29/04/18

Yale SCHOOL OF MANAGEMENT

Celgene Corporation Valuation

Recommendation: **BUY**

- Using APV we calculated an Equity value of **$99.973 billion** compared with a market cap **$66.4 billion**.
- We used a 3-stage process to come up with our valuation:
  - Current drug portfolio - **$72.635 bn**
  - Pipeline - **$16.885 bn**
  - R&D Dept - **$10.453 bn**
- Combining the above, we believe the company is undervalued by **50.56%**.

Celgene [CELG]

As of 29/04/2018	
Latest Price	91.18
52week High	147.17
52week Low	84.25
P/E	17.38
EPS (Trailing 12M)	5.99
Dividend Yield	-
Market Cap	66.4 Billion
Exchange	NASDAQ

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Celgene Overview

Celgene is a major US based global biopharmaceutical corporation which primarily focuses on the discovery, development, and commercialization of therapies designed for the treatment of cancer and other sever, immune, inflammatory conditions (Celgene.com, 2018). Currently its main products target the likes of;

- Multiple Myeloma (bone marrow cancer)
- MDS (Myelodysplastic syndrome)
- Psoriatic arthritis

They will further diversify this product range with their expansive diverse pipeline. The company plan on expanding its portfolio through successful pipeline candidates as well as through collaborations and acquisitions.

Although Celgene is a worldwide company, the majority ~60%~ of their revenues come from the US. The majority of their other revenues come from Europe, although the company has operations all over the world.

The company's two largest customers are CVS and McKesson which represent more than 10% of sales each (D&B Hoovers, 2018).

Celgene's Growth Drivers

Growth in a biotechnology company revolves around patents. In a sense, it is extremely simplistic as you are accounting for your current portfolio of patents and that of future potential patents. If you have a patent on a useful drug, you may virtually take control of that specific market in which the drug is operating until patent expiry. The patent guarantees you will not face any direct competition as nobody will be able to produce the exact same drug as you until the expiration, allowing you to make large sales over this period. However, upon expiration of a patent, a company will face a lot of competition from cheaper generic drugs and ultimately stand not to make the gains they had previously been making; a phenomenon called the *patent cliff*.

The second main growth driver is the product pipeline. Aside from producing drugs that have already been approved, Celgene also directs vast resources into the creation of new drugs through R&D expenditure. Celgene disclose drugs they currently have in the pipeline and what phase each of them are in, giving us an indication of their approval proximity by the FDA which we will discuss further in our valuation of drugs awaiting FDA approval and drugs at other phases of development.

Patent Cliff

The patent cliff occurs when a current company patent expires, allowing other companies to make generic forms of the previously patented drug. Since the 1990s this has become a major issue as the speed at which generics can take control of the market with their cheaper versions of the same drug has accelerated greatly (Aitken et al., 2013). According to Glazier, Fezza and Reynolds (2016), upon the loss of exclusivity, brand unit sales (on average) will dip by 16% within the space of one year. After a patent expires, generics swoop in and acquire (on average) between 80%-90% of total drug sales (Marketrealist.com, 2016)

(Renoe, 2017). Although literature and past studies do not give a specific timeframe over which this loss of market share occurs, from our own independent research it seems as though it takes approximately 5 years. For the purposes of the report, we assume that it takes 5 years after the loss of a patent before 80-90% of those drugs sales are depleted. The reason we such a dramatic lose in sales is because on average the cost of the generic drug will be 80-85% lower than the cost of the patented drug (Renoe, 2017). In 2017, generics account for 83% of the entire drug volume in the US. This is illustrated in *figure 1* which displays the decline in volume of branded drug sales as well as the increasing number of generics. We anticipate this margin increasing slightly more to 85% for generic drugs and we foresee the margin stabilizing at this point .

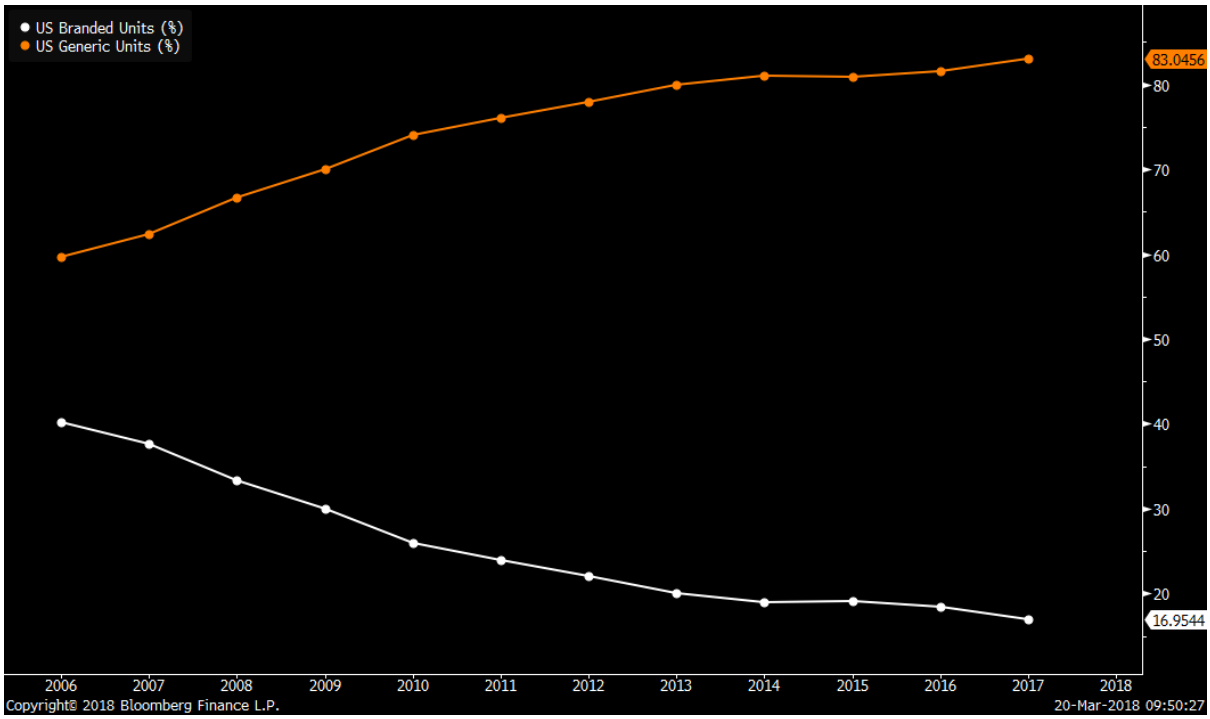

Figure 1 – US-branded units vs US Generic units – Source - Bloomberg

Current Portfolio of Drugs

Method for Valuation

For the purposes of valuing Celgene's current portfolio of drugs, we refer to the above information to value the drugs after patent expiration. We employ a 16% loss for year 1 and then we are predicting an 85% loss (an average of the loss of 80-90% expected by consensus) in sales by the end of 5 years which is line with the aforementioned margin of generics we predicted above using *figure 1*. It must be noted that this is an average and some drugs may fair better and some worse and could potentially vary the forecast, however this is our best estimate given the information we are privy too. We can calculate the figure one year after the patent ends and five years after using these figures, and we linearly interpolated the figures in between these two figures to get the middle period (years 2, 3 and 4 after the patent expires). We will then keep a constant figure after year 5 as foresee Celgene keeping some small market share with each drug.

So for example if the patent expires in 2018, we forecast as follows;

$$2018\ sales = \ 2017\ sales + (2017\ sales * \ -16\%)$$

$$2022\ sales = 2017\ sales + (2017\ sales * \ -85\%)$$

Then, we simply interpolate 2019, 2020 and 2021 using the forecasted 2018 and 2022 figures (note: this was the pattern for most of the drug forecasting however some drugs followed a slightly different individualised forecast if we felt this pattern would not apply, so please read *'Reveneus – Each individual Drug'* to get a more in depth breakdown of each drug individually). Because Celgene breakdown their geographical location of each of their products into two sections, US sales and International Sales, we were able to account for the fact that sometimes patents expired at differed times in the US and EU. For the purpose of the different patent expiration years, we assumed that ALL international sales would follow the EU patent year. This is a valid assumption as most of the companies non US sales come from

Europe, so we believe using the EU patent expiration to forecast the international sales was the most valid assumption to make given the information we are privy to.

