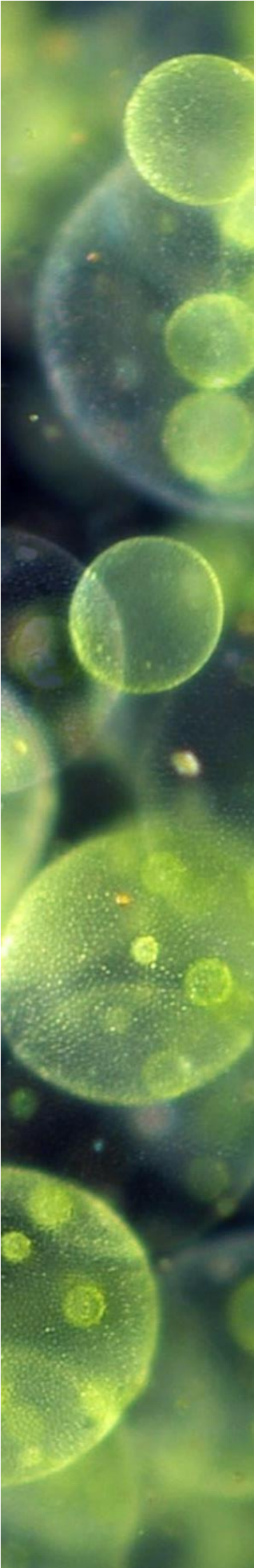

Microalgae strain catalogue

A strain selection guide for microalgae users: cultivation and chemical characteristics for high added-value products

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INTRODUCTION

Microalgae are a broad group of diverse, typically single-celled, photosynthetic microorganisms that derive from marine, brackish, freshwater or terrestrial environments. In this catalogue we include both eukaryotic and prokaryotic (cyanobacteria) species.

There is increasing commercial interest in the usage of microalgae for a wide variety of applications including animal feed, aquaculture, biofertilisers, waste pollutant remediation, nutrients and chemicals for food production, nutraceutical supplements such as omega-3 fatty acids, cosmetics, biofuels and bioenergy, pharmaceutical products, colourings, antioxidants and flavourings. These applications all depend on the characteristics and chemical composition of different microalgae species and strains.

It is estimated that there are many thousands of microalgae species with different properties. In addition, strains of microalgae belonging to the same or closely related species will have different characteristics and will have differences in their chemical composition due to living in different environments and adapting to the different physical conditions of these environments. Out of these many possible strains, only a relatively small number have been collected and are stored within individual labs and in culture collections. Furthermore, only a small number of strains of different species have been physiologically and biochemically characterised, and an even smaller number of strains are currently commercially used.

While the majority of available microalgae strains remain largely uncharacterised, a substantial amount of research has been performed on a small number of strains with desirable characteristics. Nevertheless, strain characteristics information can be challenging to identify and is typically found within many different, sometime inaccessible literature sources. Therefore, this resource has been developed to provide collated information on the cultivation characteristics and the chemical composition of selected microalgae species.

Each entry summarises the characteristics of a different species, with details taken from one or more strains of that species, which are present in a publicly accessible culture collection. As many details as possible about the cultivation procedures of each strain have been described so that the chemical composition characteristics might be reproducible. However, it must be noted, that strain properties can vary based on different environmental parameters and even on different locations where conditions are considered identical. Moreover, originally identical strains (from the same original source) can adapt their characteristics over time, therefore some caution must be taken when interpreting information assigned to a particular named strain.

We hope that you find this catalogue resource useful and informative. Nee editions of the catalogue will be produced over time. By registering your interest with EnhanceMicroAlgae (https://www.enhancemicroalgae.eu/) you will be sent a new edition when it is released. In addition, any feedback to this resource is welcome.

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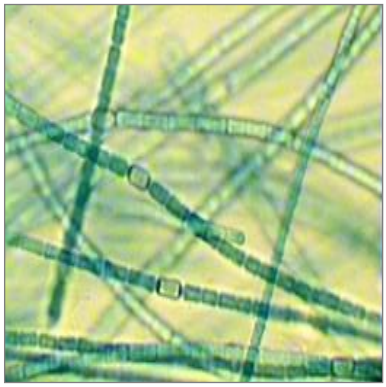
STRAIN CATALOGUE

Important notes:

- Unless otherwise specified, it should be interpreted that cultivation data shown in the following pages was obtained during cultivation in batch and in phototrophic growth mode using either natural (air) or artificial supplementation of CO_2.
- A compilation of important algal growth media recipes shown throughout the catalogue is included in Appendix 1.
- Similarly, a (non-exhaustive) list of the major Culture Collections is provided in Appendix 2.
- A list of common acronyms used throughout the catalogue and their corresponding description is presented here:

Acronym	Description
PBR	Photobioreactor
nd	Non-disclosed
STR	Stirred Tank Reactor
L:D	Light:Dark cycle (photoperiod)
BG11	Blue-Green medium
BBM	Bold's Basal Medium

1. *Anabaena cylindrica*



A freshwater filamentous cyanobacteria with robust growth characteristics and a source of pigments. It has nitrogen-fixation characteristics and some strains have been observed to produce hydrogen [1].

Commonly cultivated strains include:
CCAP 1403/2A, IAM M1 (PCC 7122), 10 C (CSMA)

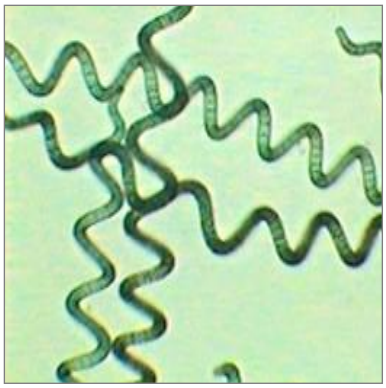
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1403/2A [2]	**System:** PBR **Medium:** BG11 **Temperature:** 22°C **Light:** 70 µmol/m^2/s, 16h L: 8h D	0.078	0.171	2.4
IAM M1 (PCC 7122) [3]	**System:** 5 PBR's in series (0.2 dm^3 each) **Medium:** Detmer medium **Carbon source:** CO_2 6% **Temperature:** 298 K (24.85°C) **Light:** 1000 lx, L:D cycle N/A	nd	nd	From: 0.667 (1st PBR) to:~2.66 (5th PBR)
10 C [4] (CSMA)	**System:** Fermentor (1 L) **Medium:** BG11 **Carbon source:** CO_2 and acetate **Temperature:** 25°C **Light:** 32 W cool white fluorescent lamp. Continuous illumination	nd	nd	~0.3 (BG11) ~0.6 (BG11+acetate)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
56% protein [2] 7% lipid 25% carbohydrate --- 43-56% protein [5] 4-7% lipid 25-30% carbohydrate	nd	nd	nd

2. *Arthrospira platensis*



A filamentous cylindrical cyanobacteria that is commonly known commercially as spirulina. It is widely cultivated as a food source and nutritional supplement particularly because it is rich in protein and contains essential amino acids [6]. It is commonly cultivated in open ponds but can also be grown in photobioreactors. It can grow under a range of temperature conditions but has optimum growth at higher temperatures, ~35°C [7].

Commonly cultivated strains include:
SAG 21.99, SAG 85.79, SAG 257.80, WH879

Cultivation characteristics

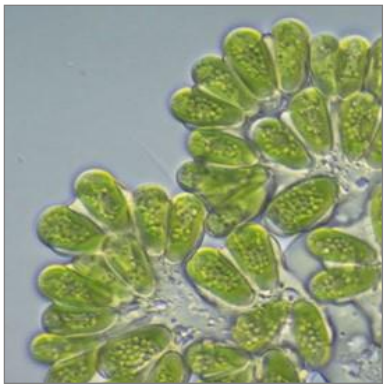
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
SAG 85.79 [2]	**System:** PBR **Medium:** Zarrouk medium **Temperature:** 22°C **Light:** 70 µmol/m^2/s, 16h L: 8h D	0.06	0.21	3.1
SAG 21.99 [8]	**System:** PBR (0.5 L) **Medium:** Zarrouk medium **Temperature:** 30°C **Light:** 120 µmol/m^2/s, Continuous light	nd	0.231	2.274
Mixed culture: *Arthrospira* sp. [9]	**System:** outdoor raceway ponds, surface area 100 m^2, culture depth 30 cm **Medium:** SOT medium **Temperature:** outdoors **Light:** outdoors	nd	34 *(g/m^2/d, accounts for irradiance surface area)*	0.62

WH879 [10]	**System:** Fed-batch PBR (1 L) **Medium:** Zarrouk medium **Temperature:** 28°C **Light:** 300 µmol/m^2/s, Continuous light	nd	0.594 *(feeding only Nitrate)*	6.78 (*feeding fresh medium*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
62% protein [2] 9% lipid 20% carbohydrate	nd	90 mg/g phycocyanin [2] 39.8 mg/g chlorophyll 3.8 mg/g carotene - - - 0.28-1.5% chlorophyll [8] - - - 5-12% phycocyanin [9] - - - 16.1±0.2% phycocyanin [10]	C16:0 40.1% [2] C16:1 9.2% C18:0 1.2% C18:1 5.4% C18:2 17.9% C18:3 18.3% other 7.9%

3. *Botryococcus braunii*



A eukaryotic planktonic Trebouxiophyceae strain, naturally found in freshwater and brackish ponds, that is typically a very slow growing microalga due to the high production of triterpene hydrocarbon oils with applications for various classes of biofuel (petroleum, kerosene, diesel) production by hydrocracking. There are a wide variety of *Botryococcus* strains (races) with very diverse oil productivities [11].

