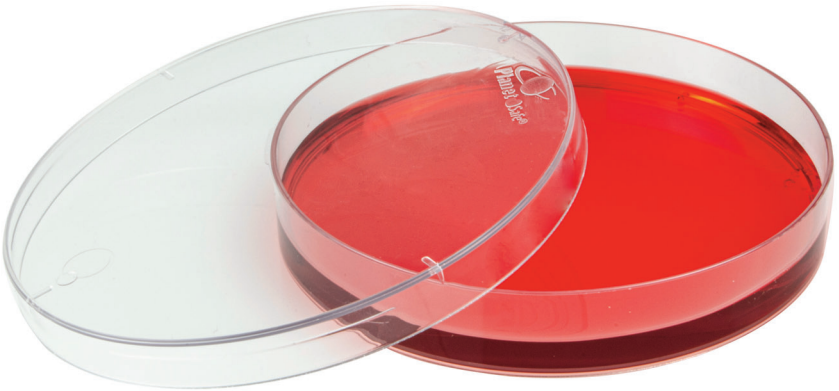
Planet-Safe®
Sustainable Labware
From Diversified Biotech, Inc.

100% Plant-Based Cell Culture Labware

Petroleum free & sustainably-sourced



ASTM D6400
Industrially Compostable

USDA CERTIFIED BIOBASED PRODUCT
PRODUCT 98%

Planet-Safe® At-A-Glance

The plant-based material (PLA) used to make Planet-Safe® Labware is derived from sugarcane starch, the cultivation and harvest of which is certified by *Bonsucro*, a leading global platform and standard that promotes sustainable sugarcane production, processing and trade.

The sugarcane harvesting, refining and polymerization process is designed to minimize carbon emissions by reducing travel distance, energy consumtion and water utilization. During production, by-products are re-purposed and waste material is processed to produce energy which is used on site and directed back to the local energy grid.

Planet-Safe® Cell Culture Dishes and Microplates made from PLA are optically clear and naturally more hydrophilic than petrochemical resins such as polystyrene. This beneficial property allows a variety of anchorage-dependent cell species to grow without additional surface coatings or treatments.

Planet-Safe® labware is commercially compostable where available. Biohazardous labware may be incinerated, releasing a neutral amount of carbon dioxide and water. When landfill disposal is required, Planet-Safe® Labware provides a carbon sequestration benefit three times greater than that of polystyrene-based labware.

BON SUCRO

What is PLA?

PLA or polylactic acid is biopolymer derived from the starch of renewable feedstocks. Planet-Safe® resin is made from sugarcane. After growing and harvesting the sugarcane, it is brought to a sugar mill to extract the sugar. The sugar obtained is then fermented using microorganisms to produce lactic acid, an organic acid also produced by the human body. This lactic acid is then converted into PLA pellets suitable for injection molding into various labware.

1.75 sq m^2 of sugarcane crop captures 1.83 kg of CO_2

PLA carbon footprint is on average,

75% lower

than fossil-fuel based resin

PLA bioresin is sourced from plants like sugarcane

↓

Sugarcane crop is processed in a sugarmill into raw sugar

↓

Raw sugar is transformed into lactic acid using a natural fermentation process

↓

Lactic acid goes through a polymerization process converting it to PLA resin

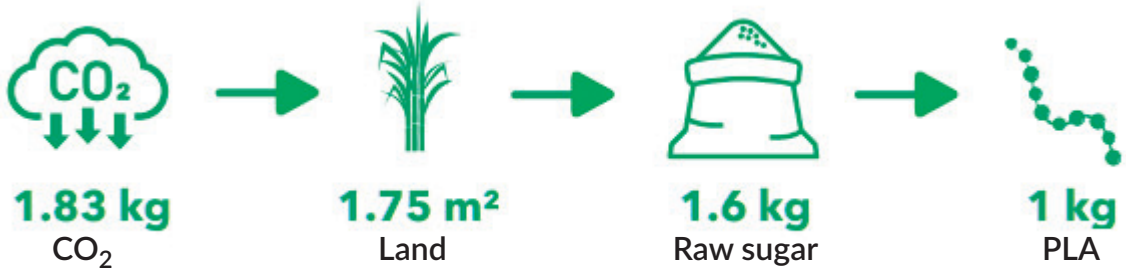
[1]

Environmental Advantages of PLA

Carbon Footprint

Global Warming Potential (GWP) is used to measure the amount, in kilograms, of CO_2 introduced into the atmosphere for every 1 ton of material production. Sugarcane grown to produce PLA absorbs and stores CO_2 at a rate of 1,833kg CO_2/ton of PLA. During PLA production, net emissions from cultivation, processing and polymerization are 2,334 kg CO_2/ton of PLA.

