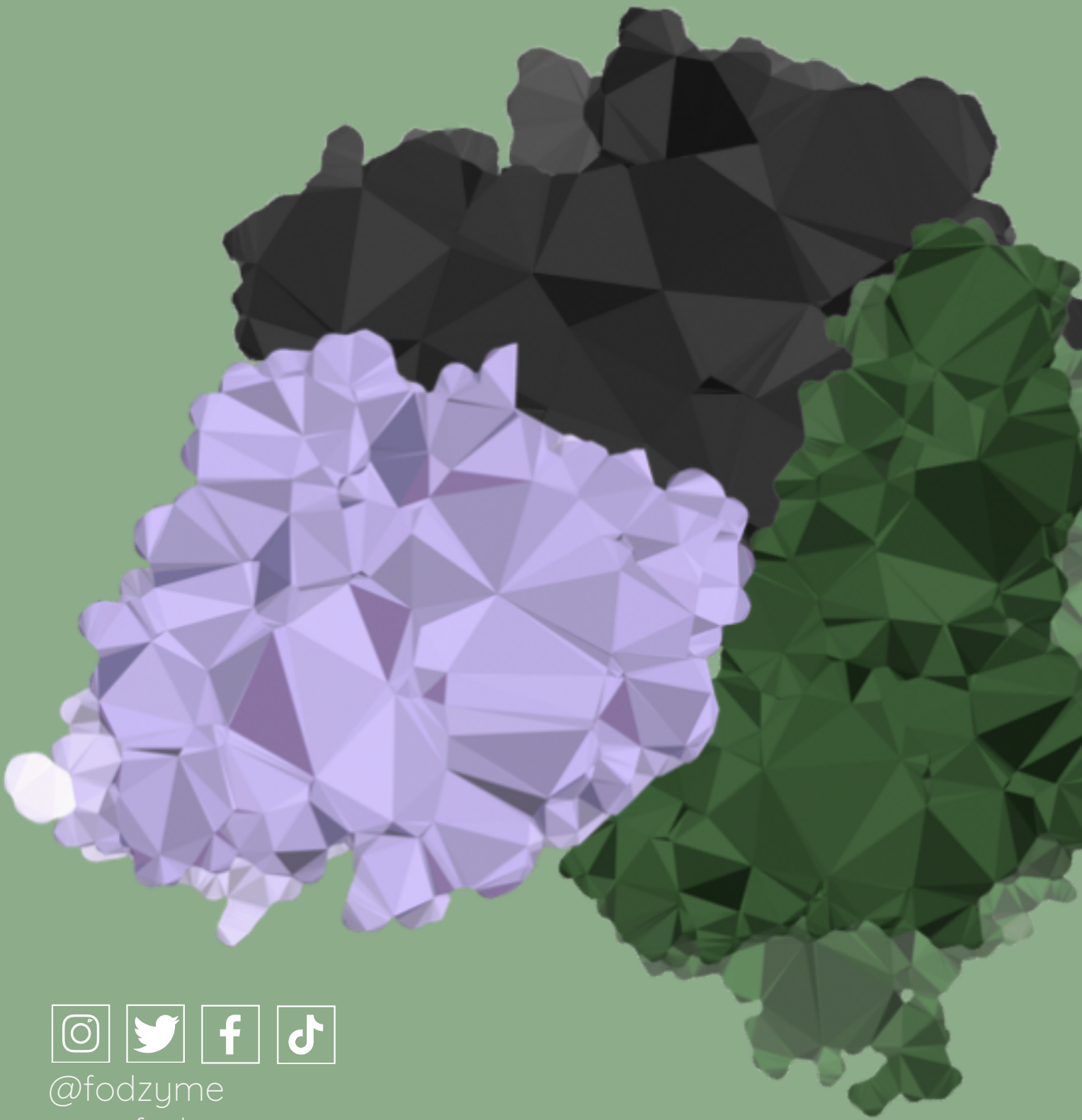
[5] Cooper GM. *The Cell: A Molecular Approach*. 2nd edition. Sunderland (MA): Sinauer Associates; 2000. The Central Role of Enzymes as Biological Catalysts. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK9921/>

[6] Prospecbio.com. 2022. The Types of Enzymes and How They Work | ProSpec. [online] Available at: <https://www.prospecbio.com/enzymes> [Accessed 20 June 2022].

[7] Frisvad, J. C. (2018, October 6). Safety of the fungal workhorses of industrial biotechnology: update on the mycotoxin and secondary metabolite potential of *Aspergillus niger*, *Aspergillus oryzae*, and *Trichoderma reesei*. SpringerLink. https://link.springer.com/article/10.1007/s00253-018-9354-1?error=cookies_not_supported&code=0a5f0e21-229c-4894-a0a9-d9540911aa73

[8] U.S. Food and Drug Administration. Enzyme Preparations Used in Food (Partial List). Published 2020. Accessed January 11, 2022. <https://www.fda.gov/food/generally-recognized-safe-gras/enzyme-preparations-used-food-partial-list>





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