Commonly cultivated strains include:
CCAP 807/2, SAG 30.81, CCALA 777, CCALA 778, CCALA 835, UTEX Bb 572, AC755, AC759, AC760, AC761, AC765 [12]

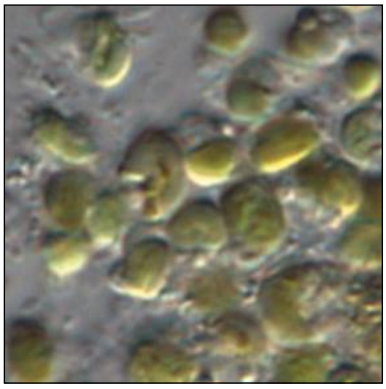
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 807/2 [2]	**System:** PBR **Medium:** 3N-BBM **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.027	0.098	1.94
AC755 [12]	**System:** Bubble column PBR (0.4 L) **Medium:** Chu 13 medium **Temperature:** 23°C **Light:** 150 µmol/m^2/s, 18h L: 6h D	nd	0.06	~1.75
AC759			0.09	~2.75
AC761			0.15	~3.6
CCALA 777			0.08	~2.2
CCALA 778			0.12	~3.6
CCAP 807/2			0.14	~4.6

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
40% protein [2] 33% lipid 6% carbohydrate	nd	6% α-carotene [13] 6% β-carotene 22% lutein	C16:0 29.5% [2] C16:1 3.3% C18:0 1.0% C18:1 44.9% C18:2 21.1% other 0.3%

4. *Chaetoceros calcitrans*



A marine planktonic diatom. It is a roughly cylindrical alga, elliptical in valve view and rectangular in girdle view. The cells bear long cell wall prolongations (seta) at their poles which join cells together to form chains.
C. calcitrans (Paulsen) Takano is known as a potential species for producing biodiesel [14], with high growth rates even at low light intensities [15].

Commonly cultivated strains include:
CCMP 60/00/00 1315, CCAP 1010/11, CCMP1315; NEPCC 590; PLY537, UPMAAHU10.

([16])

Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCMP 60/00/00 1315 [15]	**System:** 16-29 L bags **Medium:** Conway **Carbon source:** 0.2% CO_2 **Temperature:** 20-23°C **Light:** 750–1000 lx, continuous light	nd	nd	7-13x10^6 cells/mL
UPMAAHU10 [17]	**System:** 1 L flasks (outdoors and lab) **Medium:** Conway **Temperature:** 24-36°C (outdoors); 23°C (lab) **Light:** 140 µmol/m^2/s, 12h L: 12h D (outdoors); 150 µmol/m^2/s, 12h L: 12h D (lab).	nd	nd	2.50±0.20 (outdoors) 2.20±0.10 (lab)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
Protein: [17] - 41.60% (outdoors); - 43.10% (lab) Lipid: - 26.80% (outdoors); - 11.71% (lab) Carbohydrate: - 8.70% (outdoors); - 6.62% (lab)	nd	nd	C14:0 18.0% [15] C16:0 13.6% ∑SFA 34.4% C16:1(n-7) 27.6% C18:1 (n-9) 0.7% ∑MUFA 30.0% C18:3 (n-3) 0.1% C18:4 (n-3) 2.1% EPA 16.3% DHA 0.4% ∑(n-3) 19.1% 16:3 (n-4) 14.6% 18:2 (n-6) 0.4% ∑PUFA 35.6%

5. *Chlamydomonas reinhardtii*

A photosynthetic biflagellate microalga (Chlorophyta) that has been studied for more than 30 years as a model for basic and applied physiology and biochemistry, partly due to its ease of culturing and the ability to manipulate its genetics [18]. It can be cultivated photoautotrophically and also heterotrophically or mixotrophically [19]. Commercially, it is of interest for producing biopharmaceuticals and biofuel, as well being a valuable research tool in making hydrogen.

Commonly cultivated strains include:
UTEX 90, CC-124, CC-125 (equivalent to CCAP 11/32C)

Cultivation characteristics

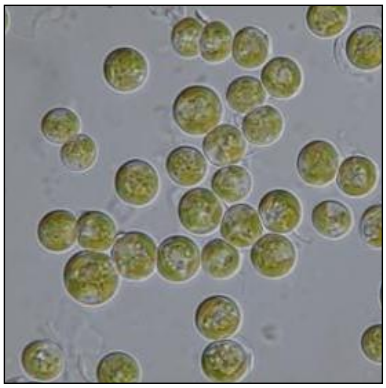
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
UTEX 90 [20]	**System:** Flat-vertical PBR **Medium:** minimal medium **Carbon source:** glacial acetic acid with supplemental CO_2 **Temperature:** 25-28°C **Light:** outdoor light conditions during May to July 2003 in Dae-jeon, Korea.	nd	nd	1.45 (fresh) 12-18 (concentrated)
CC-124 wild-type mt(-) 137c [21]	**System:** flask on a rotatory shaker **Medium:** TAP medium **Carbon source:** acetic acid **Temperature:** 23 °C **Light:** 150 µmol/m^2/s, continuous light	nd	nd	~1.25x10^7 cells/mL

CC-125 wild-type mt(+) 137c [21]	**System:** flask on a rotatory shaker **Medium:** TAP medium **Carbon source:** acetic acid **Temperature:** 23 °C **Light:** 150 µmol/m^2/s, continuous light	nd	nd	~1.10x10^7 cells/mL

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
CC-124 [21] 16.8% lipid in Control 39.8% lipid in N-starvation 37.6% lipid in S-starvation CC-125 14.2% lipid in Control 41.4% lipid in N-starvation 39.7% lipid in S-starvation --- *Autotrophic* [22] 26.1% protein 18.9% lipid 50.8% carbohydrate *Mixotrophic* 30.3% protein 27.9% lipid 38.1% carbohydrate *Heterotrophic* 22.2% protein 28.7% lipid 44.8% carbohydrate	*Autotrophic* [22] 48.1% C 5.8% N 7.3% H 38.8% O *Mixotrophic* 50.7% C 3.5% N 7.9% H 37.9% O *Heterotrophic* 50.5% C 10.5% N 7.7% H 31.3% O	*Autotrophic* [22] 0.9% Chlorophyll-a 1.5% Chlorophyll-b *Mixotrophic* 0.7% Chlorophyll-a 1.3% Chlorophyll-b *Heterotrophic* 1.8% Chlorophyll-a 0.8% Chlorophyll-b	nd

6. *Chlorella luteoviridis*



A eukaryotic freshwater Trebouxiophyceae strain (also known as *Heterochlorella luteoviridis* or *Jaagichlorella luteoviridis*) with fast growth rate and along with other *Chlorella* sp. has applications for animal feed, nutritional supplement, and biofuel. It can be cultivated autotrophically, mixotrophically or heterotrophically. [23]

Commonly cultivated strains include:
CCAP 211/3, CCAP 211/4, CCAP 211/5B

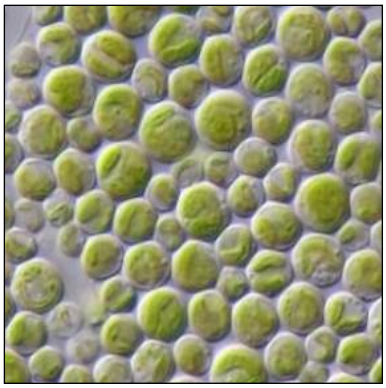
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 211/3 [2]	**System:** PBR **Medium:** Jaworski's medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.29	0.36	2.52
Indigenous wastewater *C. luteoviridis* strain [24]	**System:** 250 mL conical flasks (batch; semi-continuous) **Medium:** Raw municipal wastewater secondary treated effluent (RMWSE) + 25 % v/v sludge liquor **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	nd	~0.8 *(batch)* 1.78 *(semi-continuous)*	0.84 *(batch)* 6.01-7.99 *(semi-continuous)*
Indigenous wastewater *C. luteoviridis* strain [24]	**System:** Open pond (150 L, 10 cm depth) **Medium:** RMWSE + 25 % v/v/ sludge liquor **Temperature:** outdoors **Light:** outdoors	nd	~0.31 *(in summer)* ~0.25 *(in spring)*	nd

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
47% protein [2] 22% lipid 12% carbohydrate	nd	29.8 mg/g total chlorophyll [2] 3.4 mg/g total carotenoid	C14:0 2.4% [2] C16:0 25.0% C16:1 9.3% C18:0 7.2% C18:1 21.3% C18:2 9.7% C18:3 24.9% other 0.2%

7. *Chlorella protothecoides*



A eukaryotic green microalga belonging to the Trebouxiophyceae class. It can grow either photoautotrophically, mixotrophically or heterotrophically [25]. *C. protothecoides* shows a high industrial potential for producing lipids and fatty acids at high yield [26].

Commonly cultivated strains include:
UTEX 249, SAG 211-7b

Cultivation characteristics

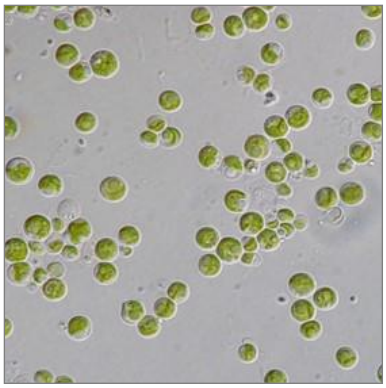
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
UTEX 249 [25]	**System:** 250 mL Erlenmeyer flasks **Medium:** BBM **Carbon source:** glucose, glycerol, or acetate **Light:** 16h L: 8h D (autotrophic and mixotrophic) and 24h D (heterotrophic)	nd	1.59±0.50 (*on glucose/acetate; 80:20*)	4.76±1.50 (*on glucose/ acetate; 80:20*)
nd [26]	**System:** 2.8 L glass flasks (PYREX) **Medium:** Modified BBM **Temperature:** 28°C **Carbon source:** CO_2, and glucose **Light:** 60 µmol/m^2/s, L:D cycle nd	nd	nd	9.54 ± 0.72 (*mixotrophic cultures)* 10.32 ± 0.83 (*heterotrophic cultures)*

nd [27] *obtained from Culture Collection of Alga at the University of Texas*	**System:** Shaking flasks / 5 L bioreactor **Medium:** BBM **Temperature:** 28°C **Carbon source:** glucose **Light:** 5 µmol/m^2/s L:D cycle nd	nd	nd	51.2 (*in improve fed-batch culture)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
52% lipids [25]	nd	nd	nd

8. *Chlorella sorokiniana*



A eukaryotic freshwater Trebouxiophyceae strain with fast growth rate with applications for animal feed, nutritional supplement, and biofuel. It can be cultivated autotrophically, mixotrophically or heterotrophically [28],[29]. Some *C. sorokiniana* show a broad temperature range and thermotolerance up to 45°C [30].

