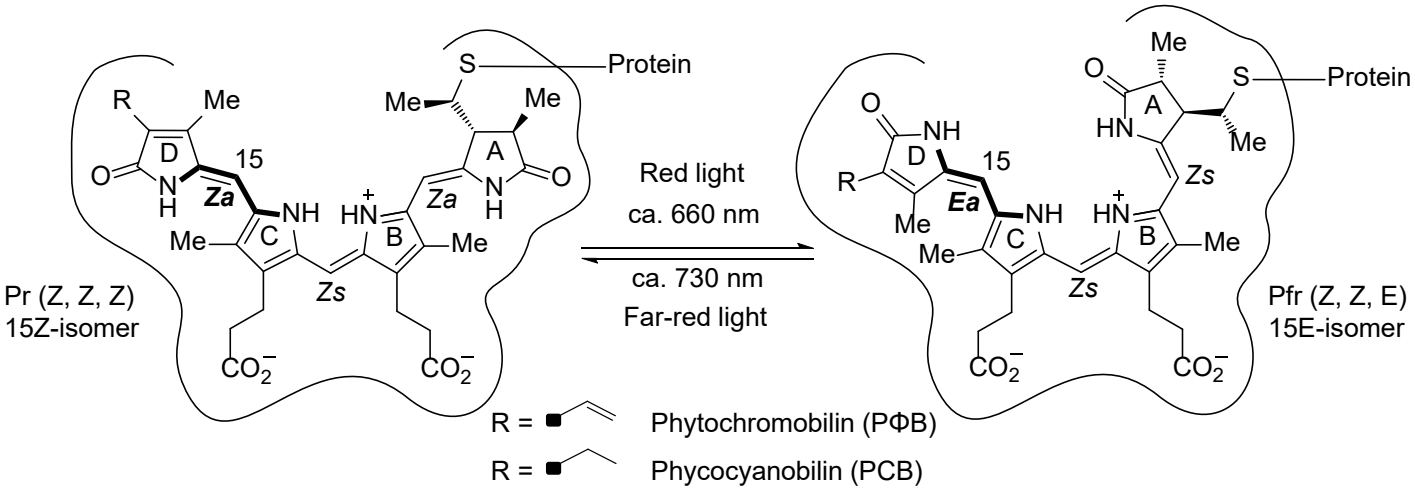
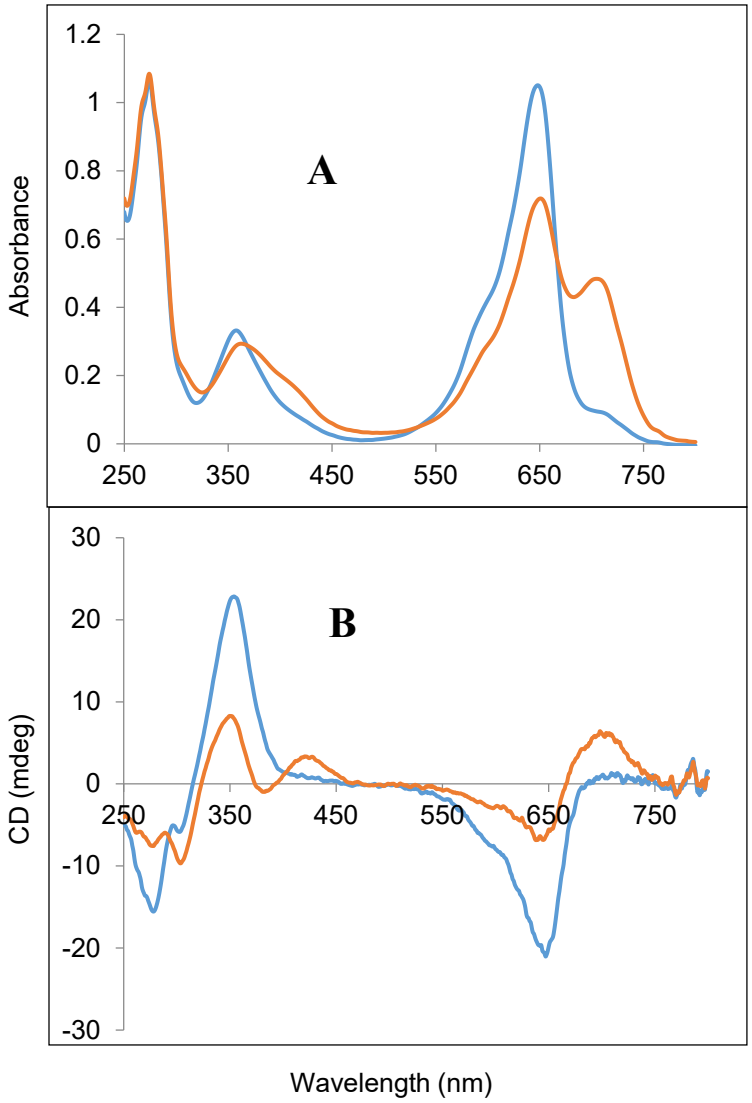