Revenues - Each Individual Drug[1]

Revlimid – This is Celgene's star drug and last year accounted for 63% of their total sales revenue. It is an oral immunomodulatory drug used to treated patients with Multiple myeloma (MM). Thanks to the likes Revlimid, patients with MM are living longer than ever before. Sales of Revlimid have grown and grown ever since the drugs has hit the market. We believe there are three main factors behind this; 1) The quality of the drug and its popularity increasing as more learn about the use of Revlimid. 2) According to Fonseca et al., (2017) the percentage of MM patients using novel therapy continuously increased from 8.7% in 2000 to 61.3% in 2014, along with 3) the fact the patients are now leaving longer. According to the SEER, In the last 2 years the average life expectancy has gone from 4 years to 5.5. years (Petersen, 2017). These three reasons are the main driver behind the revenue growth. We used these factors in order to help us predict revenue growth for the drug. We used US data to come up with the following set of stats in order to forecast revenues for Revlimid

US DATA	Figures	Source
Revenues 2017	$5420million	Bloomberg/10K
What Revlimid Sells for	$241760 per year	Fiercepharma.com
Patients Supplied in 2017	22444 people	(5420million/241760)
Patients Diagnosed Per Year	30000	Medicalxpress.com
Patients average live span	5.5 years	Myelomacrowd.org

[1] All Information regarding, the function of the drugs, patent expiration dates & competitors has come from Celgene's latest 10K report AND all information regarding side effects/ pros and cons of drugs, from iodine.com

Market size 2017	165000	(30000*5.5)
Market Share	13.60%	(22444/165000)
Expected new cases 2018	30770	Cancer.org
Expected Deaths 2018	12770	Cancer.org
New Patients Revlimid will supply in 2018	2448	(30770*13.6% + 12770*13.6%)
Total Patients Revlimid will supply in 2018	24892	(22444+2448)
2018 US Revenues	$6018million	(24892*$241760)

Two important assumptions were made in order to get to that 2018 US Revenue figure. It assumes that the price of the drug will remain the same and that the market share which Revlimid have will also remain the same. Using this 2018 revenue meant that we estimate sales increasing by 10.91% between 2017 and 2018. Considering the fact that the CAGR (15-17) was 18.8% our predication seems reasonable. We used the 'New Patients Revlimid will supply in 2018' from the above table to predict growth going forward in both US and international markets. We basically said that this figure will be indicative of many new patients they will supply in 2019 and so on. So we kept adding 2448 to last year's patients and multiplying it out just as we did in the table above to get the forecasted figures. Management say they expect the drug to reach revenues of $15 billion by 2020, however our assumptions lead us to believe it will not be till 2023 before they hit their peak revenues of $13.5 billion which is below managements bullish prediction. We believe this difference opinion stems from management expecting to gain a larger market which we don't anticipate due to excess competition from biosimilars. We think it is more logical to estimate Revlimid sustaining its stable market share given this increased amount of competition. We feel that is

unlikely that Revlimid will lose any market given that fact that it has been on the market since 2004 and historically sustained a stable market share. When its patent expires in 2027 in the US and 2024 in Europe, we expect the drug to slightly deviate from our normal patent cliff assumptions. We believe the patent cliff fall will be greater with this drug as generics and biosimilars eat away its market share. We believe that because of the massive revenues the drug has generated there will be even greater generic competition than normal and hence we believe that revenues could drop by as much as 95% as opposed to 85%, our normal assumption.

Pomalyst/Imnovid – The former name being the drugs US marketed brand name while the latter is the European brand name. This drug is used to treat MM patients who have previously undergone at least 2 other treatments (including a proteasome inhibitor and lenalidomide) and who's condition has either not improved or worsened from using these other therapies. It is estimated that MM will grow by about 60% by 2021 (Gibney, 2017) and we used this synopsis to forecast Pomalyst/Imnovid going forward. We believe that the drug will increase sales in line with MM growth and hence predict sales in 2021 to be 60% higher than 2017 sales. Interoperating 2018-2020 using a CAGR 12.47% to get us to that 2021 figure. That seems like a high growth rate however it is actually a lower growth rate than what it has been growing at between 15-17 having a CAGR of 28%. We think that due to the increased competition the likes of Takeda with their drug Velcade and Amgen with their drug Kyprolis, the rate at which Pomalyst/Imnovid will slow, hence why we believe our predication to be reasonable. We believe that that the 2021 revenue figure will remain stable until patent expiration. With its US patent expiring in 2025 and European in 2023, we expect it to follow our normal patent cliff assumption guidelines.

Otezla – This drug has exploded onto the scene since its introduced in 2014. It is a tablet which is used to treat Psoriatic arthritis. Otezla's main competitor is Stelara produced

by Johnson and Johnson. Otezla is a tablet taken twice daily as opposed to Stelara which is an injection which taken about once a month depending on the stage of your cycle (Carter, 2017). We believe given the convenience of Otezla, it will have the ability to knock Stelara off its shelf. We believe that Otezla is going to steal half of the market which seems to be way the drug has been trending since it hit the market in 2014. Last year Johnson and Johnson sold $4 billion worth of Stelara, $2.8 billion in the US and $1.2 billion in Europe. Given the aforementioned assumption that it takes approx. 7 years for a drug to reach peak sales, we believe that by 2020 revenues for Otezla will grow by nearly 64% to $2 Billion which comes from the assumption that Otezla will steal half of Stelara sales which is $2 Billion. This may seem like an extreme growth pattern but given the convenience of the drug at its CAGR of 64.61% between 2015-2017, we believe it is a justified assumption. We anticipate sales staying stable after 2020 until the drug falls off the patent cliff in 2024 in the US and 2028 in Europe.

Abraxane – This is a solvent-free chemotherapy product. The drug has seen stable growth over the past 3 years, with a CAGR (15-17) of 1.28%. We foresaw no reason as to why it would not continue to grow at this rate. We believe that this trend will continue until the loss of expiration of the US patent in 2026 and European in 2022.

Other Products – This consists of drugs such as Idhifa, Vidaza and Thalomid. They combined only account for less than 7% of total revenue. We averaged the patent expiration dates and noticed that the US other products had already fallen villan to the patent cliff in 2011 and hence why the revenues are already so low. For that reason we decided to keep the 2017 figure going forward. For the European other products patent expiration is 2019, and so we simply calculated 2018 using a CAGR (15-17) of 4.41% and then let the products fall off the patent cliff in 2019 following our normal guidelines.

Other Revenues – These other revenues consist of royalty revenues which only accounted for 0.07% of total sales. These revenues have been fairly constant over the years. We decided to simply use an average of the last three years to predict 2018 and use the same figure for the duration of the forecast period due to the lack of information. We believe this is the most accurate forecast we can produce given the information we are privy too.

Valuation of Current Portfolio of Drugs

Historically Celgene have been doing better than the industry and their competitors (Amgen, Biogen and Gilead) in terms of year on year growth which is illustrated in *figure 2.5*. Although this information had no bearing on our projections, it perhaps backs up why expect continued growth going forward until the patent cliff gets the better of the current drug portfolio. The above information was used to forecast sales revenues. *Figure 2* is an illustrated version of the forecast revenues for the current portfolio of drugs ONLY.