Commonly cultivated strains include:
UTEX 1230, UTEX 1602, UTEX 3016, UTEX 2805, IBVF 211-32

Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
UTEX 1230 [2]	**System:** PBR **Medium:** 3N-BBM **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.115	0.185	3.7
IBVF 211-32 [31]	**System:** 2 L stirred tank reactor (STR) **Medium:** Sueoka medium **Carbon source:** CO_2, and acetate **Temperature:** 25°C **Light:** 100 µmol/m^2/s, Continuous light	nd	1.16	1.18 (*on CO_2*) ~3.1 (on acetate)
UTEX 1602 [32]	**System:** 250 mL flasks **Medium:** Kuhl medium **Carbon source:** 1 % CO_2, glucose **Temperature:** 25°C **Light:** 100 µmol/m^2/s, Continuous light	nd	nd	0.68 *(on CO_2)* 5.08 *(on glucose)*
UTEX 2805 [33]	**System:** 250 mL flasks **Medium:** synthetic medium **Temperature:** 27°C **Light:** 60 µmol/m^2/s, L:D cycle nd	nd	nd	2.11±0.26 x 10^6 *(cell/mL)*

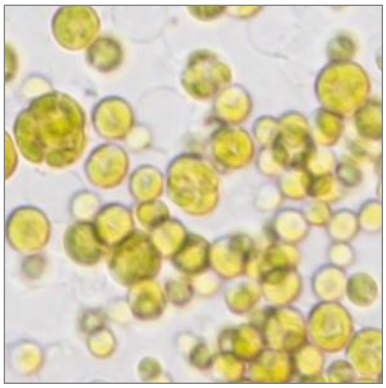
Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
56% protein [2] 22% lipid 17% carbohydrate --- 6.65% lipids (*on CO_2*) [32] 31.58% lipids (*on glucose*) --- 40% lipids [31]	46% C [2] 2% N C/N ratio 21	32.4 mg/g total chlorophyll [2] 1.2 mg/g beta-carotene 7.1 mg/g lutein	C16:0 22.0% [2] C16:1 4.3% C16:2 11.5% C16:3 5.1% C18:0 3.5% C18:1 11.3% C18:2 31.1% C18:3 9.1% other 2.1% - - - C16:0 20.99% [32] C16:1 5.56% C16:2 4.82% C18:0 0.33% C18:1 2.95% C18:2 13.79% C18:3 33.31%

Additional biomass considerations:

Supplementation of glucose as a carbon source can increase cell density, biomass production and total lipid yield but decreases protein abundance and chlorophyll biosynthesis [29].

9. *Chlorella zofigiensis*



A freshwater green microalga. It can grow phototrophically, heterotrophically and mixtrophically, and it is easy to be cultured and scaled up both indoors and outdoors, achieving high cell density. It is considered a potential alternative for astaxanthin production [34].

Commonly cultivated strains include:
UTEX B32

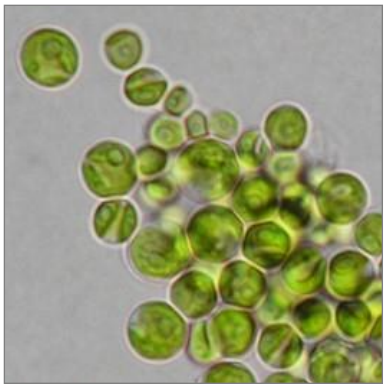
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
nd [35]	**System:** 300 mL glass PBRs **Medium:** BG11 **Carbon source:** 5% CO_2 Temperature: 25°C **Light:** 300 µmol/m^2/s, continuous light	nd	nd	2.50
UTEX B32 [36]	**System:** Flat-panel, airlift-loop PBR **Medium:** Modified M8 **Carbon source:** CO_2 Temperature: 25°C **Light:** from 63 to 245 µmol/m^2/s, continuous light	nd	0.75	12

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
nd	nd	2.4 mg/g astaxanthin [36] 1.3 mg/g canthaxanthin 0.8 mg/g ketolutein	335 mg/g TAGs [36]

10. *Chlorella vulgaris*



A eukaryotic marine Trebouxiophyceae strain that has large-scale commercial cultivation in Asia as a high protein-rich food and feed source, a nutritional supplement, and biofuel source. It can be cultivated autotrophically, mixotrophically or heterotrophically [37–39]. It has quite robust growth for cultivation in open ponds as well as photobioreactors [40].

Commonly cultivated strains include:
CCAP 211/8K, CCAP 211/11B, CCAP 211/21A, CCAP 211/21B, CCAP 211/79, UTEX 2805, UTEX 2714

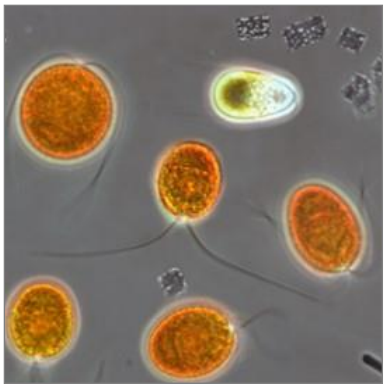
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 211/79 [2]	**System:** PBR **Medium:** Jaworski's medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.18	0.428	3.0
UTEX 2805 [33]	**System:** 250 mL flasks **Medium:** synthetic medium **Temperature:** 27°C **Light:** 60 µmol/m^2/s, L:D cycle nd	nd	nd	3.2±0.5 x 10^6 *(cell/mL)*
UTEX 2714 [41]	**System:** 250 mL flasks **Medium:** modified/optimised synthetic medium **Carbon source:** glucose/glycerol **Temperature:** 26°C **Light:** 60 µmol/m^2/s, L:D cycle nd	nd	1.87	5.62
nd [42] *purchased from Connecticut Valley Biological Supply Co. Inc*	**System:** PBR (3.8 gallon, 6 L working volume) **Medium:** BBM **Temperature:** 25°C **Light:** 276 µmol/m^2/s, L:D cycle nd	nd	0.35	~1.6

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
58% protein [2] 12% lipid 17% carbohydrate --- 51-58% protein [5] 14-22% lipid 12-17% carbohydrate --- 40.10% lipid [41]	52% C 3% N C/N ratio 19	22.6 mg/g total chlorophyll 2.7 mg/g total carotenoid	C14:0 3.1% C16:0 25.1% C16:1 5.3% C16:3 1.3% C18:0 0.6% C18:1 12.6% C18:2 7.2% C18:3 19.1% C20:3 0.8% other 24% --- C14:0 3.01% [43] C16:0 16.99% C16:1 13.61% C16:2 5.47% C16:3 7.93% C18:0 1.51% C18:1 8.55% C18:2 14.44% C18:3 16.63% C20:4 1.24% C20:5 10.17%

11. *Dunaliella salina*



A eukaryotic marine Chlorophyceae strain that is extremely salt tolerant and is widely cultivated as a source of beta-carotene. It has commercial interest as a source of anti-oxidant, colouring, nutritional supplement and cosmetics [44–47]. Large scale cultivation of *D. salina* is typically in open pond or large coastal lagoons [48].

Commonly cultivated strains include:
CCAP 19/18

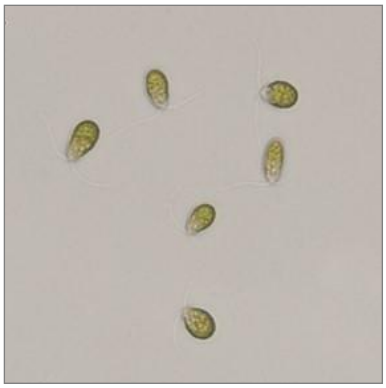
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 19/18 [2]	**System:** PBR **Medium:** F2 (f/2) medium **Temperature:** 22°C **Light:** 70 µmol/m^2/s, 16h L: 8h D	0.135	0.224	1.28
nd [49] *obtained from NLP corp (Busan, Korea)*	**System:** PBR (5L, 3 L working volume) **Medium:** f/2 medium **Temperature:** 20°C **Light:** 108.9 µmol/m^2/s, 12h L: 12h D	nd	0.0375	0.25
nd *obtained from Guangyu Co. (Shangai, China)*	**System:** Bubble column (350 mL working volume) **Medium:** high-salinity medium **Temperature:** 28°C **Light:** 800 µmol/m^2/s, Continuous	0.66	nd	3.38 ~0.5 (*in 100 µmol/m^2/s*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
48% protein [2] 24% lipid 23% carbohydrate --- 57% protein [5] 6% lipid 32% carbohydrate --- ~42% lipids in two-stage system [49]	41% C [2] 2% N C/N ratio 21	27 mg/g beta-carotene [2]	C16:0 28.1% [2] C16:1 2.0% C18:0 2.9% C18:1 17.2% C18:2 9.2% C18:3 15.9% C20:1 4.8% other 19.9%

12. *Dunaliella tertiolecta*



A eukaryotic brackish water Chlorophyceae strain that is less salt tolerant than *D. salina* and has lower productivity of beta-carotene but is of interest for its fatty acid yields with applications for nutritional supplements, and biofuel [50].

Commonly cultivated strains include:
CCAP 19/6B, BE 003

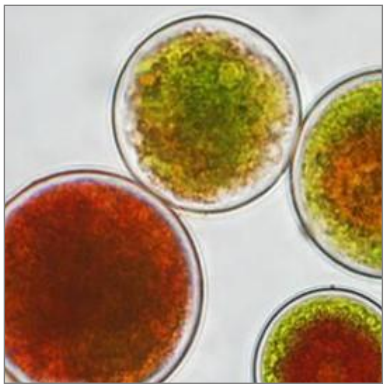
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 16/6B [2]	**System:** PBR **Medium:** F2 (f/2) medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.048	0.128	1.6
nd [49] *obtained from NLP corp (Busan, Korea)*	**System:** PBR (5L, 3 L working volume) **Medium:** f/2 medium **Temperature:** 20°C **Light:** 108.9 µmol/m^2/s, 12h L: 12h D	nd	0.0442	0.28
BE 003 [51]	**System:** PBR (2.2 L working volume) **Medium:** f/2 medium (modified with various $NaNO_3$ concentrations) **Temperature:** 28°C **Light:** 17.5 klx continuous	nd	nd	0.45±0.02 (*75 mg/L $NaNO_3$*) 1.27±0.07 (*300 mg/L $NaNO_3$*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
58% protein [2] 12% lipid 8% carbohydrate --- ~40% lipids in two-stage system [49]	44% C [2] 2% N C/N ratio 20	3.95±0.06 to 5.1±0.4 mg/g total carotenoids [51]	C16:0 17.7% [2] C16:1 0.9% C16:2 3.0% C16:3 1.2% C16:4 10.6% C18:1 4.9% C18:2 12.4% C18:3 30.2% other 19.1%

13. *Haematococcus pluvialis*



A eukaryotic freshwater Chlorophyceae strain with the ability to produce very high concentrations of astaxanthin, with applications for aquaculture, nutritional supplement, and cosmetics, and with antioxidant characteristics. *H. pluvialis* has a green phase then a red phase of growth, which is induced by light, nitrogen or saline stress [52–54].