Unlike other plastics, such as polystyrene (PS), the uptake of CO_2 and subsequent sequestration represent a significant reduction in carbon footprint and a PLA GWP of 501 kg CO_2/ ton (2,334 - 1,833kg). This represents a carbon footprint 83% lower than PS which has a GWP of 2,917 kg CO_2/ton [2].



By-Product Utilization

PLA generates multiple by-products during three main production steps which include sugar milling, lactide production and polymerization. A multi-functional approach is in place to utilize the majority of these by-products either in-house for current processes or in other industries to aid in less harmful practices.

Process Step	By-Product	Utilization	Alternative Use Case
Sugar Milling	Electricity	Bagasse for co-generation Excess exported to local grid	In-house use eliminates need for fossil-fuel based sources
	Molasses	Used for production of ethanol	Biofuel utilization versus conventional gasoline
	Filter Cake	Used as a soil conditioner	Reduces the need for other fertilization additives
Lactide Production	Fermentation Residue	Used as a soil conditioner	Reduces the need for other fertilization additives
	Gypsum	Recycled: agriculture 56% construction 44%	Replaces some amount of mined gypsum
	Stillage	Fuel - 30% Animal feed/biogas - 70%	Avoids heat from coal and can be economically allocated at market price
PLA Production	Lactide Recycle	Reused in lactide or lactic acid production	Replaces some amount of needed sugar or lactic acid based on recycle stream composition
	PLA Recycle	Reused in PLA, lactide or lactic acid production	Replaces some amount of needed lactide or lactic acid based on recycle stream composition

Planet-Safe®: Certifications

Compostability

The standard used to determine if a plastic product can be aerobically composted in a municipal or industrial facility is ASTM D6400. To be considered industrially compostable, a plastic product must reach a minimum disintegration of 90%, based on weight loss, after being tested for a maximum of 84 days in a laboratory scale disintegration environment [3].

As shown in Fig. 1 below, Planet-Safe® Cell Culture Dishes will breakdown under the appropriate conditions within 21 days, reaching 90% prior to day 77, and will reach 100% disintegration prior to day 84. Since Planet-Safe® 96-Well Cell Culture Microplates are a more robust item, disintegration begins prior to day 21 and reaches 90% prior to day 84. Though the evaluation is ended after 84 days, extrapolating the data shows that 100% disintegration will be reached by day 88. This is represented in Fig. 1 by the green and white line.

