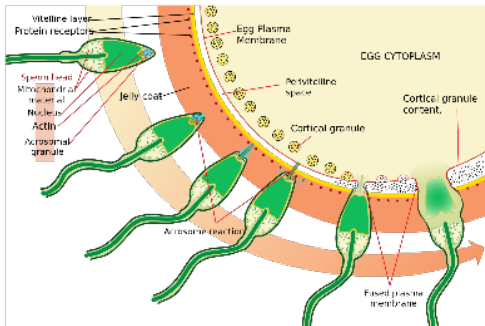
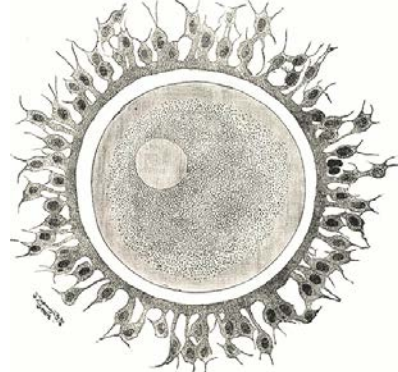


# 生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	卵細胞的表層阻止多餘的精子 (Egg cell coating blocks extra sperm)
生物系統 LIVING SYSTEM	哺乳類動物 (Mammals)
功能類別 FUNCTIONS	#催化化學性分解 #化學性分解聚合物 #改變材料特性 #調節生殖或生長 #Catalyze chemical breakdown #Chemically break down polymers #Modify material characteristics #Regulate reproduction or growth
作用機制標題	包圍卵細胞的外層迅速變硬以阻止多餘的精子 (Coat surrounding egg cell of mammals rapidly hardens to block extra sperm)
生物系統/作用機制 示意圖	 
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)	
<p>在哺乳類動物中，卵子（卵細胞）與精子的受精作用通常發生在雌性的輸卵管內（連接卵巢和子宮的管道）。卵子和精子各含一半產生有效胚胎所需的 DNA。當精子和卵子結合後，其細胞即含有成對的染色體。多精入卵 (polyspermy) 是指一個卵子與一個以上的多精子結合。當此情況發生時，細胞裡會有多餘的染色體，受精卵通常無法存活。為了避免此情況，哺乳類動物的卵細胞在受精後，表面會快速發生變化，稱為皮質反應 (cortical reaction)。皮質反應可以防止其他精子融合。哺乳類動物的卵子覆蓋著一層厚厚的表層，精子必須鑽入表層才能到達細胞膜。卵細胞厚厚的表層和其他大尺度的解剖構造，會減緩精子的速度，意味著只有最強健的精子才能到達卵子，並且數量相對比較少。第一個到達卵細胞的精子與其融合，並且釋放其 DNA 和信號傳導因子。一種稱為 PLC<math>\zeta</math> 的酵素，被認為是觸發皮質反應的重要因素之一。PLC<math>\zeta</math> 觸發了卵細胞所儲存的鈣離子釋放，鈣從細胞內跑到膜上，並在膜上觸發皮質囊泡的釋放。皮質囊泡是膜結合的囊袋，裡面含有反應性化學物質和酶的混合物，一但釋放到膜與表層之間的空間，就會同時剪切卵細胞表層的精子受體尖端，防止更多的精子與卵結合，並與卵的表層結合增厚，變得像混凝土一樣，使隨後到達的精子無法進入。</p> <p>In mammals, fertilization of the ovum (egg cell) by sperm usually occurs within the fallopian tube (the duct connecting the ovary to the uterus) of the female. The ovum and the</p>	

sperm each contain half the DNA required to produce a viable embryo. When a sperm and ovum fuse, the resulting cell contains two copies of each chromosome. Polyspermy is the fusion of more than one sperm with a single ovum. When this happens, there are extra copies of all the chromosomes in the cell and the fertilized egg is usually not viable. In order to prevent this, mammalian egg cells undergo a rapid surface change called a cortical reaction following fertilization. The cortical reaction prevents other sperm from fusing. Mammalian ova are covered in a thick coating that sperm must burrow through to reach the cell membrane. This, together with other large-scale anatomical features, slow sperm down, meaning only the strongest reach the egg, and in relatively small numbers. The first sperm to reach the membrane of the egg cell fuses with it, releasing its DNA payload along with signaling factors. One factor, an enzyme called PLC $\zeta$ , is thought to be important for triggering the cortical reaction. PLC $\zeta$  triggers the release of calcium ions from stores within the egg cell. The calcium washes through the cell to the membrane, where it triggers the release of cortical vesicles. Cortical vesicles are membrane-bound sacs containing a cocktail of reactive chemicals and enzymes. Once released into the space between the membrane and the coating, they simultaneously clip the tips of sperm receptors on the cell surface, preventing more sperm from binding, and crosslink the thick coating of the egg, setting it like concrete and making it impossible for late arrivals to burrow through.