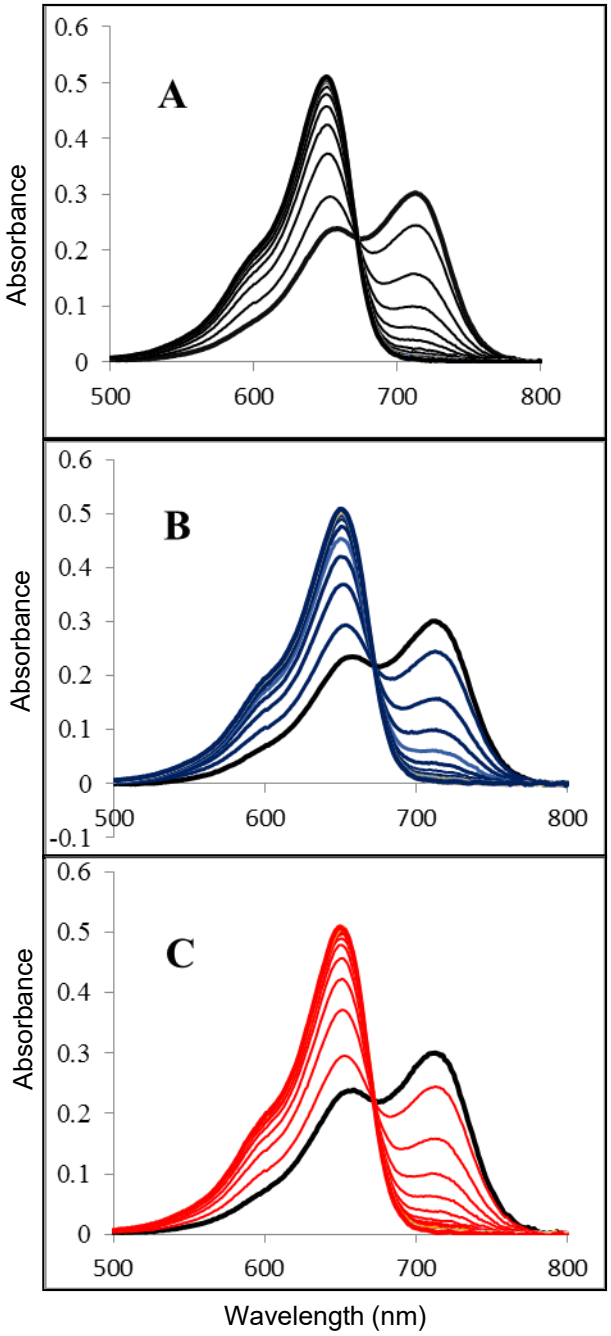
Supplementary Figure S1. Schematic illustrations for the structure of a native chromophore phytochromobilin (PΦB) and an analog chromophore, phycocyanobilin (PCB) used in this study in Pr and Pfr.