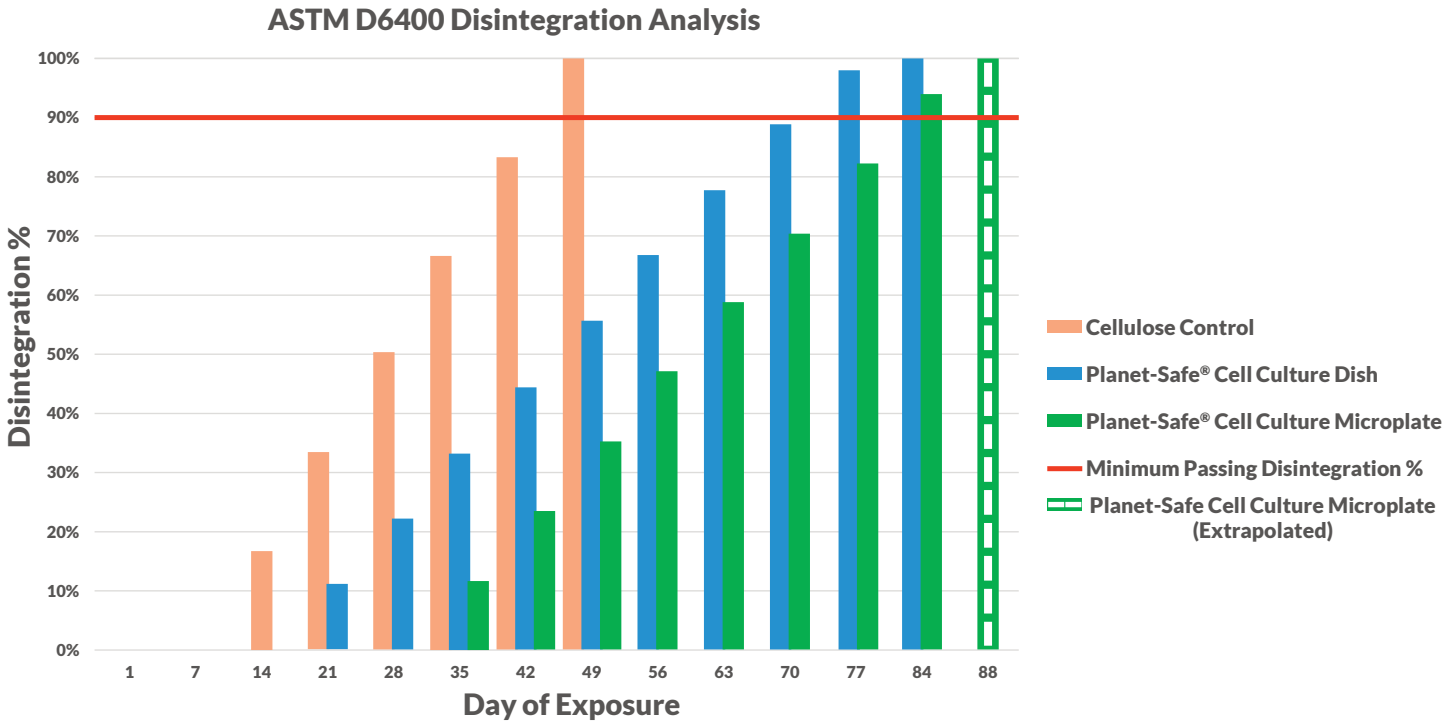


Fig. 1 Overall disintegration percentage of Planet-Safe® items and cellulose control over 84 day trial period. The red line represents the minimum amount of disintegration. The green and white line represents extrapolated data to determine days required to reach 100% disintegration (microplate).

Phytotoxicity

Industrial compost containing biodegraded Planet-Safe® labware is safe and will not hinder plant growth. Compost mixtures containing biodegraded Planet-Safe® material were evaluated for seed germination per ASTM D6002, and plant growth per OECD 208 [4].

To determine any resulting reduction in germination or healthy growth, three replicates each of six different material mixtures were used to grow both barley and cress. Fig. 2 shows the average germination of each mixture indicating the percentage of seeds that sprouted and produced healthy plants showing no residual negative effects.

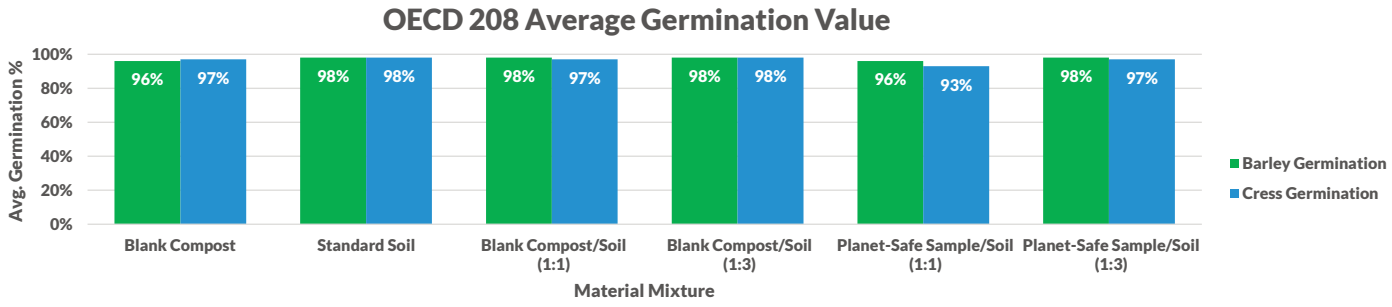


Fig. 2 Average germination percentage of control seeds planted in various material mixtures.