Commonly cultivated strains include:
CCAP 34/6, SCCAP K-0084, SCCAP K-0084, LUGU, CPCC 93

Cultivation characteristics

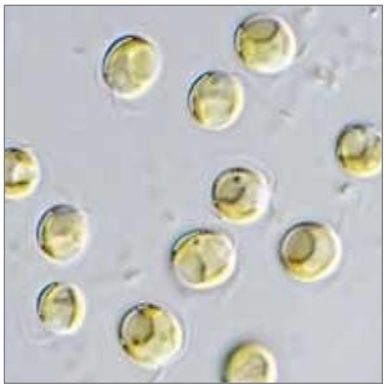
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 34/6 [2]	**System:** PBR **Medium:** Jaworski's medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.098	0.157	3.14
SCCAP K-0084 [55]	**System:** 250 mL flasks **Medium:** BG11 medium **Carbon source:** ribose, sodium acetate, or gluconate **Temperature:** 25°C **Light:** 45±3 µmol/m^2/s, L:D cycle nd	nd	nd	1.03 (*on ribose*) 0.77 (*on acetate*) 1.12 (*on gluconate*)
SCCAP K-0084 [55]	**System:** 250 mL flasks **Medium:** BG11 medium **Carbon source:** gluconate **Temperature:** 25°C **Light:** 105±3 µmol/m^2/s, L:D cycle nd	nd	nd	2.09

LUGU [56] (*18S GenBankKM115647.1*)	**System:** 1 L flask (650 mL working volume). **Medium:** BG11 medium + fulvic acid **Carbon source:** sodium acetate **Temperature:** 25°C **Light:** 50 µmol/m^2/s L:D cycle nd	nd	nd	1.57 (with 0 *mg/L fulvic acid*) 1.84 (with 5 mg/L fulvic acid)
CPCC 93 [57]	**System:** 2.2 L PBR **Medium:** M1B5 **Temperature:** 23±2°C **Light:** 15-30 klx 12 h L: 12h D	nd	nd	2.028±0.09 (*on air*) 4.37±0.07 (*on 5% CO_2*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
68% protein [2] 26% lipid 9% carbohydrate	36% C [2] 4% N C/N ratio 10 --- 43.57±0.61% C [57] 6.26±0.54% H 1.98±0.16% N 0.47±0.03% S	23.2 mg/g astaxanthin [2] 2.8 mg/g beta-carotene 10.2 mg/g lutein 5.8 mg/g total chlorophyll (in red phase) --- 5.2±1.7 ug/mL chlorophyll [55] (*at 0 µmol/m^2/s*) 41.3±2.9 ug/mL chlorophyll [55] (*at 105 µmol/m^2/s*) --- 5.01 mg/g [56] astaxanthin content	C16:0 22.4% [2] C16:1 0.6% C16:2 2.1% C16:3 3.1% C16:4 5.8% C18:0 0.9% C18:1 19.5% C18:2 28.7% C18:3 12.6% other 4.3%

14. Isochrysis galbana



A eukaryotic marine microalga which is a species of Haptophyta. For its good nutritive characteristics (especially in relation to polyunsaturated fatty-acid composition), is of substantial interest in aquaculture [58]. It is also investigated for its high amount of fucoxanthin [59].

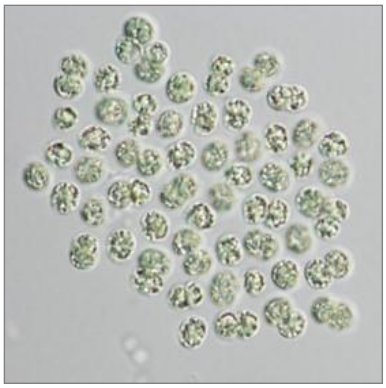
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
nd [60] *from Marine Microalgae Research Center, Ocean University of China*	**System:** Erlenmeyer flasks **Medium:** f/2 **Temperature:** 23°C **Light:** 4.0 mW/cm^2, 16 h L: 8 h D	nd	nd	1.69x10^7 cells/mL *(500 µmol/L phosphorous)*
nd [61] *Aquatic Research Laboratory at Isfahan University of Technology, Isfahan, Iran*	**System:** 10 L carboys **Medium:** Walne's medium **Temperature:** 25°C **Light:** 80 µmol/m^2/s, 12 h L: 12 h D	nd	nd	1.55x10^7 cells/mL *(144mg/L nitrogen)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
30% protein [60] 33% carbohydrate *(100 µmol/L phosphorous)* --- 36.3% protein [61] *(36 mg/L nitrogen)* 47% carbohydrate *(0 mg/L nitrogen)* 30.6% lipids *(144 mg/L nitrogen)*	nd	3.24% chlorophyll [60] *(100 µmol/L phosphorous)* --- 1.21 mg/L total carotenoid [61] *(72 mg/L nitrogen)*	C14:0 26.34% [61] C16:0 43.46% C16:1 1.4% C18:1n-7 17.25% C18:3n-3 3.52% C20:0 4.42% C20:3n-3 2.03% *(0 mg/L nitrogen)*

15. *Microcystis aeruginosa*



A cyanobacteria strain known for toxic bloom formation. It can produce neurotoxins and is also a source of butylated hydroxytoluene, which has antioxidant characteristics [62].

Commonly cultivated strains include:
CCAP 1450/1, FACHB-469.

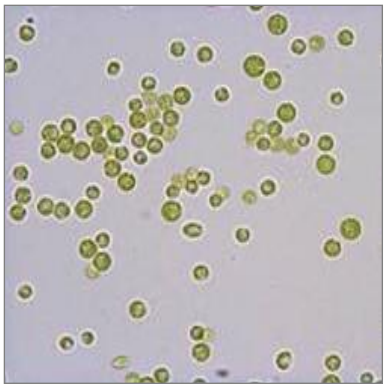
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1450/1 [2]	**System:** PBR **Medium:** BG11 medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.04	0.06	0.68
FACHB-469 [63]	**System:** 250 mL flasks (150 mL working volume) **Medium:** BG11 medium with dissolved organic carbon, DOM **Temperature:** 25°C **Light:** 50 µmol/m^2/s, 12h L: 12h D	nd	nd	1.7x10^7 cells/mL

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
66% protein [2] 9% lipid 8% carbohydrate --- ~4.5-8 pg $cell^{-1}$ protein [63] ~2-12 pg $cell^{-1}$ polysaccharides *(under various organic sources)*	nd	~0.4-0.55 ug 10^6 $cell^{-1}$ chlorophyll content [64]	nd

16. *Nannochloropsis occulata*



A eukaryotic marine strain of the Eustigmatophyceae class with applications as a nutritional supplement, and biofuel, particularly due to its fatty acid characteristics. It can be cultivated autotrophically in photobioreactor or open pond conditions, with stress induction such as nitrogen starvation, typically used to induce higher fatty acid yields [65,66].

Commonly cultivated strains include:
CCAP 849/1

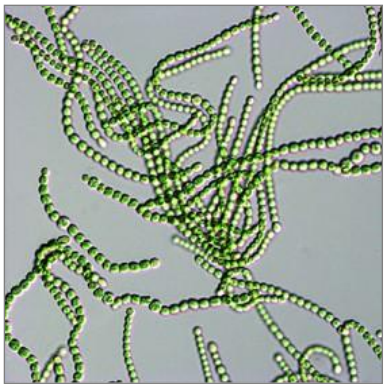
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 849/1 [2]	**System:** PBR **Medium:** F2 (f/2) medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.09	0.32	2.5
nd [49] *obtained from NLP corp (Busan, Korea)*	**System:** PBR (5L, 3 L working volume) **Medium:** f/2 medium **Temperature:** 20°C **Light:** 108.9 µmol/m^2/s, 12h L: 12h D	nd	0.0475	0.51
nd *obtained from the Fisheries Research Institute (Taiwan)*	**System:** 3 L PBR Two stages: 1st N replete, 2nd N deplete **Medium:** Basal medium with 35 g/L salinity **Temperature:** 25°C **Light:** 300 and 500 µmol/m^2/s, Continuous	nd	nd	3.36 (*300 µmol/m^2/s*) 3.44 (*500 µmol/m^2/s*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
40% protein 33% lipid 10% carbohydrate --- ~30% lipids in two-stage system [49]	55% C 3% N C/N ratio 21	nd	C14:0 7.2% [2] C16:0 23.4% C16:1 26.9% C16:3 0.5% C18:1 13.2% C18:2 1.2% C20:4 2.7% C20:5 14.3% other 10.1% --- C14:0 4.13% [43] C16:0 20.70% C16:1 17.12% C16:2 3.88% C16:3 5.35% C18:0 0.98% C18:1 7.46% C18:2 8.75% C18:3 10.08% C20:4 2.88% C20:5 18.67%

17. *Nostoc* sp.



A cyanobacteria strain that is grown as a food and feed source, and a nutritional supplement in Asia due to its protein and vitamin constituents [67].

Commonly cultivated strains include:
CCAP 1403/17, TISTR 8872, TISTR 8873

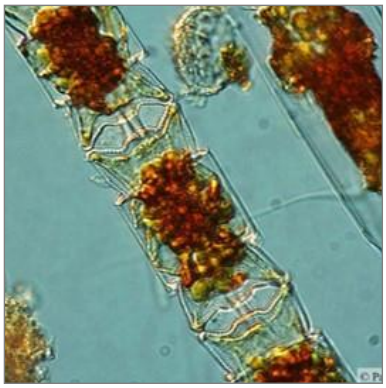
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1403/17 [2]	**System:** PBR **Medium:** BG11 medium **Temperature:** 22°C **Light:** 70 µmol/m^2/s, 16h L: 8h D	0.122	0.197	1.38
TISTR 8872 [68]	**System:** Conical flasks (300 mL working volume) **Medium:** BG11 medium **Temperature:** 28±1°C **Light:** 60 µmol/m^2/s, 12h L: 12h D	nd	nd	0.3±0.0
TISTR 8873 [68]	**System:** Conical flasks (300 mL working volume) **Medium:** BG11 medium **Temperature:** 28±1°C **Light:** 60 µmol/m^2/s, 12h L: 12h D	nd	nd	0.2±0.04

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
42% protein [2] 8% lipid 33% carbohydrate --- From 30.66±0.58 to 32.85±1.52% starch [68]	nd	0.6 mg/g chlorophyll [2] 1.7 mg/g carotenoids	nd

18. *Odontella aurita*



A marine diatom that is of interest as a nutritional supplement, and for pharmaceutical applications due to its fatty acid characteristics, in particular the accumulation of polyunsaturated fatty acids [69].