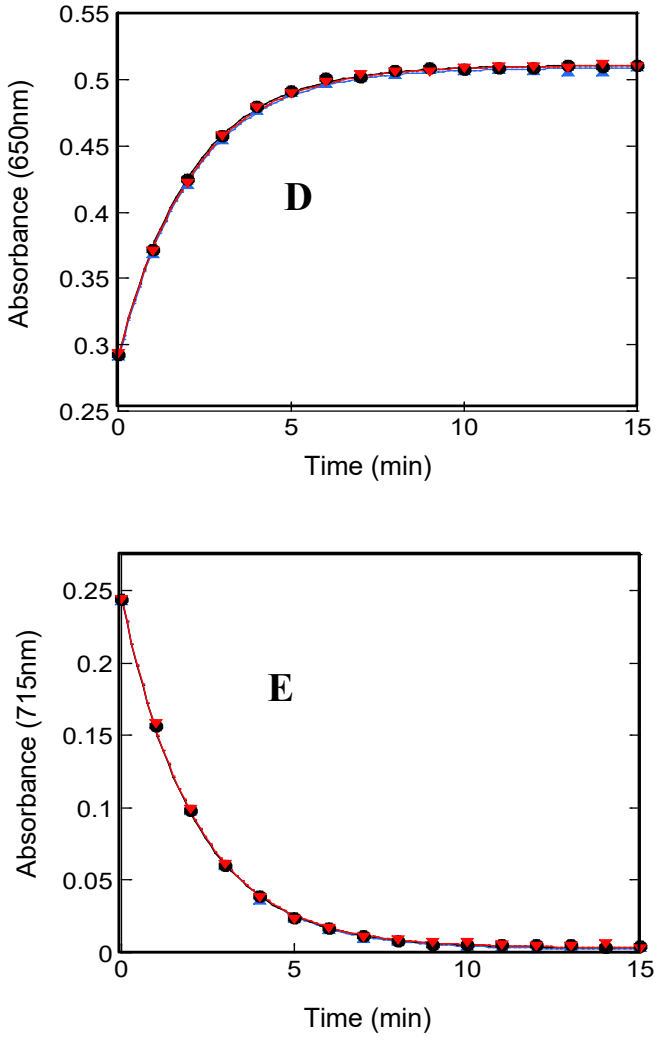
The chromophore undergoes a *cis-trans* and a reverse photoisomerization at carbon 15 in response to red and far-red light absorption, respectively.



Supplementary Figure S2. UV-Vis absorption (A) and CD (B) spectra of PCB-bound *At*phyB-N651 measured to calculate CD spectra of 100% Pr and Pfr.

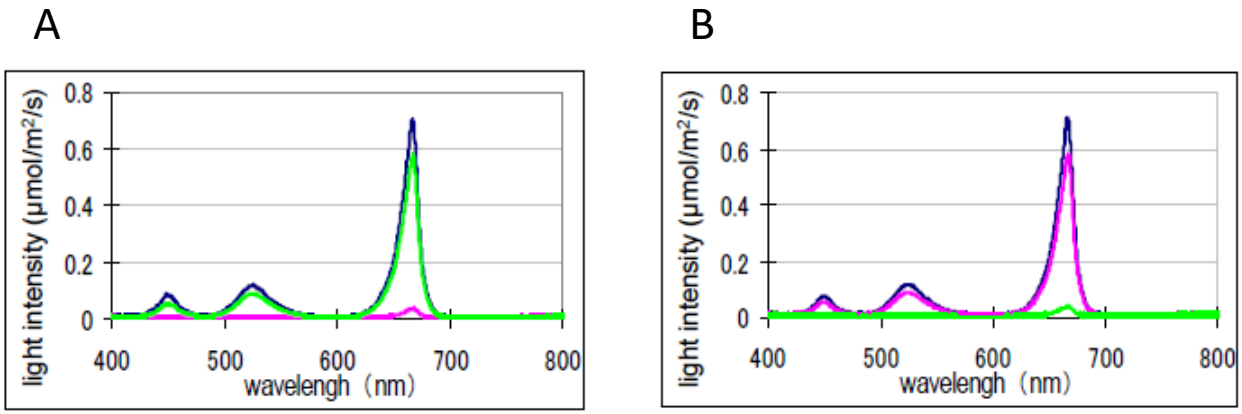
CD spectra were measured after saturating far-red (blue) and red (orange line) light irradiation in the same buffer solution as that in Figure 4A at 25ºC. UV-Vis absorption spectra were measured immediately after the measurement of the CD spectra to estimate the actinic effect of the CD measuring light.