USDA BIOPREFERRED

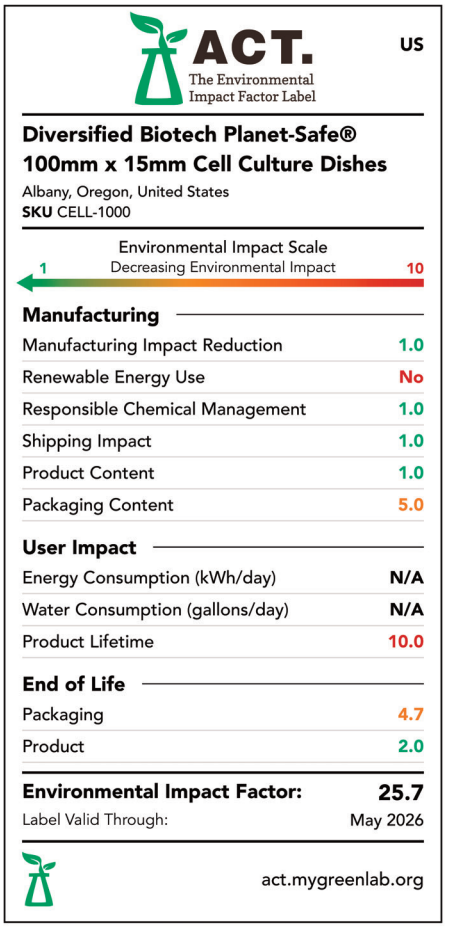
Managed by the USDA, The BioPreferred Program [5] leverages mandatory federal purchasing programs to decrease US reliance on petroleum and increase the use of renewable/sustainable products. To make it easier for consumers to identify these biobased products, a voluntary labeling initiative was created to display on certified products and product listings.

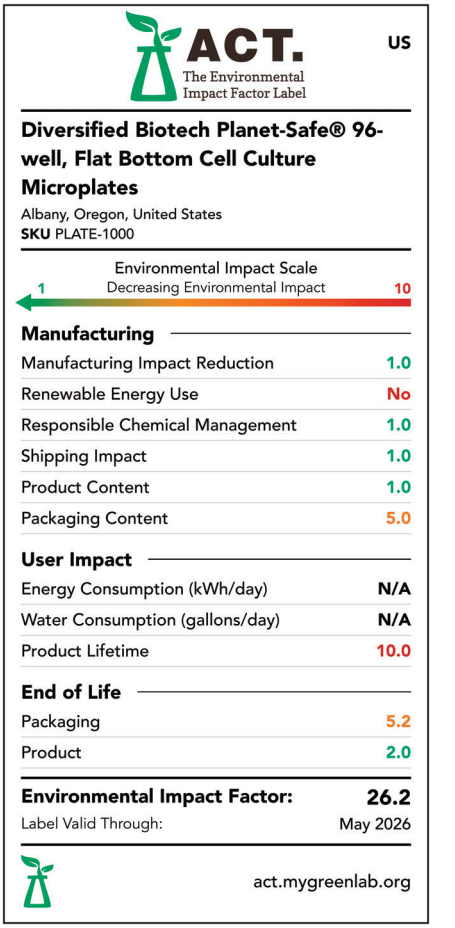
To achieve BioPreferred status a product must undergo ASTM D6866 testing to confirm it contains the required minimum amount of biobased content [6]. A Radiocarbon measurement determines the overall amount of biobased carbon and reflects it as a percentage. Planet-Safe® Labware became the first laboratory consumable to receive BioPreferred status in February of 2024 with a rating of 98%.