Commonly cultivated strains include:
CCAP 1054/1, SCCAP K 1251

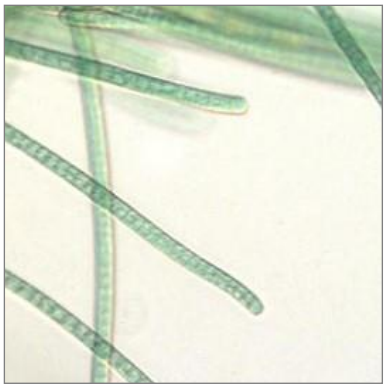
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1054/1 [2]	**System:** PBR **Medium:** f/2 + Si medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.001	0.011	0.2
SCCAP K 1251 [70]	**System:** PBR (1.2 L working volume) **Medium:** Modified L1 medium **Temperature:** 25±1°C **Light:** 150 µmol/m^2/s for 1st two days, then 300 µmol/m^2/s continuous	nd	nd	3.95 (*low nitrogen*) 5.84 (*high nitrogen*)
SCCAP K1251 [71]	**System:** Glass column (300 mL working volume) **Medium:** Artificial seawater enriched with L1 medium **Temperature:** 25±1°C **Light:** 150 µmol/m^2/s Continuous	nd	nd	6.34 (*high nitrogen*) 6.58 (*high phosphorous*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
48% protein [2] 5% lipid 20% carbohydrate --- ~25% protein [70] ~10% lipids 60.33% Chrysolaminarin (carbohydrate) --- 15.3% protein [71] 15.9% lipid 50.4% carbohydrate 47.2 % β-1,3-glucan	30% C [2] 5% N C/N ratio 6.5	2.33% fucoxanthin [70] (carotenoid) 60.33% Chrysolaminarin	C14:0 27.2% [2] C16:0 7.7% C16:1 18.7% C16:2 3.1% C16:3 5.7% C16:4 3.1% C18:1 1.9% C18:2 1.2% C18:4 0.8% C20:5 22.8% other 7.8%

19. *Oscillatoria lutea*



A cyanobacteria strain that is of interest as a source of chemicals including butylated hydroxytoluene, which has antioxidant characteristics [72].

Commonly cultivated strains include:
CCAP 1459/3

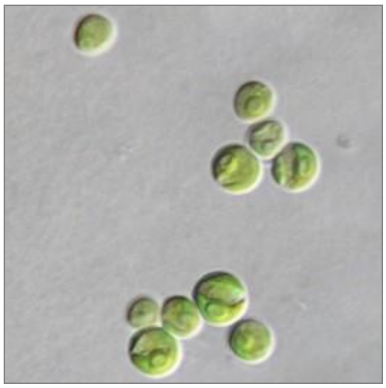
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1459/3 [2]	**System:** PBR **Medium:** BG11 medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.04	0.05	0.76
nd (*Oscillatoria lutea* var. *contorta*) obtained from	**System:** 500 mL flasks (250 mL working volume) **Medium:** grown on barley straw extract **Temperature:** 20°C **Light:** 65 µmol/m^2/s, 12h L: 12h D	nd	nd	~500 ug L (*measured as Chlorophyl a*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
48% protein [2] 9% lipid 18% carbohydrate	nd	9.8 mg/g chlorophyll [2] 1.7 mg/g carotenoids	nd

20. *Parachlorella kessleri*



A eukaryotic freshwater Trebouxiophyceae strain with potential applications as animal feed, nutritional supplement, and biofuel. It can be cultivated autotrophically, mixotrophically or heterotrophically [73].

Commonly cultivated strains include:
CCAP 211/11G, QWY28, GB1

Cultivation characteristics

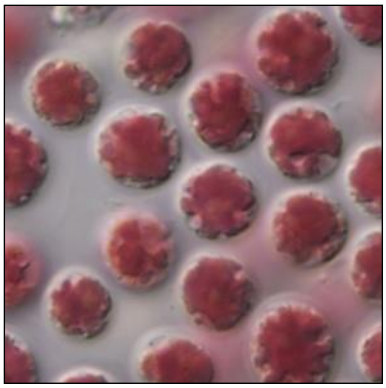
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 211/11G [2]	**System:** PBR **Medium:** Jaworki's medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.36	0.413	2.74
QWY28 [74] *collected from rivers in the district of Harbin city, China*	**System:** Conical flasks **Medium:** Artificial seawater **Temperature:** 30°C **Light:** 200 µmol/m^2/s, L:D cycle nd	nd	0.633±0.027	3.8
QWY28 [74] *collected from rivers in the district of Harbin city, China*	**System:** 500 mL glass vessels, 2.5 % CO_2 **Medium:** Raw swine wastewater **Temperature:** 27-30°C **Light:** 200 µmol/m^2/s, L:D cycle nd	nd	0.775±0.026	6.2
QWY28 [74] *collected from rivers in the district of Harbin city, China*	**System:** 500 mL glass vessels, 2.5 % CO_2 **Medium:** Raw swine wastewater **Temperature:** 27-30°C **Light:** 600 µmol/m^2/s, L:D cycle nd	nd	1.150±0.056	9.2

GB1 [75] *GenBank KX151669.1*	**System:** 500 mL flasks (200 mL working volume) **Medium:** BG11 **Carbon source:** glucose **Temperature:** 25±2°C **Light:** 28 µmol/m^2/s, Continuous	nd	0.176±0.00 (*phototrophic*) 1.362±0.01 (*mixotrophic*) 1.311±0.01 (*heterotrophic*)	1.043±0.02 (*phototrophic*) 8.176±0.06 (*mixotrophic*) 7.871±0.09 (*heterotrophic*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
51% protein [2] 25% lipid 16% carbohydrate --- 54% carbohydrate [74] (*of which ~35% is glucose*) --- 41.29±0.90% protein [75] 20.14±0.58% lipid 34.15±0.42% carbohydrate	nd	23.6 mg/g total chlorophyll [2] 4.1 mg/g total carotenoid --- 9.17±0.11 mg/g Chlorophyll a [75] --- 3.98±0.02 mg/g Chlorophyll b 2.60±0.02 mg/g carotenoids	C14:0 1.1% [2] C16:0 12.1% C16:1 7.2% C18:0 4.2% C18:1 24.2% C18:2 23.5% C18:3 26.8% C20:0 0.5% other 2.1%

21. Porphyridium purpureum



A species of marine red algae belonging to the Porphyridiophyceae family. It presents high potential to produce B-phycoerythrin (B-PE), long chain polyunsaturated fatty acids (LC-PUFAs) and exopolysaccharides (EPS) which are excellent feedstocks for food, nutraceuticals and pharmaceuticals [76].

Commonly cultivated strains include:
SCS-02, CCAP 1380/3, CoE1

Cultivation characteristics

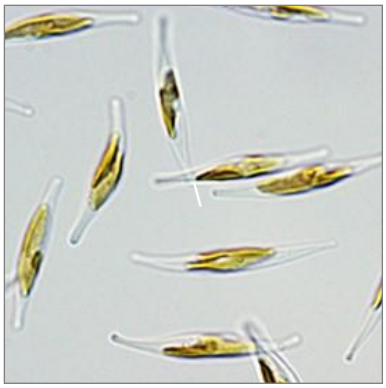
Strain	Cultivation Conditions	Mean biomass productivity (mg/L/d)	Maximum productivity (mg/L/d)	Maximum production (g/L)
SCS-02 [77]	**System:** Glass column PBR **Medium:** ASW medium **Temperature:** 25±1°C **Light:** 350 µmol/m^2/s, continuous light	nd	nd	5.54 *(high nitrogen)*
CCAP 1380/3 [78]	**System:** two 600 L PBRs *(one for Batch Culture and another for semi-continuous culture)* **Medium:** f/2 commercial medium *(Cell-hi F2P, Varicon)* **Temperature:** those registered in Summer season in Wales (11-22°C) **Light:** those registered in Summer season in Wales (average of 376.4 µmol/m^2/s)	26.60 *(Batch)* 47.04 *(Semi-continuous)*	72.5 *(Batch)* 145 *(Semi-continuous)*	0.97 *(Batch)* 1.04 *(Semi-continuous)*

CoE1 [79]	**System:** 1 L flasks **Medium:** ASW, KOCK, Pringsheim II and f/2 medium. **Temperature:** 25°C **Light:** from 110 to 220 µmol/m^2/s, continuous light	nd	nd	9.95 *(ASW medium)* 9.25 *(*Pringsheim II *medium)* 8.34 *(KOCK medium)* 2.58 *(f/2 medium)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
47.1% protein [77] *(high nitrogen)* 12% lipid *(high nitrogen)* 52.1% carbohydrate *(low nitrogen)* --- ~ 15-22% protein [78] ~ 17-20% lipid ~ 15-25% carbohydrate	nd	nd	C16:0 ~32% [77] C16:1 ~2% C18:0 ~1% C18:1 ~2% C18:2 ~11% C20:4 ~27% C20:5 ~15% --- C16:0 13.32% [79] C18:0 2.32% C18:2 8.38% C20:3 1.26% C20:4 9.03% C20:5 2.60% Others 2.90% *(220 µmol/m^2/s, 3 L/min of aeration)*

22. *Phaeodactylum tricornutum*



A marine diatom strain with ability to produce high yields of fatty acids including polyunsaturated fatty acids, therefore can be used to produce animal feeds, nutritional supplements, and biofuels [80,81].

Commonly cultivated strains include:
CCAP 1055/1, CCMP 632, PTN0301, CCMP 632.

Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 1055/1G [2]	**System:** PBR **Medium:** f/2 + Si medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.084	0.16	3.2
PTN0301 [82] *Isolated from water samples collected in the North Sea*	**System:** 1 L bottles **Medium:** modified f/2 medium, with air or CO_2 supply **Temperature:** 20±1°C **Light:** 90-110 µmol/m^2/s, 16h L: 8h D	nd	nd	1.6 (*with CO_2*) 1.0 (*with air*)
PTN0301 [82] *Isolated from water samples collected in the North Sea*	**System:** open ponds (1000 L) **Medium:** digestate from anaerobic digestion **Temperature:** outdoors **Light:** outdoors	0.041	nd	Between 0.3 and 0.8
CCMP 632 [83]	**System:** 1 L flasks (800 mL working volume) **Medium:** mixture of municipal wastewater (MW) and seawater (SW) **Temperature:** 20±1°C **Light:** 120 µmol/m^2/s, 12h L: 12h D	nd	0.289±0.0001 (*in MW:SW=2:1*) 0.238±0.002 (*in MW:SW=1:1*)	1.04±0.01 (*in MW:SW=2:1*) 0.97±0.02 (*in MW:SW=1:1*)

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
42% protein [2] 12% lipid 39% carbohydrate --- *Growth on air* [82] 41.5±0.4% protein 26.7±0.0% lipid 9.5±2.3% polysaccharides *Growth on CO_2* [82] 33.5±1.0% protein 33.8±3.7% lipid 24.0±0.1% polysaccharides	nd	nd	C14:0 7.5% [2] C16:0 12.6% C16:1 23.8% C16:2 4.1% C16:3 8.4% C16:4 2.9% C18:1 1.4% C18:2 2.1% C20:4 0.7% C20:5 30.2% other 6.3% --- C14:0, 6.55±0.32% [82] C16:0, 19.24±0.19% C16:3+C16:1, 49.41±2.68% C18:0, 0.74±0.10 % C86:2+C18:1, 3.63±0.25% C20:4, 1.15±0.12% C20:5, 17.77±2.23%

23. Rhodomonas sp.

A flagellate unicellular red alga with cell size between 9.2 and 9.9 µm. This marine microalga plays a significant role as live food in aquaculture due to its EPA and DHA content [84].

Commonly cultivated strains include:
Hf-1.

Cultivation characteristics

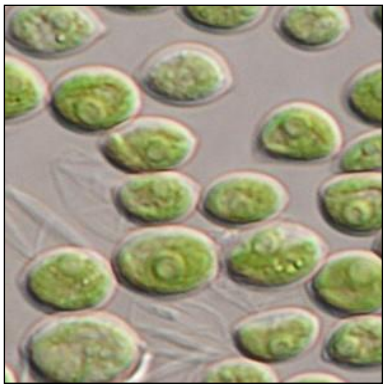
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
Hf-1 [84]	**System:** 200 mL Erlenmeyer flasks **Medium:** f/2 medium, salinity of 28 psu. **Temperature:** 20°C **Light:** 35 µmol/m^2/s, continuous light.	nd	nd	4.36±0.20 x 10^6 *(cell/mL) (temperature, 24°C)* 3.74±0.28 x 10^6 *(cell/mL) (salinity, 21 psu)* 3.60±0.49 x 10^6 *(cell/mL) (light intensity 80* µmol/m^2/s*)* 4.57±0.22 x 10^6 *(cell/mL) (light color, White)*

nd [85] *from the Dutch aquaculture industry*	**System:** Flat-panel PBR **Medium:** ASW medium **Temperature:** (15–20–25–30°C) **Light:** 60–195–330–495–600 µmol/m^2/s, continuous light.	nd	1.4 *(25°C, 600 µmol/m^2/s)*	11.25 x 10^6 *(cell/mL) (25°C, 600 µmol/m^2/s)*
nd [86] *isolated from coastal waters in north-eastern Brazil (state of Paraíba).*	**System:** 500 mL Erlenmeyer flasks **Medium:** f/2 medium, salinity of 34 psu. **Temperature:** 21± 2°C **Light:** 50 µmol/m^2/s, 12h L: 12h D.	nd	nd	11.3 x 10^5 *(cell/mL) (N-sufficient medium)* 5.0 x 10^5 *(cell/mL) (N-starved medium)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
Protein: [86] ~ 30 µg/10^6cell *(N-sufficient medium)* ~ 25 µg/10^6cell *(N-starved medium)* Carbohydrates: ~ 25 µg/10^6cell *(N-sufficient medium)* ~ 150 µg/10^6cell *(N-starved medium)*	nd	Chlorophyll a: [86] ~ 1.3µg/10^6cell *(N-sufficient medium)* Chlorophyll c: ~ 1.1 µg/10^6cell *(N-sufficient medium)* Phycoerythrin: ~ 5.5 µg/10^6cell *(N-sufficient medium)*	Σ SFA 13-16% [85] Σ MUFA 3-7% Σ PUFA *(excl. EPA + DHA)* 47-56% Σ EPA + DHA 11-22%

24. Scenedesmus obliquus



A freshwater green unicellular microalga belonging to the class Chlorophyceae. Its cells can be grouped to form colonies and they are non-motile. It is one of the most widely used lipid-producing microalga [87].

Commonly cultivated strains include:
FACHB 416, SJTU-3

Cultivation characteristics

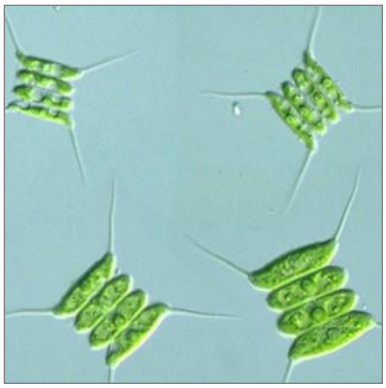
Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
nd [88] *from laboratory of live food culture, Institute of Tropical Aquaculture, University Malaysia Terengganu, Malaysia.*	**System:** 1 L Erlenmeyer flasks in outdoor natural conditions **Medium:** BBM **Temperature:** 17-34°C **Light:** nd Environmental light/dark cycle	nd	nd	1.50×10^7 *(cell/mL)*
nd [88] *from laboratory of live food culture, Institute of Tropical Aquaculture, University Malaysia Terengganu, Malaysia.*	**System:** 1 L Erlenmeyer flasks, laboratory control conditions **Medium:** BBM **Temperature:** 25°C **Light:** 2000 µmol/m^2/s, Continuous light	nd	nd	2.80×10^7 *(cell/mL)*

FACHB 416 [89]	**System:** 250 mL conical flasks. **Medium:** BG-11 medium *+ 0, 25, 50, 100, 200, 500 mg/L linear alkylbenzene sulfonate (LAS)* **Temperature:** 25°C **Light:** 50 µmol/m^2/s, 12h L: 12h D	nd	nd	1.60 x 10^7 *(cell/mL) (at LAS concentrations <100 mg/L)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
Outdoor natural conditions [88] 30.7±0.01% protein ~20±0.0% lipid ~20±0.0% carbohydrates *Control conditions* [88] 37.7±0.02% protein ~37±0.0% lipid 38.2±0.02% carbohydrates --- *25 mg/L LAS treatment* [89] 24.0% lipid	nd	nd	C15:0 3.3% [89] C16:0 22.6% C18:0 1.8% C18:1 8.6% C18:2 3.5% C18:3 47.7% C20:5 10.4% C22:0 2.1%

25. *Scenedesmus quadricauda*



A freshwater green unicellular microalga belonging to the class Chlorophyceae. It can grow in a wide range of industrial waste waters with reasonably good adaptation ability [90]. It is considered a versatile biofuel feedstock [91].

Commonly cultivated strains include:
ABU12

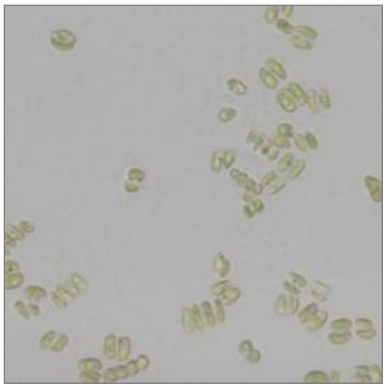
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
ABU12 [92]	**System:** 200 mL Erlenmeyer flasks **Medium:** BBM **Temperature:** 23±2°C **Light:** 150 µmol/m^2/s, continuous light	nd	nd	~0.75
nd [90]	**System:** 7 L tank. **Medium:** Wastewater *(from Shek Wu Hui Sewage Treatment Works)* **Temperature:** 28°C **Light:** 7000 lx, 12h L: 12h D	nd	nd	0.995 *(acclimated cultute)* 0.940 *(non-acclimated cultute)*
nd [93] *from reservoirs in the region of Fez (northern Morocco)*	**System:** Erlenmeyer flasks **Medium:** synthetic medium **Temperature:** 20-25°C **Light:** 300 µmol/m^2/s, 16h L: 8h D	nd	~0.99	nd

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
Acclimated culture [90] ~20.0% lipid *Non-acclimated cultures* ~18.0% lipid --- 4.38 – 9.55% protein [93] 6.91 – 10.60% lipid 3.67 – 24.76% carbohydrates	Nd	*Acclimated culture* [90] ~5.5mg/L chloropyll-a *Non-acclimated culture* ~5.3mg/L chloropyll-a	*Acclimated culture* [90] C14:0 0.7% C16:0 50.4% C16:1 1.6% C18:0 3.1% C18:1n9 3.0% C18:2n6 24.3% C18:3n3 14.6% C18:3n6 2.3% *Non-acclimated culture* C14:0 0.9% C16:0 55.6% C16:1 2.4% C18:0 1.5% C18:1n9 3.3% C18:2n6 19.9% C18:3n3 14.4% C18:3n6 2.1%

26. Scenedesmus subspicatus



A eukaryotic freshwater Chlorophyceae strain. Common applications include animal feeds, nutritional supplements, and biofuels. It can be cultivated autotrophically, mixotrophically or heterotrophically [94].