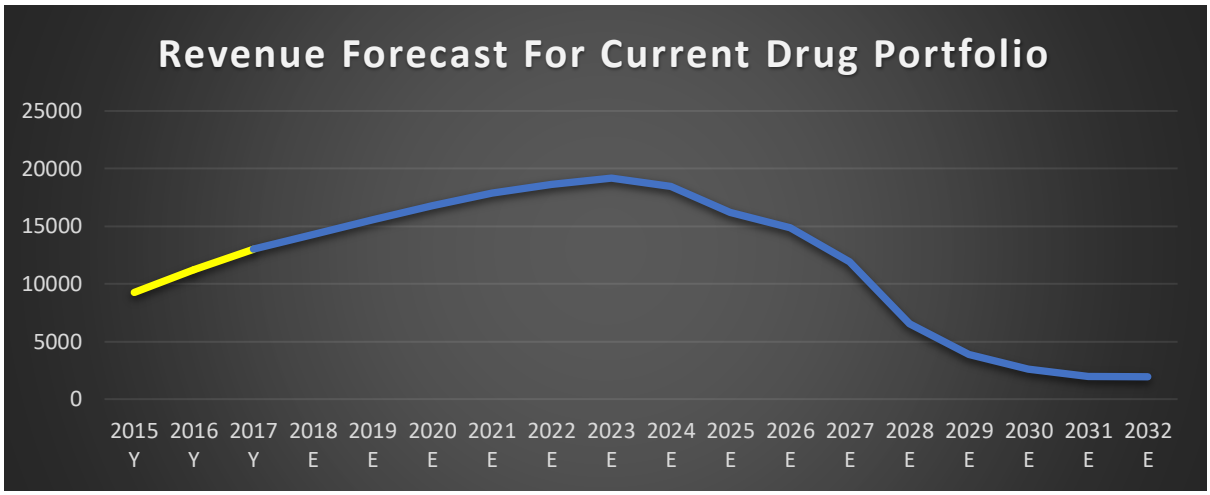

Figure 2 – Forecasted Revenues for the Current Drug Portfolio

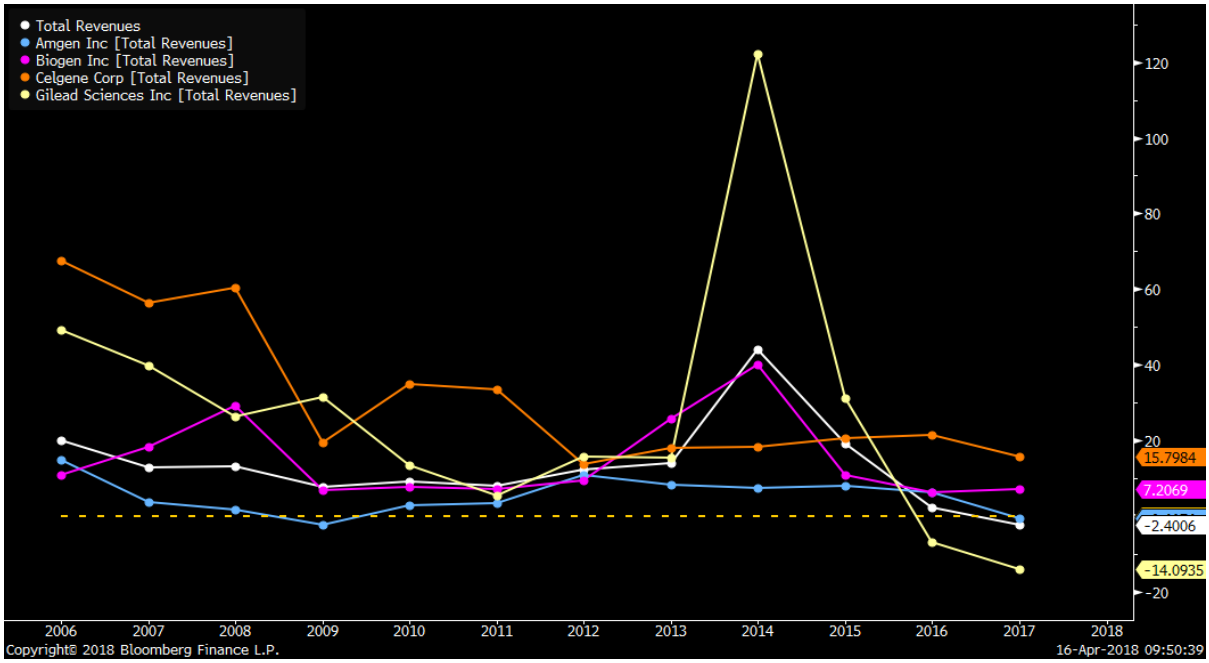

Figure 2.5 – Historical Year on Year Revenue - source:Bloomberg

Cost of Goods Sold

After calculating these revenues, we made a few other assumptions to complete our DCF. Since biotech companies tend not to have much fluctuation in their margins, we were able to keep most margins constant (Basu et al., 2008). We noticed that COGS (cost of goods sold) consistently grew at the same rate as revenue. There was a high correlation between revenue and COGS over the last 7 years and we saw no reason for this to change so we used the changing revenue figure to predict COGS.

Selling General & Administrative Expenses

As Basu et al., (2008) outlined, SG&A tend to remain as a constant percentage of revenue and there has been a 0.97 correlation between the two variables over the past 7 years. We envisage no change in this pattern in the near future and so forecast SG&A in line with sales.

Research & Development

Figure 3 shows Celgene's R&D expenditure compared with their main biotech competitors. You can (orange line) that as off 2017 became the industry leader in R&D spending. The have been consistently growing their R&D even as the rest of the industry drops their R&D expenses. We expect the R&D department to continue to grow unlike the rest of the industry. EvaluatePharma (2017) predicted that Celgene's R&D department would grow at a rate of about 2.9% which is in line with what we were thinking. Given the reliability, historical accuracy of the source as well as the lack of information we are privy too we believed this would be the best measure of R&D expense and so we forecasted their R&D expense growing by 2.9% based on this information.

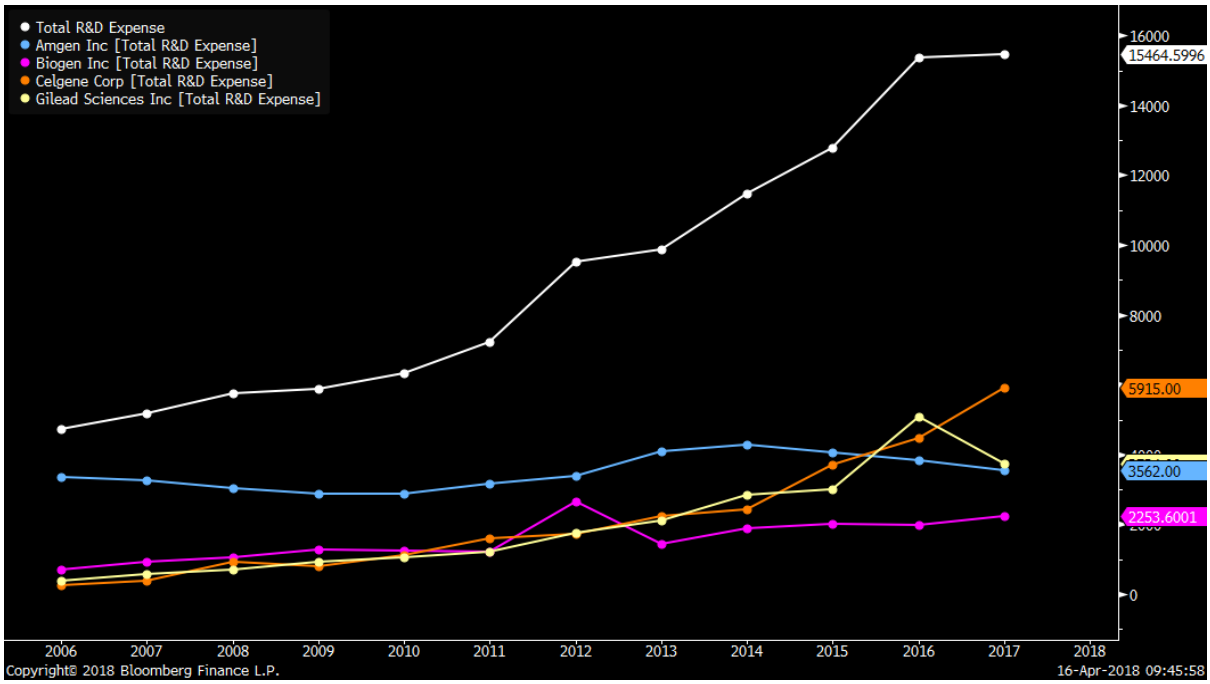

Figure 3 - R&D Expenses - source:Bloomberg

Depreciation & Amortization

We noticed that Depreciation and Amortization had been a constant ratio of current assets. We had forecasted Current assets which can be seen in the working capital section and decided to use the average ratio over the last 6 years that Depreciation and Amortization to Current assets had going forward. Again going back to Basu et al., (2008), we feel as though

this is reasonable as emphasis must be geared towards revenue forecasts for the purpose of the Biotech industry.