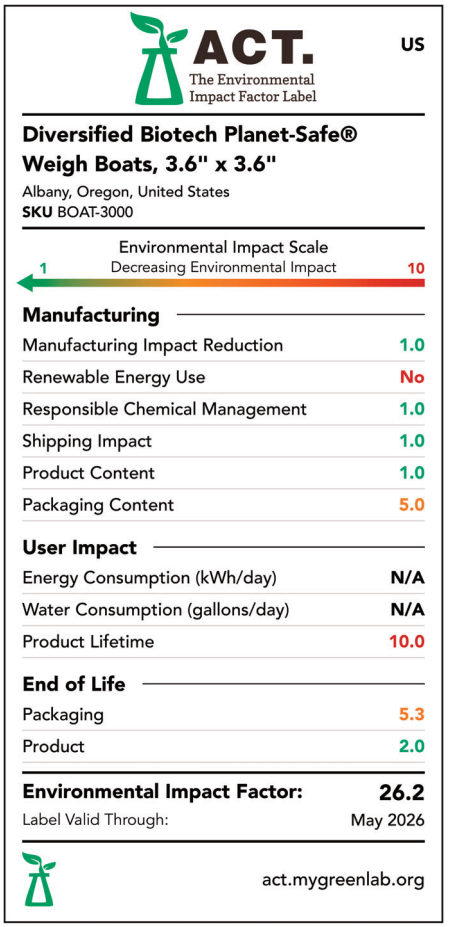
ACT® LABEL

The ACT Environmental Impact Factor Label was designed to address the need of both scientists and procurement specialists for clear information about the environmental impact of laboratory products [7]. By emphasizing Accountability, Consistency, and Transparency (ACT) around manufacturing, energy and water use, packaging, and end-of-life, ACT makes it easy to choose more sustainable products.

The certification process entails third-party verification of the sustainable impacts of a product, its operations, and its end of life. Most categories are graded on a scale of 1-10 with lower numbers indicating a lower overall environmental impact.







Planet-Safe®: Cell Growth Results

Cell Adhesion Efficacy

Planet-Safe® 96-well F-bottom microplates (Cat. # PLATE-1000) and Corning® Costar 96-well Stripwell microplates (Cat. # 9102) were utilized to study cellular adhesion and growth rate using NBT-II cells. PrestoBlue™, a non-destructive cell viability reagent, was used to measure cellular metabolic activity. NBT-II cells were seeded in 0.2ml growth medium consisting of DMEM/F12, HEPES buffer, and glutamine with subsequent additions of Penicillin-Streptomycin antibiotics and 10% FBS. Cell densities of 3-4 × 10^5 and 1 × 10^5 cells/well were utilized and tested in three separate experiments at each density.

Once seeded, samples were incubated at 37°C for 5 hours. Growth medium was then removed, 0.2ml PrestoBlue™ (10% in medium) was added, and samples were incubated for 30 minutes. After 30 minutes, the fluorescence of each plate was measured using a BioTek Synergy Neo2 (Gen5 IVD Software) plate reader to determine the cell adherence efficiency between the Planet-Safe® and Corning® surfaces. As presented in Fig. 3, by measuring the metabolic activities of these cells at 24hrs post-seeding, across 6 separate experiments, the Planet-Safe® surface was found to contain, on average, 42% more cells. The resulting measurements indicate that the Planet-Safe® surface is more conducive to cell adhesion. Evaluation of this information using the statistical t-Test confirms that difference in measurements is statistically significant.