Commonly cultivated strains include:
CCAP 276/20

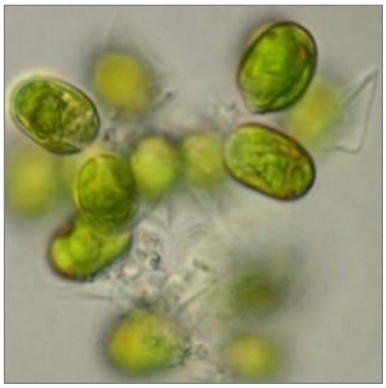
Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
CCAP 276/20 [2]	**System:** PBR **Medium:** Jaworski's medium **Temperature:** 22°C **Light:** 150 µmol/m^2/s, 16h L: 8h D	0.09	0.11	2.1
CCAP 276/20 [95]	**System:** 250 mL flasks (200 mL working volume) **Medium:** Jaworski's medium (different P levels) **Temperature:** 25°C **Light:** 144.8 µmol/m^2/s, 16h L: 8h D	nd	nd	2.4x10^6 cells mL^{-1} (*in low-P medium*) 5.2x10^6 cells mL^{-1} (*in intermediate-P medium*) 4.6x10^6 cells mL^{-1} (*in high-P medium*)
nd [96] *Isolated from the River Nile, Egypt*	**System:** 1 L flasks (700 mL working volume) **Medium:** BBM **Temperature:** 28±2°C **Light:** 2500 lux, L:D cycle nd	nd	~0.9 (*stationary phase*) ~0.65 (*late exponential phase*)	nd

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
58% protein [2] 16% lipid 29% carbohydrate	nd	19.6 mg/g total chlorophyll [2] 0.3 mg/g total carotenoid --- 0.098±0.061 pg cell^{-1} Chlorophyll-a (*in Low N medium*) [97] 0.617±0.111 pg cell^{-1} Chlorophyll-a (*in High N medium*) [97]	C14:0 1.5% [2] C16:0 21.8% C16:1 6.0% C16:2 4.0% C16:3 0.7% C18:1 17.9% C18:2 21.7% C18:3 3.8% other 22.6%

27. Tetraselmis subcordiformis



A marine unicellular green microalga with a cell size of 10–20 µm that is a widely used feed in aquaculture for its high nutrient levels. It has been proven to accumulate starch autotrophically or mixotrophically [98,99].

Commonly cultivated strains include:
FACHB-1751

Cultivation characteristics

Strain	Cultivation Conditions	Mean biomass productivity (g/L/d)	Maximum productivity (g/L/d)	Maximum production (g/L)
FACHB-1751 [100]	**System:** 600 mL glass air bubble column PBR *(500 mL working volume)* **Medium:** ASW *(P deprivation and P repletion)* **Temperature:** 25°C **Light:** 200 µmol/m^2/s, continuous light	nd	0.68±0.13 *(P-deprivation recultivated in P-replete medium)*	5.3±0.4 *(P-deprivation recultivated in P-replete medium)*
nd [101] *from the Culture Collection of Microalgae at Shanghai Ocean University in China*	**System:** 60 L PBR **Medium:** f/2 medium **Temperature:** 15, 20, 25, 30 °C **Light:** 100 µmol/m^2/s, continuous light	nd	nd	~0.10 d^{-1} *(at 20°C)*

Biomass characteristics

Biomass composition	Element composition	Pigments	Fatty acids
46.9±1.9% starch [100] *(P-deprivation recultivated in P-replete medium)* --- 22.25% lipid [101] *(at 20°C)* --- 18.0 ± 0.3% protein [102] 10.7 ± 0.8% lipid 47.4 ± 1.4% carbohydrate	nd	nd	C16:0 14.93–18.49%[101] C16:3n3 6.77–12.30% C18:3n3 15.99–23.65% C20:0 9.04– 10.09%

APPENDIX 1. MEDIA RECIPES

A compilation of the microalgae media recipes shown in this strain catalogue is presented in this appendix. The reader should be aware that recipes shown here follow the standard protocol where culturing medium is prepared by mixing specific quantities of stock solutions so as to reach the desired components' medium concentrations.

Unless otherwise specified, all media is prepared by carrying out the following protocol:

1. Prepare all necessary stock solutions* by dissolving each component in 1 L of distilled H_2O (dH2O);
2. Add/mix the corresponding quantity of stock solutions into dH2O;
3. bring final volume to 1 L;
4. adjust pH if required; and
5. autoclave (sterilize at 15 psi for 15 min).

Preparation of stock solutions is very useful during media preparation as it reduces weighing errors, particularly for those components that are necessary in very small quantities (micronutrients). Whilst we have aimed to provide preparation instructions for stock solutions within all the media recipes presented here, the reader should be aware that stock solution's recipes can be modified accordingly so long as the final medium concentration of each component is met.

It is also important to note that microalgae media recipes have been subject to modifications (e.g. replacing one component for another, increasing or decreasing component concentrations, etc.) to fit the desired cultivation needs, such as optimisation of biomass or metabolite concentration, maximise nutrient uptake, etc. We would therefore encourage the reader to browse the open literature, where different variations of the recipes shown here, as well as many other, have been widely explored.

Useful sources for algal media recipes

- CCAP media recipes [103]
- Algal Culturing Techniques, by Rober A. Andersen, Elsevier Academic Press (2005) [104]

A.1. Artificial Seawater (ASW) medium

ASW components and concentrations[103]

Component [68]	**Stock solution** *g per 1000 mL H_2O*	**Quantity used for medium**
Extra salts		3.75 mL
$NaNO_3$	30	
Na_2HPO_4	1.2	
K_2HPO_4	1	
Vitamin solution		2.5
Biotin	0.0002	
Calcium pantothenate	0.02	
Cyanocabalamin	0.004	
Folic acid	0.0004	
Inositol	1.0	
Nicotinic acid	*0.02*	
Thiamine HCl	*0.1*	
Thymine	*0.6*	
Soil extract (SE1)	*See below*	25 mL
Tricine		0.5 g

Soil extract

Soil should be air-dried. Dried soil is autoclaved together with a volume of distilled water equivalent to double the volume of soil. Once autoclaved, the supernatant is decanted, filtered (Whatman No 1 paper), and placed in appropriate vessels until used for media preparation. Soil selection is an important consideration for ASW media. Readers are referred to the recipe provided by CCAP [103].

A.2. Blue-Green medium (BG11)

Mix stock solutions and bring to 1 L; adjust pH to 7.1 (with NaOH or HCl).

BG11 medium components and concentrations[103]

Component	**Stock solution** *g per 500 mL dH_2O*	**Quantity used for medium**
$NaNO_3$	75	10 mL
K_2HPO_4	2	10 mL
$MgSO_4 \cdot 7H_2O$	3.75	10 mL
$CaCl_2 \cdot 2\ H_2O$	1.80	10 mL
Citric acid	0.3	10 mL
Ammonium ferric citrate green	0.3	10 mL
$EDTA \cdot Na_2$	0.05	10 mL
Na_2CO_3	1	10 mL
Trace metals solution	*See recipe below*	1 mL

Trace metals solution (also known as A5 + Co Trace metals solution) [103]

Component	**Stock solution** *qty per litre dH_2O*
H_3BO_3	2.860 g
$MnCl_2 \cdot 4H_2O$	1.810 g
$ZnSO_4 \cdot 7H_2O$	0.220 g
$CuSO_2 \cdot 5H_2O$	0.08 g
$Na_2MoO_2 \cdot 2H_2O$	0.39 g
$Co(NO_3)_2 \cdot 6H_2O$	0.05 g

A.3. Bold's Basal Medium (BBM) and 3N-BBM

The recipe for BBM is presented below. 3N-BBM is identical to BBM medium but requiring 3 times the nitrogen (i.e. 3N) used in BBM.

BBM medium components and concentrations[103]

Component	**Stock solution** ***g per 400 mL dH₂O***	**Quantity used for medium**
Macronutrients		
$NaNO_3$	10	10 mL
$MgSO_4 \cdot 7H_2O$	3	10 mL
NaCl	1	10 mL
K_2HPO_4	3	10 mL
KH_2PO_4	7	10 mL
$CaCl_2 \cdot 2H_2O$	1	10 mL
Trace elements solution	See recipe below	1 mL
Boric acid solution	See recipe below	1 mL
Alkaline EDTA solution	See recipe below	1 mL
Acidified Iron solution	See recipe below	1 mL

BBM Trace elements solution[103]

Component	**Stock solution** ***qty per litre dH₂O***
$ZnSO_4 \cdot 7H_2O$	8.82 g
$MnCl_2 \cdot 4H_2O$	1.44 g
MoO_3	0.71 g
$CuSO_4 \cdot 5H_2O$	1.57 g
$Co(NO_3)_2 \cdot 6H_2O$	0.49 g

BBM additional solutions[103]

Component	**Stock solution** *qty per litre dH_2O*
Boric acid solution	
H_3BO_3	11.42 g
Alkaline EDTA solution	
EDTA	50 g
KOH	31 g
Acidified Iron solution	
$FeSO_4 \cdot 7H_2O$	4.98 g
H_2SO_4	1 mL

A.4. Chu 13 medium (Modified)

Chu 13 medium components and concentrations [105]

Component	**Quantity used for medium**
KNO_3	400 mg
K_2HPO_4	80 mg
$MgSO_4 \cdot 7H_2O$	200 mg
$CaCl_2 \cdot 2H_2O$	107 mg
Fe citrate	20 mg
Citric acid	100 mg
Micronutrients	
$CoCl_2$	0.02 mg
H_3BO_3	5.72 mg
$MnCl_2 \cdot 4H_2O$	3.62 mg
$ZnSO_4 \cdot 7H_2O$	0.44 mg
$CuSO_4 \cdot 5H_2O$	0.16 mg
Na_2MoO_4	0.084 mg
H_2SO_4 0.072 N	1 drop

A.5. Conway medium

Conway medium components and concentrations [106]

Component	***mg per 1L H_2O***
KNO_3	100
Na_3HPO_4	20
Trace metal	
$Na_2H_2EDTA \cdot 2H_2O$	45
$FeCl_3 \cdot 6H_2O$	1.3
$ZnCl_2$	4.2
$MnCl_2 \cdot 4H_2O$	0.36
$CoCl_2 \cdot 6H_2O$	4
$CuSO_4 \cdot 5H_2O$	4
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	1.8
H_3BO_3	33.4
Vitamin	
Thiamin HCl	0.2
Cyanocobalamin	0.01

A.6. Detmer medium (DM) modified

Detmer medium components and concentrations [107]

Component	**Quantity used for 1 L medium**
$Ca(NO_3)_2 \cdot 4H_2O$	1 g
KH_2PO_4	0.26 g
$MgSO_4 \cdot 7H_2O$	0.55 g
KCl	0.25 g
$FeSO_4 \cdot 7H_2O$	0.02 g
EDTA·2Na	0.2 g
Trace elements	
H_3BO_3	0.0029 g
$ZnCl_2$	0.00011 g
$MnCl_2 \cdot 4H_2O$	0.00181 g
$(NH_4)_6MoO_{24} \cdot 4H_2O$	0.000018 g
$CuSO_4 \cdot 5H_2O$	0.00008 g

A.7. f/2 medium

This is a seawater medium, prepared by bringing up the final volume to 1 L with filtered natural seawater. Adjust pH to 8 with 1 M NaOH or HCl.

f/2 medium components and concentrations [103]

Component	**Stock solution** *qty per 1 L dH_2O*	**Quantity used for medium**
$NaNO_3$	75 g	1 mL
$NaH_2PO_4 \cdot H_2O$	5.65 g	1 mL
Trace metals solution	*See recipe below*	1 mL
Vitamins solution	*See recipe below*	1 mL

f/2 trace metals solution [103]

Component	**Stock solution** *qty per L dH_2O*
Na_2EDTA	4.16 g
$FeCl_3 \cdot 6H_2O$	3.15 g
$CuSO_4 \cdot 5H_2O$	0.01 g
$ZnSO_4 \cdot 7H_2O$	0.022 g
$CoCl_2 \cdot 6H_2O$	0.01 g
$MnCl_2 \cdot 4H_2O$	0.18 g
$Na_2MoO_4 \cdot 2H_2O$	0.006 g

Vitamins solution [103] (filter-sterilise and store frozen).