Capital Expenditures

Capital Expenditure had been a fairly constant ratio of Depreciation and Amortization so we decided to keep this trend going forward, using our forecasted Depreciation and Amortization to predict Capital Expenditures.

Working Capital

To forecast increase in net working capital, we examined the historical ratio of both current assets to sales and current liabilities to sales. We noticed that these ratios remained relatively stable so we got the average ratio for both current assets to sales and current liabilities to sales over the last 8 years and used that ratio to predict future current assets and current liabilities. Subtracting the forecasted current assets and current liabilities figures allowed us to get the change in net working capital figures going forward.

Terminal Growth Rate

We predicted a terminal value halfway between predicted US GDP and predicated inflation which led us to our 2.47% figure. We extracted predicted inflation using statista.com (2018) and predicted US GDP using OECD data on knoema.com (2018). Due of the fact that the last of our patents expires in 2034, the last year of negative growth will be 2038. We expect that Celgene will keep a small percentage of each the market but have lost 85% of sales to generics as well as other competitors (as aforementioned in our earlier assumptions). If it was purely to stabilise, we would be utilising a terminal growth matching that of predicted inflation. However, given Celgene's past dominance we expect it may grow

that market share very marginally and hence we predict a terminal growth rate which is slightly greater than predicted inflation.

Valuation using APV

Our assumptions used for the risk-free rate, market premium, beta and tax are all outlined in the appendix. We employed APV (adjusted present value) to discount our cash flows and that assumptions made to allows APV's usage are also outlined in the appendix. Based on the same, we derived an Equity value for the current drug portfolio of **$72.635 bn** as illustrated in *table 1*.

EBIAT 2018	8,426
Terminal Growth Rate	2.47%
Cost of Equity	9.55%
PV of FCF	69,055
PV of TV	4,526
PV (All Equity)	**73,580**
Total Debt	**15,838**
Risk Free Rate	2.00%
Interest on Debt	317
Tax Rate	18.0%
Tax Shield	57
PV of Tax Shield	2,851
Plus Cash & CE	12,042
Less: Total Debt	15,838
EV of Current Drug Portfolio	**72,635**

Table 1 – Equity value (EV) of Current Drug Portfolio using APV

Product Pipeline

Our pipeline valuation provides estimated valuations for drugs at each of phases I, II and III of development.

Revenues for each of the above are forecasted into the future and discounted back to the present using a cost of equity of 9.55%. We then applied an estimated future EBIT margin of 71.81% (an average of the expected EBIT margin (excluding R&D) over the next five years) before introducing the previously outlined tax rate of 18% giving what we believe to be a fair estimate of the present value of future cash flows.

The following probabilities of reaching the market have been applied to the number of drugs at each respective stage of development:

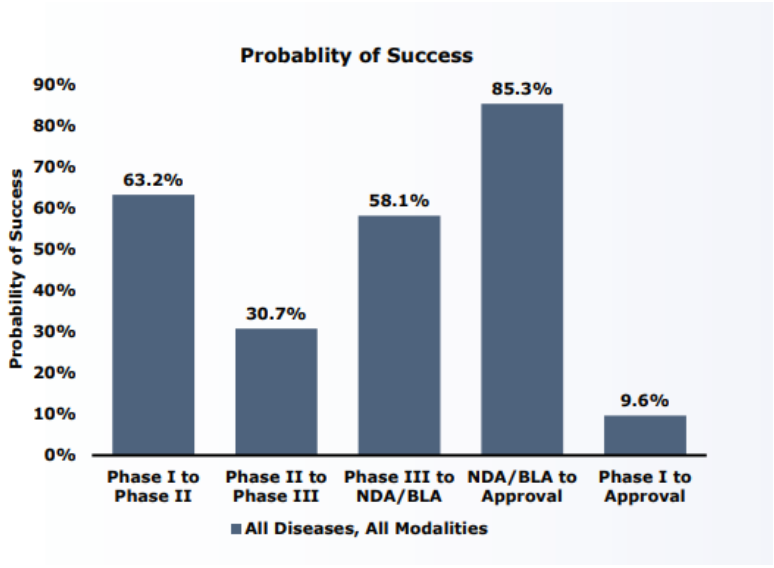

Figure 4 – Probability of Success per Phase – source: Biotechnology Innovation Organisation, 2015

1. Phases I, II & III Valuation

The average time spent between phase III, regulatory approval and reaching the market is 46.7 months (TUFTS, 2014) and the probability of progressing beyond the final stage of development is 49.6% (Biotechnology Innovation Organisation, 2015), both of which have been incorporated into our cash flow projections for each of the following drugs (see appendix). Celgene currently has 41 different drugs (some drugs cover more than one indication) in phases I, II and III of development. Due to the difficulty of breaking out potential cash flows for each drug due to the lack of availability of specific revenue information, we derived an average revenue per drug figure of $460m per annum based on the amount of drugs that were contained in the company's current portfolio in a given year.

Description	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Revlimid	321	774	1,325	1,706	2,469	3,208	3,767	4,280	4,980	5,801	6,974	8,187
Thalomid	433	447	505	437	390	339	302	245	221	185	152	132
Pomalyst								305	680	983	1,311	1,614
Abraxane					71	386	427	649	848	968	973	992
Vidaza			207	387	534	705	823	803	612	591	608	628
Azacitidine												
Otezla									70	472	1,017	1,279
Istodax					16	31	50	54	66	69	79	76

Total Drugs Per Year	1	1	2	2	4	4	4	5	6	6	6	6
Total Revenue Per Year	$ 433	$ 447	$ 711	$ 824	$ 1,011	$ 1,461	$ 1,602	$ 2,056	$ 2,496	$ 3,268	$ 4,140	$ 4,721
Average Rev Per Drug Per Year	$ 433	$ 447	$ 356	$ 412	$ 253	$ 365	$ 401	$ 411	$ 416	$ 545	$ 690	$ 787
Average Rev Per Drug '06 - '17	$ 460											
Above is exclusing Revlimid as it's an 'outlier'.												

Table 2- Average Revenue Per Drug Calculation Table

From there, we calculated terminal revenues using a growing perpetuity formula incorporating cost of equity @ 9.55% and a terminal growth rate of 2.47%. The resultant revenues were subsequently adjusted for the probability of the drugs reaching the market from each respective phase and discounted appropriately based on the average time taken before the drug would be available for sale. Finally, we applied operating costs and taxation to derive a final estimate of the present value of the products in phase I, II & III of development.

Phase III	$m	
Average Revenue per Drug	459.60	
Drugs in Phase III	6	
Total Average Revenue	2,757.59	
Predicted Terminal Revenues	38,088.23	
Predicted PV of Terminal Revenues	26,556.20	*
Probability of reaching market	49.56%	
Effective PV of Phase III Revenues	13,161.07	

*Discounted 46.7/12 years @ 1+WACC as average time spent in phase III is 30.7 months and FDA approval takes 16 months on average according to tufts.edu.

Table 3 – Forecast Revenues for phase 3 products

Phase II	$m	
Average Revenue per Drug	459.60	
Drugs in Phase II	10	
Total Average Revenue	4,595.98	
Predicted Terminal Revenues	63,480.38	
Predicted PV of Terminal Revenues	44,260.33	*
Probability of reaching market	15.20%	
Effective PV of Phase II Revenues	6,727.57	

*Discounted 77/12 years @ 1+WACC as average time spent in phase II is 30.3 plus 30.7 spent at phase III and a further 16 for FDA approval according to tufts.edu.