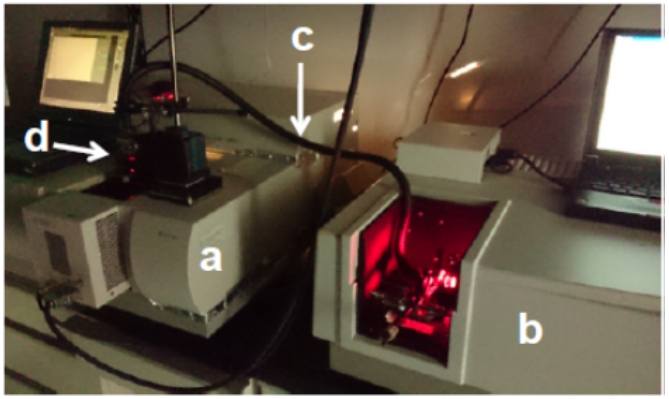
Supplementary Figure S3. UV-Vis absorption spectra changes of PCB-bound *At*phyB-N651 during the photoreaction from a red light-induced photostationary state to Pr at 25ºC.

Spectra changes of the red light-induced photostationary state (black thick lines) were monitored by repeat scanning of every 1 min (thin lines) until 15 min (thick lines) after the onset of far-red light illumination of LPL (black lines in A), L- CPL (blue lines in B) and R-CPL (red lines in C). (D) and (E) show kinetics of the photoreaction monitored at a Pr (650 nm) and a Pfr (715 nm) peak, respectively. (●), (▲) and (▼) indicate absorbance changes induced by LPL, L-CPL and R-CPL obtained from the spectra changes in (A), (B) and (C), respectively. Black, blue and red lines are simulation curves fitted with a single exponential for the first order reaction.



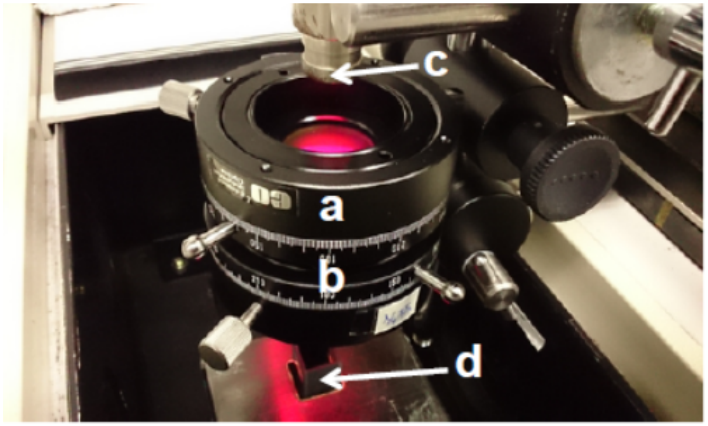
Supplementary Figure S4. Emission spectra of LED light in the growth chamber with a R-CPL (A) and L-CPL (B) polarizing filters.

The spectra indicate R-CPL (green), L-CPL (purple) and total light (dark blue)



Supplementary Figure S5. A picture showing the arrangement of the UV-Vis absorption spectrophotometer (a) and the fluorescence spectrophotometer (b).