Component	**Stock solution** **Qty per L^{-1} dH_2O)**
Cyanocobalamin (Vitamin B_{12})	0.0005 g
Thiamine HCl (Vitamin B_1)	0.1 g
Biotin	0.0005 g

A.8. f/2+Si (Guillard's medium for diatoms)

This is a seawater medium, prepared by bringing up the final volume to 1 L with filtered natural seawater. Adjust pH to 8 with 1 M NaOH or HCl.

f/2 + Si medium components and concentrations [103]

Component	**Stock solution g per 1 L dH_2O**	**Quantity used for medium**
$NaNO_3$	75	1 mL
$NaH_2PO_4 \cdot H_2O$	5.65	1 mL
Trace metals solution	*See recipe below*	1 mL
Vitamins solution	*See recipe below*	1 mL
Sodium metasilicate solution		1 mL
$Na_2SiO_3 \cdot 9H_2O$	*30 g*	

F/2 + Si trace metals solution [103]

Component	**Stock solution Qty per L dH_2O**
Na_2EDTA	4.16 g
$FeCl_3 \cdot 6H_2O$	3.15 g
$CuSO_4 \cdot 5H_2O$	0.01 g
$ZnSO_4 \cdot 7H_2O$	0.022 g
$CoCl_2 \cdot 6H_2O$	0.01 g
$MnCl_2 \cdot 4H_2O$	0.18 g
$Na_2MoO_4 \cdot 2H_2O$	0.006 g

Vitamins solution [103] (filter-sterilise and store frozen).

Component	**Stock solution** **Qty per L^{-1} dH_2O)**
Cyanocobalamin (Vitamin B_{12})	0.0005 g
Thiamine HCl (Vitamin B_1)	0.1 g
Biotin	0.0005 g

A.9. Jaworski's Medium (JM)

JM medium components and concentrations [103]

Component	**Stock solution** *g per 200 mL dH_2O*	**Quantity used for medium**
$Ca(NO_3)_2 \cdot 4H_2O$	4 g	1 mL
KH_2PO_4	2.48 g	1 mL
$MgSO_4 \cdot 7H2O$	10 g	1 mL
$NaHCO_3$	3.18 g	1 mL
EDTA solution		1 mL
EDTA·Fe·Na	0.45 g	
EDTA· Na2	0.45 g	
Trace elements solution		1 mL
H_3BO_3	0.496 g	
$MnCl_2 \cdot 4H_2O$	0.278 g	
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	0.2 g	
Vitamins solution	*See recipe below*	1 mL
NaNO3	16 g	1 mL
$Na_2HPO_4 \cdot 12H_2O$	7.2 g	1 mL

Vitamins solution [103] (filter-sterilise and store frozen).

Component	**Stock solution** *qty per 200 mL dH_2O*
Cyanocobalamin (Vitamin B_{12})	0.0008 g
Thiamine HCl (Vitamin B_1)	0.0008 g
Biotin	0.0008 g

A.10. Kuhl medium

Kuhl medium components and concentrations [32]

Component	Quantity used for 1 L medium
KNO_3	1 g
$NaH_2PO_4 \cdot H_2O$	0.621 g
$Na_2HPO_4 \cdot 2H_2O$	89 mg
$MgSO_4 \cdot 7H_2O$	246.5 mg
EDTA	9.3 mg
H_3BO_3	0.061 mg
$CaCl_2 \cdot 2H_2O$	14.7 mg
$FeSO_4 \cdot 7H_2O$	6.95 mg
$ZnSO_4 \cdot 7H_2O$	0.287 mg
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	0.01235 mg
$MnSO_4 \cdot H_2O$	0.169 mg
$CuSO_4 \cdot 5H_2O$	0.00249 mg

A.11. SOT medium

Bring final volume to 1 L and adjust pH to 9.

SOT medium components and concentrations [108]

Component	**Stock solution** *g per L dH_2O*	**Quantity used for medium**
$NaHCO_3$		16.8 g
K_2HPO_4		0.5 g
$NaNO_3$		2.5 g
K_2SO_4		1 g
NaCl		1 g
$MgSO_4 \cdot 7H_2O$		0.2 g
$CaCl_2 \cdot 2H_2O$		0.04 g
$FeSO_4 \cdot 7H_2O$		0.01 g
EDTA		0.08 g
Trace metal Mix A5		1 mL
H_3BO_3	2.86	
$MnCl_2 \cdot 4H_2O$	1.81	
$ZnSO_4 \cdot 7H_2O$	0.222	
$NaMoO_4 \cdot 2H_2O$	0.39	
$CuSO_4 \cdot 5H_2O$	0.079	
$Co(NO_3)_2 \cdot 6H_2O$	49.4 mg	
Trace metal Mix B6 (modified)		1 mL
NH_4NO_3	0.23	
$K_2Cr(SO_4)_4 \cdot 24H_2O$	96 mg	
$NiSO_4 \cdot 7H_2O$	47.8 mg	
$Na_2WO_4 \cdot 2H_2O$	17.9 mg	
$Ti_2(SO_4)_3$	40 mg	

A.12. Sueoka medium

Sueoka medium components and concentrations [31]

Component	**Stock solution** *g per L dH_2O*	**Quantity used for 1 L medium**
KH_2PO_4		0.72 g
K_2HPO_4		1.44
$MgSO_4 \cdot 7H_2O$		0.02
$CaCl_2 \cdot 2H_2O$		0.01
NH_4Cl		0.5
Trace elements		1 mL
EDTA	10	
H_3BO_3	2.28	
$ZnSO_4 \cdot 7H_2O$	4.4	
$MnCl_2 \cdot 4H_2O$	1.02	
$FeSO_4 \cdot 7H_2O$	1	
$CoCl_2 \cdot 6H_2O$	0.32	
$CuSO_4 \cdot 5H_2O$	0.32	
$Mo_7O_{24}(NH_4)_6 \cdot 4H_2O$	0.22	

A.13. Walne's medium

Walne's medium components and concentrations [81]

Component	**Stock solution** *g per L dH_2O*	**Quantity used for 1 L medium**
$NaNO_3$	100	1 mL
EDTA (Disodium salt)	45	
H_3BO_3	33.6	
$NaH_2PO_4 \cdot 4H_2O$	20	
$FeCl_3 \cdot 6H_2O$	1.3	
$MnCl_2 \cdot 4H_2O$	0.36	
Trace metals solution	*g per 100 mL*	1 mL
$ZnCl_2$	2.1	
$CoCl_3 \cdot 6H_2O$	2	
$(NH4)_26MO_7O_{24} \cdot 4H_2O$	0.9	
$CuSO_4 \cdot 5H_2O$	2	
Vitamine solution		1 mL
Thiamine	10	
Cyanocobalamin	10	
Biotin	0.2	

A.14. Zarrouk medium

Zarrouk medium components and concentrations [109]

Component	**Stock solution ($g\ L^{-1}\ dH_2O$)**	**Quantity used for medium**
$NaNO_3$		2.5 g
K_2HPO_4		0.5 g
K_2SO_4		1 g
NaCl		1 g
$MgSO_4 \cdot 7H_2O$		0.2 g
$CaCl_2 \cdot 2H_2O$		0.04 g
$FeSO_4 \cdot 7H_2O$		0.01 g
EDTA		0.08 g
$NaHCO_3$		16.8 g
Micronutrient solution		1 mL
H_3BO_3	2.86	
$MnCl_2 \cdot 4H_2O$	1.81	
$ZnSO_4 \cdot 4H_2O$	0.222	
Na_2MoO_4	0.0177	
$CuSO_4 \cdot 5H_2O$	0.079	

APPENDIX 2. CULTURE COLLECTIONS

ACRONYM	NAME	WEBSITE
CCAP	Culture Collection of Algae and Protozoa at the Scottish Association for Marine Science **UK**	https://www.ccap.ac.uk/
CPCC *formerly UTCC*	Canadian Phycological Culture Centre **Canada** *Formerly known as the University of Toronto Culture Collection of Algae and Cyanobacteria*	https://uwaterloo.ca/canadian-phycological-culture-centre/
CSMA	Culture Collection of the Centro di Studio del Microrganismi Autotrifi **Italy**	
IBVF	Biological Culture Service of the Institute of Plant Biochemistry and Photosynthesis **Spain**	https://www.ibvf.us-csic.es/en/biological-cultures-service
NCMA *Formerly CCMP*	National Center for Marine Algae and Microbiota at Bigelow Laboratory **USA** *Formerly known as the Culture Collection of Marine Phytoplankton*	https://ncma.bigelow.org/cms/index/index/
NIES	National Institute for Environmental Studies **Japan**	https://mcc.nies.go.jp/index_en.html
PCC	Pasteur Culture Collection of Cyanobacteria **France**	https://webext.pasteur.fr/cyanobacteria/
SAG	Sammlung von Algenkulturen der Universität Göttingen / Culture Collection of Algae at Göttingen University, **Germany**	http://sagdb.uni-goettingen.de/
SCCAP	Scandinavian Culture Collection of Algae & Protozoa at The University of Copenhagen, **Denmark**	http://www.sccap.dk/
UTEX	Culture Collection of Algae at The University of Texas at Austin **USA**	https://utex.org/

APPENDIX 3. DEFINITIONS

- **Lux (lx)**: A measure of radiant light from a standard candle that falls on one square meter of surface area one meter from the source.

- **Micromol (µmol/m^2/s)**: One micromol per square meter per second. A unit of measure of the amount of light hitting a surface that is in the range of 400-700 nanometers.

- **Watts (W)**: Watts per square meter (W/m ^{2}). A unit of measure of the amount of light energy hitting a surface that is in the range of 400-800 nanometers.

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