Table 4 – PV of potential Phase 2 Revenues

Phase I	$m	
Average Revenue per Drug	459.60	
Drugs in Phase I	25	
Total Average Revenue	11,489.95	
Predicted Terminal Revenues	158,700.96	
Predicted PV of Terminal Revenues	75,149.61	**
Probability of reaching market	9.60%	
Effective PV of Phase I Revenues	7,214.36	

**Discounted 96.8/12 years @ 1+WACC as average time spent in phase I is 16.8 months, phase II is 30.3 plus 30.7 spent at phase III and a further 16 for FDA approval according to tufts.edu.

Table 5 – PV of potential Phase 1 Revenues

Combining the effective present value of revenues from both drugs at the FDA stage and and those at each of phases I, II & III we derived an estimate for the PV of Celgene's product pipeline of **$16.885 bn**, as shown below:

		$m
Effective PV of Phase III Revenues		13,926
Effective PV of Phase II Revenues		7,119
Effective PV of Phase I Revenues		7,634
Estimated Effective PV of All Pipeline Revenues		**28,678**
Estimated Future EBIT Margin	71.80%	20,591
Tax @ 18%		(3,706)
Estimated PV of Product Pipeline		**16,885**

Table 6 – Estimated PV of product pipeline

2. R&D Department Value

Investment in R&D is essential to allow the company to develop new patents from which it can derive future cash flows beyond those in its currently portfolio and pipeline.

We determined how many drugs have been FDA-approved since 1998 and subsequently divided this figure by the total R&D expenditure between 1998-17, giving us a λ (lambda) of 0.00023286, as shown in the following table:

Drug	Year	R&D Expense ($m)
IDHIFA	2017	$ 5,915
	2016	$ 4,470
	2015	$ 3,697
Otezla - Active Psoriatic Arthritis	2014	$ 2,431
Pomalyst	2013	$ 2,226
	2012	$ 1,724
	2011	$ 1,600
	2010	$ 1,129
	2009	$ 795
	2008	$ 931
	2007	$ 399
	2006	$ 259
Abraxane	2005	$ 191
Focalin		
Revlimid		
Sum R&D		$ 25,766
Total Drugs		6
Lambda (Drugs/SumR&D) 0.00023286280170		

Table 7 – Lambda calculation

λ represents the amount of drugs approved per dollar invested in R&D. We then multiplied this figure by forecasted R&D expenditure for the next 10 years (forecasted R&D outlined in the Valuation of Current Portfolio of Drugs). Furthermore, we employed a Poisson probability density function to determine the likelihood of having 0-6 drugs FDA-approved in a given year based on R&D expenditure (probabilities for each year summed to 1 at P(6)) and were calculated by applying the formula in *figure 10.* We employed the Poisson PDF as the probability of an FDA approval is completely independent of past approvals and the Poisson PDF assumes the occurrence of one event does not affect the probability that a second event will occur, i.e. approval of more drugs.

$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

Figure 10

λ	0.00023286									
Poisson Probabilities	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Est R&D Expense	$ 6,086.54	$ 6,263.04	$ 6,444.67	$ 6,631.57	$ 6,823.88	$ 7,021.78	$ 7,225.41	$ 7,434.94	$ 7,650.56	$ 7,872.42
λ*R&D	1.42	1.46	1.50	1.54	1.59	1.64	1.68	1.73	1.78	1.83
P(0)	24.24%	23.26%	22.30%	21.35%	20.41%	19.49%	18.59%	17.71%	16.84%	15.99%
P(1)	34.35%	33.92%	33.46%	32.97%	32.44%	31.87%	31.28%	30.65%	30.00%	29.31%
P(2)	24.34%	24.74%	25.11%	25.45%	25.77%	26.06%	26.31%	26.54%	26.72%	26.87%
P(3)	11.50%	12.03%	12.56%	13.10%	13.65%	14.20%	14.76%	15.31%	15.87%	16.42%
P(4)	4.08%	4.38%	4.71%	5.06%	5.42%	5.81%	6.21%	6.63%	7.07%	7.52%
P(5)	1.16%	1.28%	1.41%	1.56%	1.72%	1.90%	2.09%	2.30%	2.52%	2.76%
P(6)	0.27%	0.31%	0.35%	0.40%	0.46%	0.52%	0.59%	0.66%	0.75%	0.84%

Table 8 – Poisson Probabilities

Next, we calculated the 'present' value at t0 of the following patents upon FDA approval for the following drugs in Celgene's current portfolio using both realised and projected figures (see appendix for breakdown. t0 is relative to each drug and the year of approval):

- Revlimid
- Otezla
- Pomalyst
- Abraxane
- Vidaza
- Thalomid

Summary		
	Patent Value at t0	
Revlimid	$	20,285
Otezla	$	5,091
Pomalyst	$	3,230
Abraxane	$	1,522
Vidaza	$	2,870
Thalomid	$	479
Median	$	3,050
Mean	$	5,579

Table 9 - Patent value at t0

From the above, we extracted the mean PV at T0 to which we multiplied λ*R&D figures for each of the year 2018-2027. We then subtracted R&D expenditure at each year and then applied tax at 18% before discounting the resultant cash flows using our calculated cost of equity, giving us an estimated PV of the R&D department of **$10.453 bn.**

Average PV of Patents at T0	$ 5,579.50									
λ - 0.00023862801700442	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
λ*R&D	1.42	1.46	1.50	1.54	1.59	1.64	1.68	1.73	1.78	1.83
Value of Patent	$ 7,908	$ 8,137	$ 8,373	$ 8,616	$ 8,866	$ 9,123	$ 9,388	$ 9,660	$ 9,940	$ 10,228
Less R&D Expense	$ (6,087)	$ (6,263)	$ (6,445)	$ (6,632)	$ (6,824)	$ (7,022)	$ (7,225)	$ (7,435)	$ (7,651)	$ (7,872)
	$ 1,821	$ 1,874	$ 1,929	$ 1,985	$ 2,042	$ 2,101	$ 2,162	$ 2,225	$ 2,289	$ 2,356
Tax @ 18%	$ (328)	$ (337)	$ (347)	$ (357)	$ (368)	$ (378)	$ (389)	$ (400)	$ (412)	$ (424)
Net Income	$ 1,494	$ 1,537	$ 1,581	$ 1,627	$ 1,675	$ 1,723	$ 1,773	$ 1,824	$ 1,877	$ 1,932
Discount Factor	1	2	3	4	5	6	7	8	9	10
PV @ 7.58%	$ 1,363	$ 1,281	$ 1,203	$ 1,130	$ 1,061	$ 997	$ 936	$ 880	$ 826	$ 776
Estimated PV of R&D Dept	$ 10,453									

Table 10 – Estimated PV of R&D Department

Total Valuation & Conclusion

Combining the EV based on Celgene's current drug portfolio, estimated present value of their drug pipeline and the value of their R&D department, we calculate the PV of Celgene to be **$99.973 billion**. This implies based on our calculations that Celgene is undervalued to the tune of **$33.573 billion** or **50.56%** and, as such, we recommend a **buy** on the stock.

We believe that the undervaluation and the market has this drug incorrectly priced for the following reasons;

1) To us, it would seem like the market is expecting flat sales of Revlimid because holding sales constant for Revlimid would bring us much closer to what the market is estimating the company to be worth. We however feel like that is an incorrect assumption and we clearly outlined above why we believe that this drug will continue to be a top performer for the company.
2) Excluding the pipeline, and R&D department would give us a hold, essentially begging the question, is the market only accounting for the current drug portfolio? You would expect this to be untrue, however given our strong BUY valuation we believe it is possible that the market but little or no value on the pipeline and R&D department and has only invested its time into researching the current drug portfolio of Celgene.
3) However, the most likely scenario in our opinion is that the market has marginally under estimated all three of our valuation sectors. There current portfolio is strong and has many patents not expiring for multiple years yet, leaving more time for growth. The company has a strong pipeline and is the industry leader in R&D expenses so we expect the future to be extremely bright for Celgene.

Other Analyst Recommendations

We sought other analysts' recommendations on the stock in order to give the reader a more complete overview of what the general consensus is on Celgene. It is extremely important to note that this had no bearing or influence on our valuation - it is supplementary for the reader. Information on Bloomberg shows that out of analysts covering Celgene, 43.8% recommend a hold, 53.1% state buy and 3.1% recommend a sell. This is illustrated in *figure 10*.