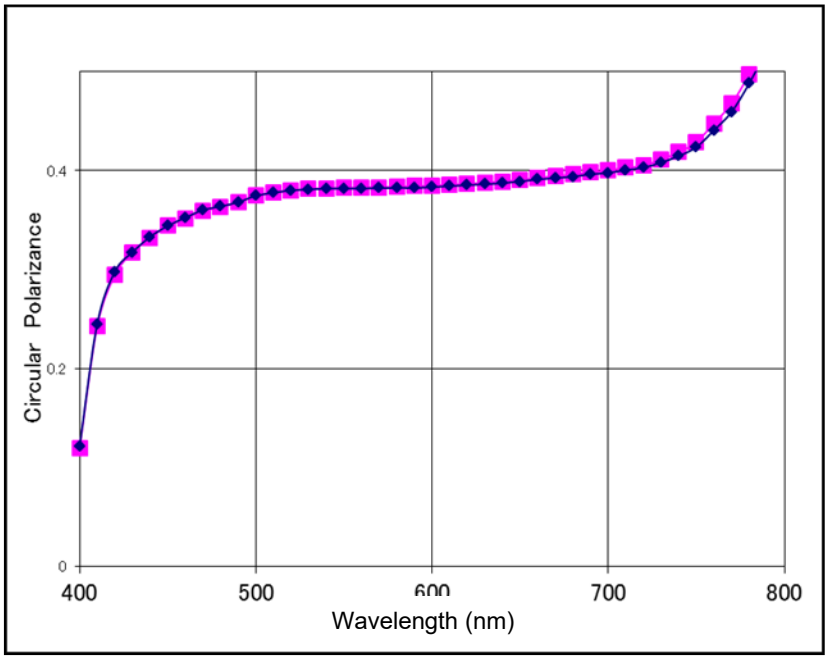
Excitation light from the fluorescent spectrophotometer is guided to a sample solution in a cuvette set at the cell holder of the spectrophotometer with a quartz light guide (c) from above through a polarized light generator (d).



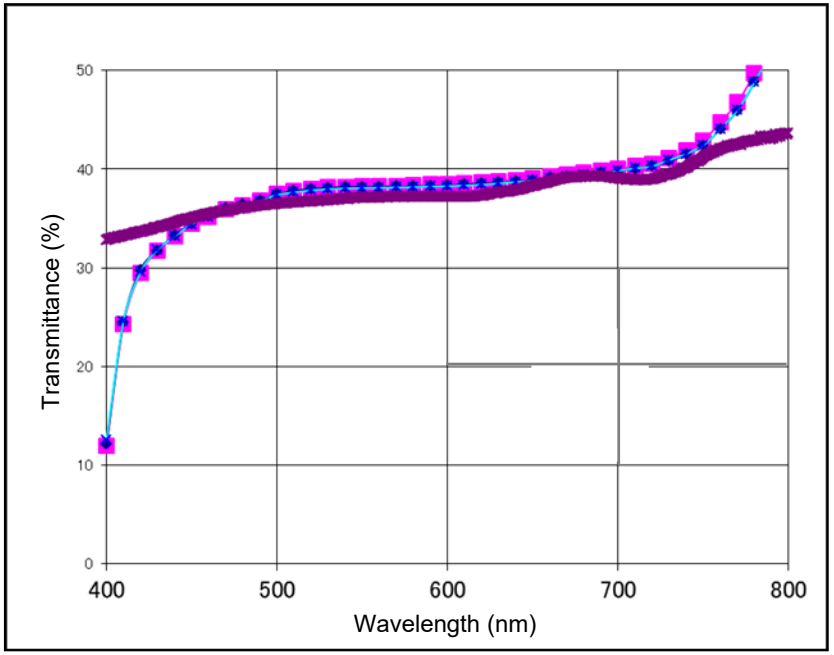
Supplementary Figure S6. A picture of the polarized light generator.

The generator consists of a polarizer (a) and a 1/4 wavelength plate (b) placed between the light guide end (c) and the surface of a sample solution in a cuvette (d).

A



B



Supplementary Figure S7. Circular polarization (A) and transmittance (B) of LPL and CPL used for the spectrophotometry.

-■-, -♦- and -x- indicate R-CPL, L-CPL and LPL produced by the polarized light generator shown in Supplementary Figure S6. -✳- shows the light without polarization.