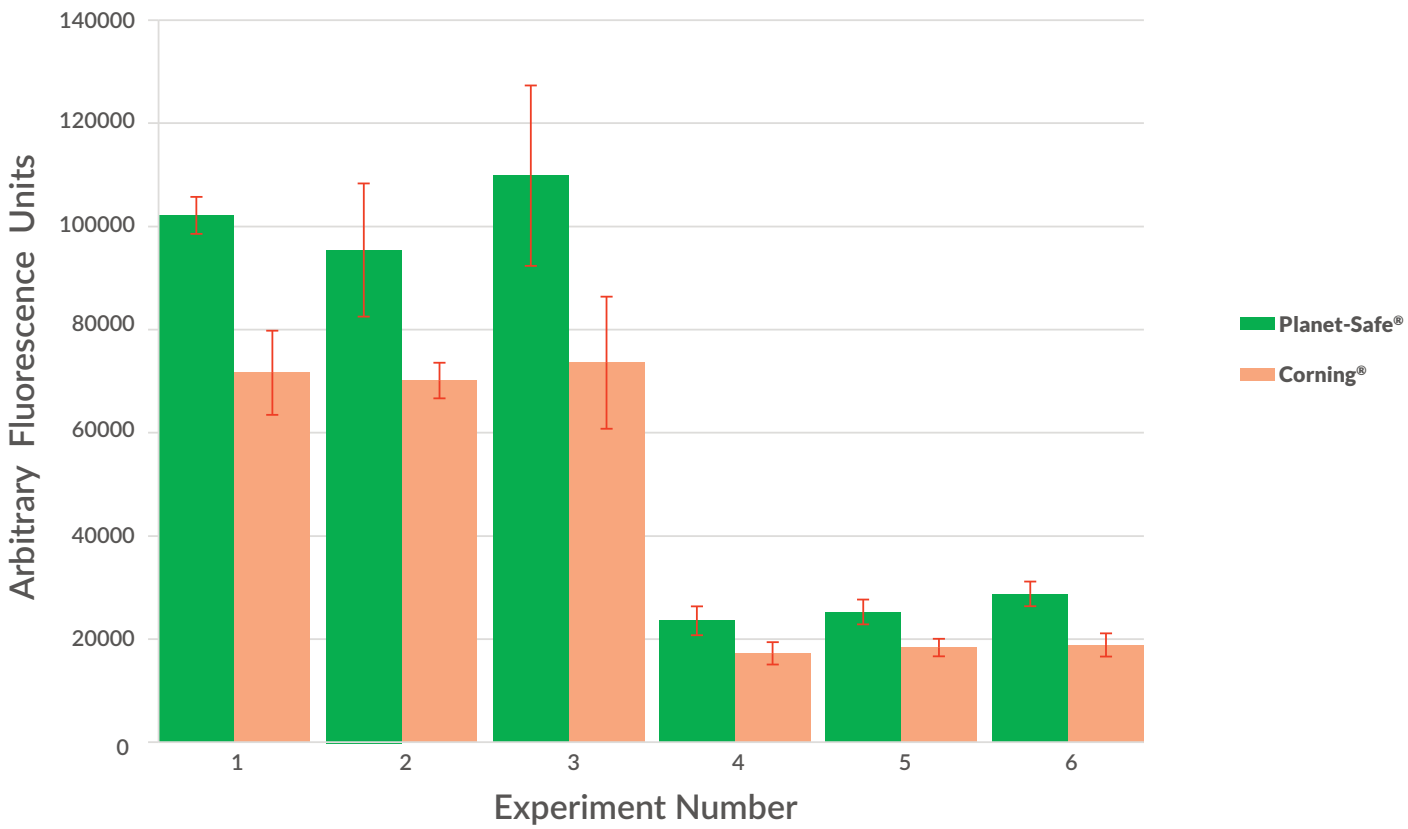
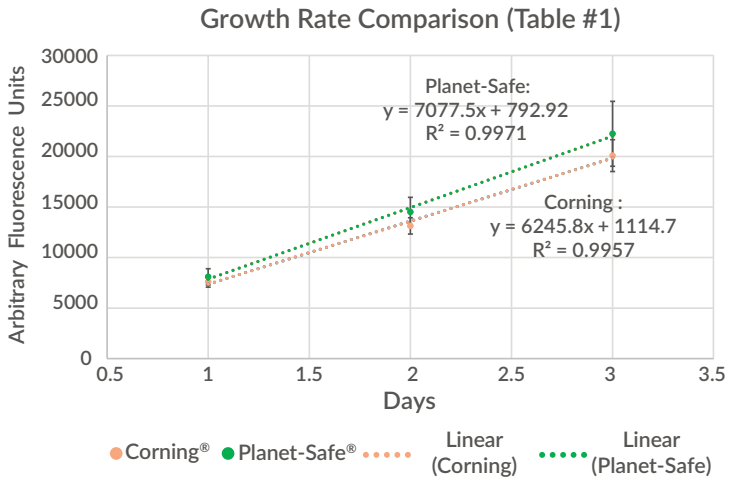
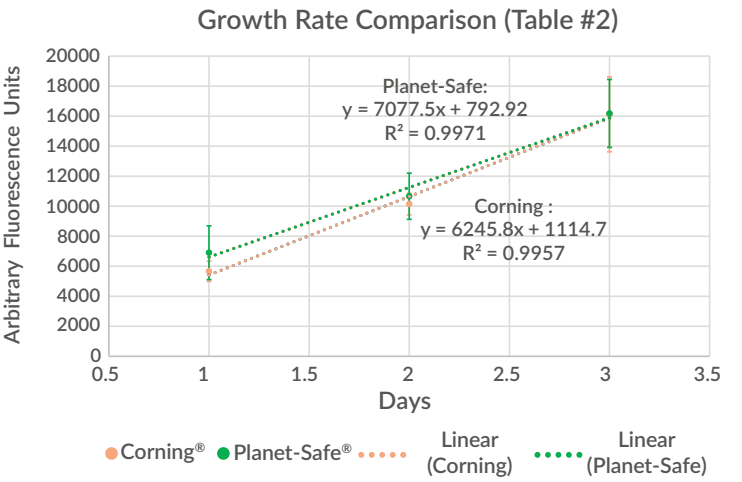