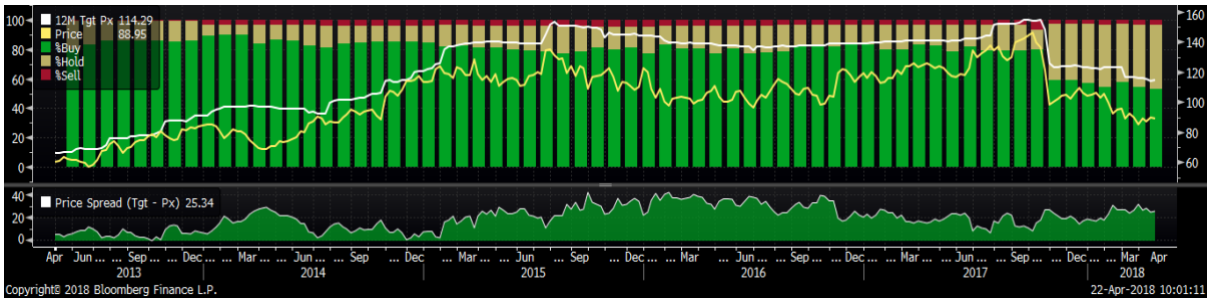

Figure 10 - Analyst Predictions - source:Bloomberg

Appendix – Key Assumptions

Adjusted Present Value (APV)

In valuing the biotech industry, we used the Adjusted Present Value (APV) rather than the weighted average cost of capital (WACC). The logic behind this was the fact the company did not have a constant debt to equity ratio which is indicative of the Biotech industry as a whole. We noticed that total debt had remained relatively constant in recent times, which is indicative of the Biotech industry. This is illustrated in *figure 11* sourced from Bloomberg which shows debt levels of Celgene. You can see that, over the last number of quarters, debt levels have been somewhat stable and foresee this stability continuing. For these two reasons, we believed using APV was a better method and hence assumed a constant amount of outstanding debt in the industry.

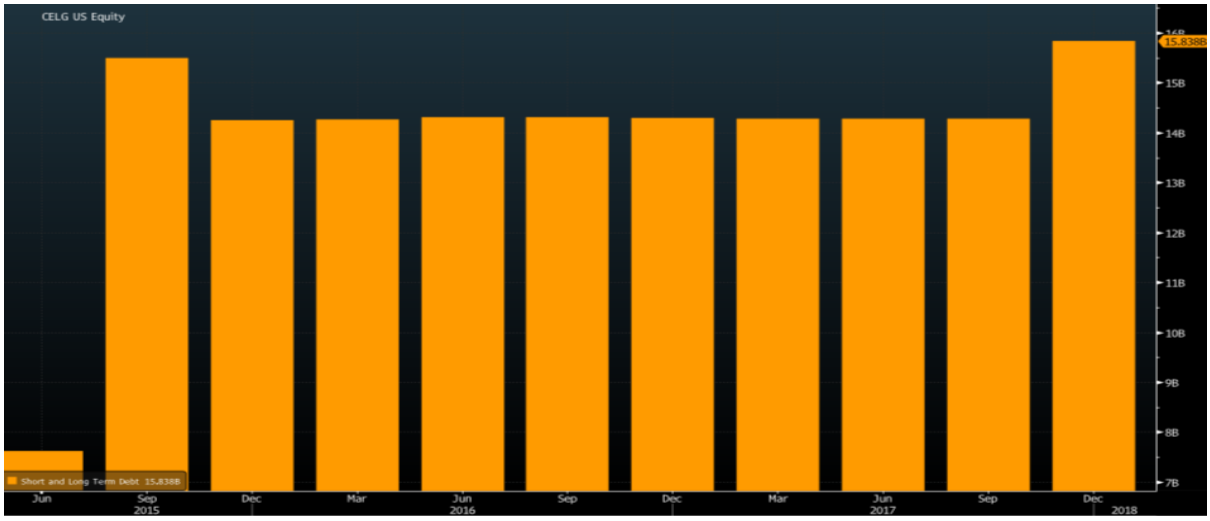

Figure 11 - Total Debt - source:Bloomberg

In using APV several formulae are needed. First is that of the Cost of Equity:

$$Cost\ of\ Equity = Rf + \beta(Rm - Rf)$$

From the above, we calculated a cost of equity of 9.55%. Using this cost of equity we acquired to the 'present value' (will be referred to as 'PV') of the free cash flows and PV of the terminal value as shown in the formula below;

$$\sum \frac{Free\ Cash\ Flows}{(1 + Cost\ of\ Equity)^t} + \frac{Terminal\ Value}{(1 + Cost\ of\ Equity)^n}$$

This gave us the PV (all equity) figure of $73580 million. The next step was to calculate the PV of the debt tax shield. This involved calculating the tax shield by:

$$Interest\ on\ debt\ \times\ Tax\ Rate)$$

We then derived the present by simply dividing the tax shield by the risk-free rate. This gave us a figure of $2851 million. That meant we had all the factors to calculate our APV which is calculated by:

$$APV = PV(All\ equity\ cash\ flows) + PV(Debt\ tax\ shield) + Net\ Debt$$

Risk-Free Rate (Rf)

Seeing as Celgene has its headquarters based in the United States we decided to use a 10-year US treasury to get our Rf. The current (as of 24/4/18) 10 year US treasury is just around 3%. Subtracting a historical risk premium (Risk of the US treasury defaulting) of 1% gave us a Rf of 2%.

Market Risk Premium

JP Morgan produced a report on 'The Quest for Market Risk Premium' (2008) in which they used nearly 100 years of data. They calculate an arithmetic historical risk premium of 6.9% which we will use for the purpose of this report (Zenner et al., 2008).

Beta

We calculated a 60-month rolling beta figure by regressing Celgene's total excess returns against the Fama French factor, Rm-Rf (excess returns), and the result is illustrated in *figure 12*. The Beta figure had been trending upwards until roughly 6 months ago. This made it slightly more difficult to forecast a figure. We decided the most accurate forecast would be to take an average across the graph, however we left out the data which was below the 10th Percentile line. We feel as no there is no chance that the beta will drop to values lower than 10th Percentile line. Taking an average of everything above that line, essentially averaging the rolling figure between, September 2013 – March 2018, gave us Beta of 1.3042. As a rule of APV we must unlever this beta and hence we use an unlevered beta of 1.0941 for the purpose of our cost of equity discount rate.

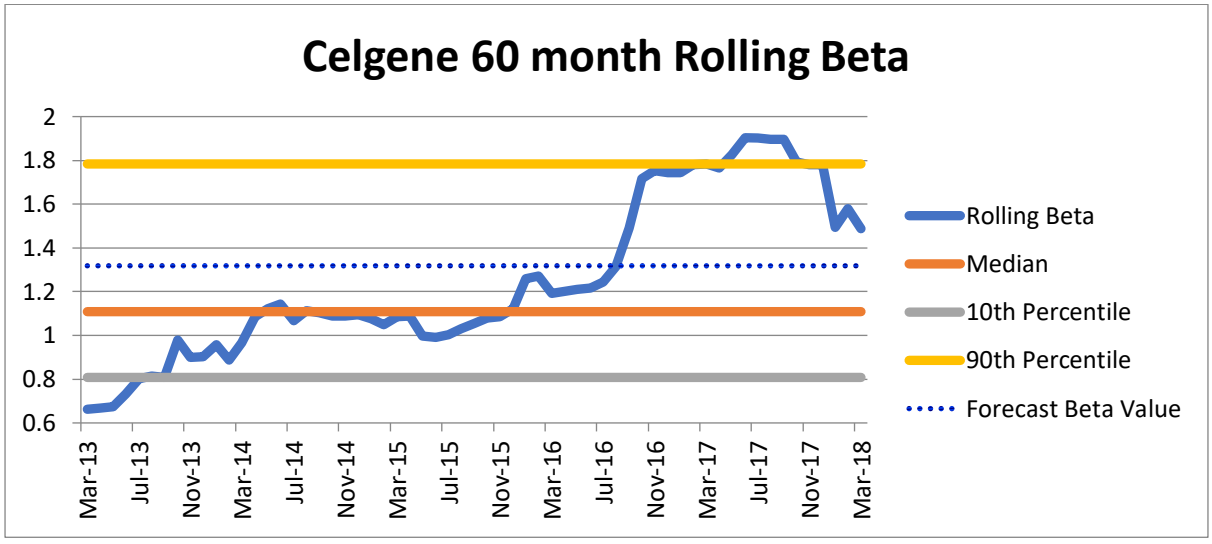

Figure 12 – 60 month Rolling Beta

Tax

The US congress along with support from president Donald Trump, have decided to dramatically decrease corporate tax rates in the United States from 35% to as low as 21% (taxsummaries.pwc.com, 2017). This new corporate tax figure came into action on the 31/12/2017 and so will have an impact on our forecasted figures. Celgene claimed that they

expect their effective tax to be stable between 18% for 2018 and the foreseeable future so we used this 18% figure for the purpose of our entire forecast period.