#### 文獻引用 (REFERENCES)

「皮質反應是一個過程，而此過程是從卵母細胞釋放出皮層顆粒 (cortical granules)，從而防止多精入卵。快速的阻斷多精入卵，能立即避免額外的精子附著於卵母細胞上。另一方面，皮質反應建立了永久的屏障阻止精子的進入，成為許多動物中在多精入卵緩慢阻斷過程中的主要部分。皮質反應是因為鈣離子流 ( $\text{Ca}^{++}$ ) 在卵的表面傳播開來。」 (Georgadaki et al. 2016: 982)

「在這個過程中，位於卵母細胞質膜下方區域的分泌性囊泡與卵母細胞質膜融合。這導致了皮質顆粒內容物的釋放，改變了細胞外基質，使其他精子無法進入。皮質顆粒含有水解酵素，例如剪切卵黃周隙蛋白 (perivitelline protein) 的蛋白酶，會硬化卵黃包膜 (vitelline envelope) 的過氧化物酶，和將水吸引到卵白蛋白空間中的糖胺聚多醣 (glycosaminoglycans)，使其膨脹並形成透明層 (hyaline layer)。」 (Georgadaki et al. 2016: 981)

「在哺乳動物中，皮質反應會改變透明帶，進而阻止多精入卵。皮層顆粒釋放出若干種酵素，把精子受體糖蛋白 ZP2 和 ZP3 分解，因此它們不再能與精子結合。」 (Georgadaki et al. 2016: 983)

“The cortical reaction is a process through which cortical granules from the oocyte are released preventing polyspermy. The fast block of polyspermy immediately prevents additional sperm getting attached to the oocyte. On the other hand, the cortical reaction establishes a

permanent barrier to sperm entry and functions as the main part of the slow block of polyspermy in many animals. The cortical reaction is propagated over the surface of the egg by a wave of  $\text{Ca}^{++}$ .” (Georgadaki et al. 2016: 982)

“In this process, secretory vesicles located in the region below the plasma membrane of the oocyte, are fused with the oocyte plasma membrane. This results in the release of contents of the cortical granules, modifying the extracellular matrix so as to be impenetrable to other sperm. The cortical granules contain hydrolytic enzymes, such as proteases that clip perivitelline proteins, peroxidases that harden the vitelline envelope and glycosaminoglycans that attract water into the perivitelline space, causing it to expand and form the hyaline layer.” (Georgadaki et al. 2016: 981)

“In mammals, the cortical reaction modifies the zona pellucida, leading to the block of polyspermy. Several enzymes are released by the cortical granules, leading to the digestion of the sperm receptor glycoproteins ZP2 and ZP3, so that they can no longer bind spermatozoon” (Georgadaki et al. 2016: 983)

#### 參考文獻清單與連結 (REFERENCE LIST)

Bleil, J. D. And P. M. Wassarman. (1980). Mammalian sperm-egg interaction: identification of a glycoprotein in mouse egg zonae pellucidae possessing receptor activity for sperm. *Cell* 20: 873-882. (<https://www.spandidos-publications.com/10.3892/ijmm.2016.2723>)

#### 延伸閱讀: Harvard 或 APA 格式

#### 生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

<https://en.wikipedia.org/wiki/Mammalia>  
<https://www.onezoom.org/life/@mammalia>  
<https://eol.org/pages/1642>

#### 撰寫/翻譯/編修者與日期

吳蕙君翻譯 (2020/04/04)；許秋容編修 (2020/06/03)；譚國鏐編修 (2020/06/05)

#### AskNature 原文連結

<https://asknature.org/strategy/egg-cell-coating-blocks-extra-sperm/>