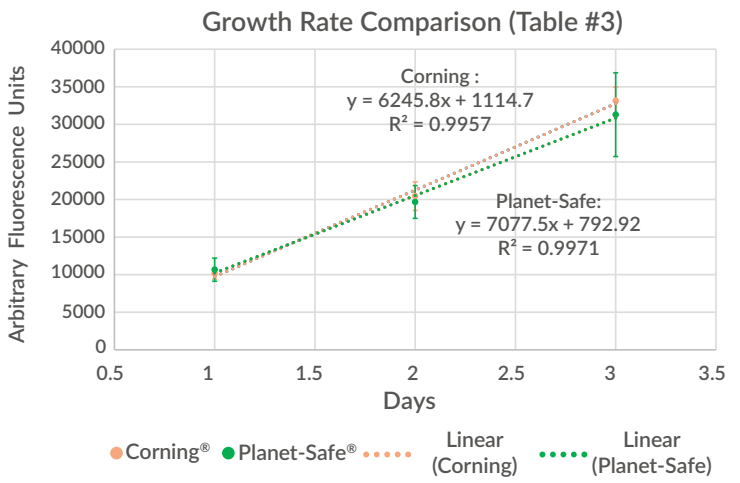
Fig. 3 Measurement of metabolic activity 24-hours post-seeding at different concentrations used to determine the number of viable cells, including standard deviation.

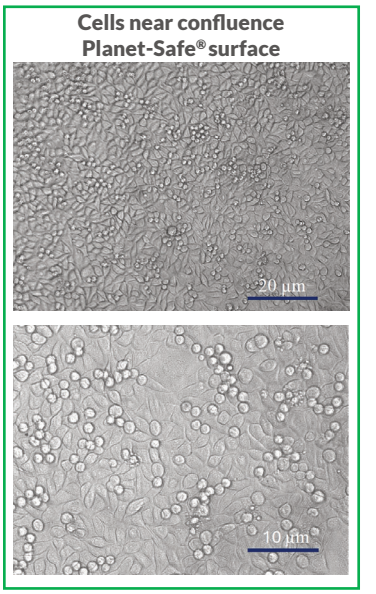
Cellular Growth Rate

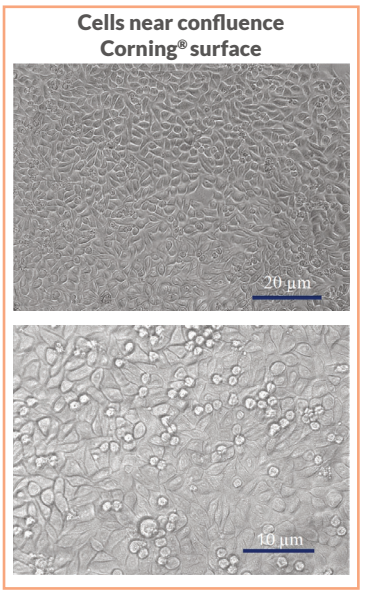
Cells propagated during the cell adhesion study were rinsed, seeded at a density of 1-2 × 10^4 cells/well in 0.2ml growth medium, and re-incubated for the purpose of measuring cellular growth rate. Cell growth measurements began 24 hours post-seeding and continued over the following 3 days. The process of removing growth medium, adding fresh Presto-Blue™ solution, fluorescence measurement, and further incubation was replicated across 3 experiments. The resulting data, shown for each experiment in Tables 1-3, indicates identical growth rates between the Planet-Safe® and Corning® surfaces.











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[3] Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities, ASTM International, (https://www.astm.org/d6400-21.html)
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[7] Introducing ACT®, My Green Lab, (https://act.mygreenlab.org/)