Appendix – Spreadsheets

Drug name (Patent Expiry year)	2015 Y	2016 Y	2017 Y	CAGR (15-17)
Total Sales Revenue (Millions of $)	**9256**	**11229**	**13003**	*18.53%*
% Change in Total Sales Revenue	-	*21.32%*	*15.80%*	
Total Product Sales Revenue	**9248**	**11225**	**12994**	*18.54%*
Revlimid (2027/2024)	5801	6974	8187	*18.80%*
US	3535	4417	5426	*23.89%*
International	2266	2557	2761	*10.38%*
Pomalyst/Imnovid (2025/2023)	984	1311	1614	*28.07%*
US	592	778	1008	*30.49%*
International	392	533	606	*24.33%*
Otezla (2024/2028)	472	1017	1279	*64.61%*
US	440	904	1058	*55.07%*
International	32	113	221	*162.80%*
Abraxane (2026/2022)	967	973	992	*1.28%*
US	653	634	607	*-3.59%*
International	314	339	385	*10.73%*
Other Products				
Other Products (2011/2019)	937	910	901	*-1.94%*
US	304	248	211	*-16.69%*
International	633	662	690	*4.41%*
Other Revenues				
Royalty Revenue	8	4	9	*3.51%*

Table 13 – Predict Revenues; Current Drug Portfolio

Drug name (Patent Expiry year)	2018 E	2019 E	2020 E	2021 E	2022 E	2023 E	2024 E	2025 E
Total Sales Revenue (Millions of $)	**14309**	**15561**	**16805**	**17859**	**18606**	**19175**	**18458**	**16212**
% Change in Total Sales Revenue	*10.04%*	*8.75%*	*7.99%*	*6.28%*	*4.18%*	*3.06%*	*-3.74%*	*-12.17%*
Total Product Sales Revenue	**14301**	**15554**	**16797**	**17852**	**18599**	**19168**	**18451**	**16204**
Revlimid (2027/2024)	9080	9973	10866	11759	12652	13545	13406	12056
US	6018	6610	7202	7793	8385	8977	9569	10161
International	3062	3363	3665	3966	4267	4568	3837	1895
Pomalyst/Imnovid (2025/2023)	1815	2042	2296	2582	2582	2427	2142	1699
US	1134	1275	1434	1613	1613	1613	1613	1355
International	682	767	862	970	970	814	529	344
Otezla (2024/2028)	1470	1705	2000	2000	2000	2000	1776	1365
US	1162	1275	1400	1400	1400	1400	1176	765
International	308	430	600	600	600	600	600	600
Abraxane (2026/2022)	1005	1018	1031	1044	987	877	808	766
US	615	623	631	639	647	655	664	672
International	390	395	400	405	340	221	144	94
Other Products								
Other Products (2011/2019)	931	816	604	467	377	319	319	319
US	211	211	211	211	211	211	211	211
International	720	605	393	256	166	108	108	108
Other Revenues								
Royalty Revenue	7	7	7	7	7	7	7	7

Table 14 – Predict Revenues; Current Drug Portfolio

Drug name (Patent Expiry year)	2026 E	2027 E	2028 E	2029 E	2030 E	2031 E	2032 E
Total Sales Revenue (Millions of $)	**14842**	**11890**	**6547**	**3899**	**2615**	**1990**	**1941**
% Change in Total Sales Revenue	*-8.45%*	*-19.89%*	*-44.94%*	*-40.44%*	*-32.93%*	*-23.91%*	*-2.44%*
Total Product Sales Revenue	**14835**	**11883**	**6540**	**3892**	**2608**	**1983**	**1934**
Revlimid (2027/2024)	11689	9495	4690	2432	1317	766	766
US	10753	9032	4461	2204	1088	538	538
International	936	462	228	228	228	228	228
Pomalyst/Imnovid (2025/2023)	1104	718	518	387	387	387	387
US	881	573	372	242	242	242	242
International	224	145	145	145	145	145	145
Otezla (2024/2028)	1097	923	714	538	423	348	300
US	497	323	210	210	210	210	210
International	600	600	504	328	213	138	90
Abraxane (2026/2022)	625	428	299	216	162	162	162
US	565	367	239	155	101	101	101
International	61	61	61	61	61	61	61
Other Products							
Other Products (2011/2019)	319	319	319	319	319	319	319
US	211	211	211	211	211	211	211
International	108	108	108	108	108	108	108
Other Revenues							
Royalty Revenue	7	7	7	7	7	7	7

Table 15 – Predict Revenues; Current Drug Portfolio

	2013 Y	2014 Y	2015 Y	2016 Y	2017 Y
Sales	6494	7670	9256	11229	13003
% growth		18.12%	20.67%	21.32%	15.80%
COGS	340	386	420	438	461
Gross Profit	6153.5	7284.5	8835.9	10791	12542
% margin	94.76%	94.97%	95.46%	96.10%	96.45%
SG&A	1,685	2,003	2,305	2,459	2,626
Other Expenses	118	191	28	459	- 1,479
EBITDA	**4,351**	**5,091**	**6,502**	**7,873**	**11,395**
% margin	67.00%	66.37%	70.25%	70.11%	87.63%
Depreciation & Amorti	374	369	402	505	471
EBIT	**3,977**	**4,721**	**6,100**	**7,368**	**10,924**
% margin	61.24%	61.55%	65.91%	65.62%	84.01%
Taxes	216	328	422	373	1,374
EBIAT	**3,761**	**4,394**	**5,679**	**6,995**	**9,550**
Plus: Depreciation & Ai	374	369	402	505	471
Less: CAPEX	139	150	286	236	279
Less: Change in Net Wc	1,762	1,995	- 168	477	3,996
Unlevered Free Cash F	**3,996**	**4,613**	**5,794**	**7,264**	**9,742**
Cost of Equity					
Discount Period					
Discount Factor					
Present Value of Free Cash Flow					

Table 16 - DCF; Current Drug Portfolio

	2018 E	2019 E	2020 E	2021 E	2022 E	2023 E	2024 E	2025 E
Sales	14309	15561	16805	17859	18606	19175	18458	16212
% growth	10.04%	8.75%	7.99%	6.28%	4.18%	3.06%	-3.74%	-12.17%
COGS	507	552	596	633	660	680	654	575
Gross Profit	**13,801**	**15,009**	**16,209**	**17,226**	**17,947**	**18,495**	**17,804**	**15,637**
% margin	96.45%	96.45%	96.45%	96.45%	96.45%	96.45%	96.45%	96.45%
SG&A	2,890	3,143	3,394	3,607	3,758	3,872	3,728	3,274
Other Expenses	-	-	-	-	-	-	-	-
EBITDA	**10,912**	**11,867**	**12,815**	**13,619**	**14,189**	**14,623**	**14,076**	**12,363**
% margin	76.26%	76.26%	76.26%	76.26%	76.26%	76.26%	76.26%	76.26%
Depreciation & Amorti	636	692	747	794	827	853	821	721
EBIT	**10,275**	**11,175**	**12,068**	**12,825**	**13,362**	**13,770**	**13,255**	**11,642**
% margin	71.81%	71.81%	71.81%	71.81%	71.81%	71.81%	71.81%	71.81%
Taxes	1,850	2,011	2,172	2,309	2,405	2,479	2,386	2,096
EBIAT	**8,426**	**9,163**	**9,896**	**10,517**	**10,957**	**11,292**	**10,869**	**9,546**
Plus: Depreciation & Ar	636	692	747	794	827	853	821	721
Less: CAPEX	306	333	360	383	399	411	395	347
Less: Change in Net Wc	- 41	1,038	1,031	875	619	472	- 595	- 1,863
Unlevered Free Cash F	**8,797**	**8,484**	**9,252**	**10,054**	**10,766**	**11,262**	**11,889**	**11,783**
Cost of Equity	9.55%	9.55%	9.55%	9.55%	9.55%	9.55%	9.55%	9.55%
Discount Period	**1.00**	**2.00**	**3.00**	**4.00**	**5.00**	**6.00**	**7.00**	**8.00**
Discount Factor	0.912830	0.833258	0.760623	0.694320	0.633796	0.578548	0.528116	0.482080
Present Value of Free	**8,030**	**7,069**	**7,037**	**6,981**	**6,824**	**6,515**	**6,279**	**5,680**

Table 17 - DCF; Current Drug Portfolio

	2026 E	2027 E	2028 E	2029 E	2030 E	2031 E	2032 E
Sales	14842	11890	6547	3899	2615	1990	1941
% growth	-8.45%	-19.89%	-44.94%	-40.44%	-32.93%	-23.91%	-2.44%
COGS	526	422	232	138	93	71	69
Gross Profit	**14,316**	**11,468**	**6,315**	**3,761**	**2,522**	**1,919**	**1,872**
% margin	96.45%	96.45%	96.45%	96.45%	96.45%	96.45%	96.45%
SG&A	2,997	2,401	1,322	787	528	402	392
Other Expenses	-	-	-	-	-	-	-
EBITDA	**11,318**	**9,067**	**4,993**	**2,974**	**1,994**	**1,517**	**1,480**
% margin	76.26%	76.26%	76.26%	76.26%	76.26%	76.26%	76.26%
Depreciation & Amorti	660	529	291	173	116	88	86
EBIT	**10,658**	**8,538**	**4,702**	**2,800**	**1,878**	**1,429**	**1,394**
% margin	71.81%	71.81%	71.81%	71.81%	71.81%	71.81%	71.81%
Taxes	1,919	1,537	846	504	338	257	251
EBIAT	**8,740**	**7,002**	**3,855**	**2,296**	**1,540**	**1,172**	**1,143**
Plus: Depreciation & Ar	660	529	291	173	116	88	86
Less: CAPEX	318	255	140	84	56	43	42
Less: Change in Net Wc	- 1,136	- 2,448	- 4,430	- 2,195	- 1,065	- 519	- 40
Unlevered Free Cash F	**10,218**	**9,723**	**8,436**	**4,581**	**2,665**	**1,736**	**1,228**
Cost of Equity	9.55%	9.55%	9.55%	9.55%	9.55%	9.55%	9.55%
Discount Period	**9.00**	**10.00**	**11.00**	**12.00**	**13.00**	**14.00**	**15.00**
Discount Factor	0.440057	0.401697	0.366681	0.334717	0.305540	0.278906	0.254594
Present Value of Free	**4,496**	**3,906**	**3,093**	**1,533**	**814**	**484**	**313**

Table 18 - DCF; Current Drug Portfolio

	1998 A	1999 A	2000 A	2001 A	2002 A	2003 A	2004 A	2005 A	2006 A	2007 A	2008 A	2009 A	2010 A
Disc Factor									1	2	3	4	5
Revlimid									321	774	1,325	1,706	2,469
Adjusted Pretax Income									73	176	301	388	561
PV									67	147	229	269	356
Disc Factor													
Otezla													
Adjusted Pretax Income													
PV													
Disc Factor													
Pomalyst													
Adjusted Pretax Income													
PV													
Disc Factor													1
Abraxane													71
Adjusted Pretax Income													16
PV													15
Disc Factor											1	2	3
Vidaza											207	387	534
Adjusted Pretax Income											47	88	122
PV											43	73	92
Disc Factor	1	2	3	4	5	6	7	8	9	10	11	12	13
Thalomid	3	24	62	82	119	224	309	388	433	447	505	437	390
Adjusted Pretax Income	1	5	14	19	27	51	70	88	98	102	115	99	89
PV	1	5	11	13	17	29	37	43	43	41	42	33	27

Table 19 - PV of Patents for Product Pipeline (i)

	2011 A	2012 A	2013 A	2014 A	2015 A	2016 A	2017 A	2018 A	2019 A	2020 A	2021 A
Disc Factor	6	7	8	9	10	11	12	13	14	15	16
Revlimid	3,208	3,767	4,280	4,980	5,801	6,974	8,187	9,080	10,071	11,169	12,388
Adjusted Pretax Income	730	857	973	1,132	1,319	1,586	1,862	2,065	2,290	2,540	2,817
PV	422	452	469	498	530	581	623	631	639	647	655
Disc Factor				1	2	3	4	5	6	7	8
Otezla				472	1,017	1,279	1,744	2,386	3,279	3,279	3,279
Adjusted Pretax Income				107	231	291	396	543	746	746	746
PV				98	193	221	275	344	431	394	359
Disc Factor			1	2	3	4	5	6	7	8	9
Pomalyst			305	680	983	1,311	1,614	1,815	2,042	2,296	2,582
Adjusted Pretax Income			69	155	224	298	367	413	464	522	587
PV			63	129	170	207	233	239	245	252	258
Disc Factor	2	3	4	5	6	7	8	9	10	11	12
Abraxane	386	427	649	848	968	973	992	1,013	1,037	1,059	1,082
Adjusted Pretax Income	88	97	148	193	220	221	226	230	236	241	246
PV	73	74	102	122	127	117	109	101	95	88	82
Disc Factor	4	5	6	7	8	9	10	11	TV	PV Total	
Vidaza	705	823	803	612	591	608	628	628			
Adjusted Pretax Income	160	187	183	139	134	138	143	143			
PV	111	119	106	73	65	61	57	52	2,017	2,870	
Disc Factor	14	15	16	17	18	19	20	21	22	23	24
Thalomid	339	302	245	221	185	152	132	129	127	124	122
Adjusted Pretax Income	77	69	56	50	42	35	30	29	29	28	28
PV	22	17	13	11	8	6	5	4	4	3	3

Table 20 - PV of Patents for Product Pipeline (ii)

	2022 A	2023 A	2024 A	2025 A	2026 A	2027 A	2028 A	2029 A	2030 A	2031 A		
Disc Factor	17	18	19	20	21	22	23	24	25	26	TV	PV Total
Revlimid	13,739	15,238	15,518	15,229	15,602	12,759	8,294	5,662	3,950	2,838		
Adjusted Pretax Income	3,124	3,465	3,529	3,463	3,548	2,901	1,886	1,287	898	645		
PV	663	671	624	559	523	390	231	144	92	60	9,114	20,285
Disc Factor	9	10	11	12	13	14	15	16	17	18	TV	PV Total
Otezla	3,279	2,886	2,163	1,694	1,388	1,058	817	660	558	492		
Adjusted Pretax Income	746	656	492	385	316	241	186	150	127	112		
PV	328	264	180	129	96	67	47	35	27	22	1,580	5,091
Disc Factor	10	11	12	13	14	15	16	17	18	TV	PV Total	
Pomalyst	2,582	2,427	2,142	1,699	1,104	718	518	387	171			
Adjusted Pretax Income	587	552	487	386	251	163	118	88	39			
PV	236	202	163	118	70	42	27	19	8	550	3,230	
Disc Factor	13	14	15	16	17	18	19	20	TV	PV Total		
Abraxane	1,029	922	858	822	672	459	320	230				
Adjusted Pretax Income	234	210	195	187	153	104	73	52				
PV	72	58	50	43	32	20	13	8	119	1,522		
Disc Factor												
Vidaza												
Adjusted Pretax Income												
PV												
Disc Factor	25	26	TV	PV Total								
Thalomid	120	117										
Adjusted Pretax Income	27	27										
PV	3	2	35	479								

Table 21 - PV of Patents for Product Pipeline (iii)

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